**THE UNIVERSITY OF HULL**

# Prediction of initial involvement of first grade Greek school children in an out-of-school, organized, community physical activity programme: an application of the theory of planned behaviour

being a Thesis submitted for the Degree of

Doctor of Philosophy

in the University of Hull

by

Mihalis Atsalakis, BSc (Thraki / Greece), MSc (Sheffield)

October, 1994

# Acknowledgements

This work was carried out under the supervision of Mr. M. Sleap, director of the Research Centre for Physical Education, Exercise and Health of the University of Hull. I gratefully acknowledge his precious advice, feedback and directions throughout my studies.

Prof. Dr. I. Pirgiotakis, deputy rector of the University of Crete, helped to adapt questionnaires in clear and understandable everyday Greek language. Also, his help was decisive in obtaining the licence to conduct research in Greek schools. Without him it would be difficult to complete the field research.

Dr. N. Rethymniotakis, pathologist-special nephrologist, was a continuous source of ethical support during my studies. In particular, I thank him for checking medicine related chapters of this thesis.

Heraklion Tennis Club / Crete, provided all the necessary facilities and equipment to run the scheduled physical activity programmes. I thank the president and the council for their interest during the programme.

Multi-RaK computer company / Bochum, Germany, kept my computer operating smoothly during analysis of the results and writing up of the thesis.

The staff of the Brynmor Jones library of the University of Hull and the British Library at Boston Spa provided invaluable directions for exploring and locating necessary bibliography.

I thank the parents who were subjects of this study, for their commitment to complete and return the requested questionnaires. It was especially interesting and pleasant to instruct their children during the physical activity programme.

Finally, I acknowledge my wife Sofia, my parents and my parents-in-law for providing a creative environment as well as ethical and financial support throughout my studies. Without their help, completion of the work would not be feasible. This thesis is gratefully dedicated to them.

October, 1994

# Contents

## Appendices

# List of Tables

# List of Figures

**Chapter 5**



**Chapter 6**



**Chapter 9**



**Chapter 10**

# List of Abbreviations

The list of abbreviations is arranged in alphabetic order.

| | |
|---|---|
| ° | temperature degrees |
| % | per cent |
| ANOVA | Analysis of Variance |
| apo B | apoprotein B |
| apo C-II | apoprotein C-II |
| apo C-III | apoprotein C-III |
| beta | standardized regression coefficient |
| CAHD | Coronary Atherosclerotic Heart Disease |
| cc | cubic centimetre |
| CETP | Cholesterol Ester Transfer Protein |
| F | regression analysis F statistic |
| HDL-C | High Density Lipoprotein-Cholesterol |
| HDL2-C | subfraction of HDL-C |
| HDL3-C | subfraction of HDL-C |
| Hg | mercury |
| HL | Hepatic Triglyceride Lipase |
| IDL-C | Intermediate Density Lipoprotein-Cholesterol |
| Kcal | Kilocalorie |
| kg | kilogram |
| l | litre |
| LCAT | Lecithin: Cholesterol Acyl Transferase |
| LDL-C | Low Density Lipoprotein-Cholesterol |
| LPL | Lipoprotein Lipase |
| m | metre |
| MANOVA | Multivariate Analysis of Variance |
| min | minute |
| ml | millilitre |
| mm | millimetre |
| mmol | millimole |
| n | sample size |
| p | probability level in statistical tests of hypotheses |
| p. | page number |
| R | regression coefficient |

| | |
|---|---|
| r | Pearson correlation coefficient |
| RMR | Resting Metabolic Rate |
| T | regression analysis T statistic |
| VLDL-C | Very Low Density Lipoprotein-Cholesterol |

# Chapter 1

# Introduction

## The General Problem

In an effort to gain a better understanding of the relationship between lifestyle and health, Blair (1988) distinguished four periods in the human evolutionary process. The pre-agricultural period extended from the beginning of human existence until about 10,000 years ago. Humans were then hunters and gatherers and lived in small nomadic groups. Physical activity levels were high and the diet low in fat and rich in complex carbohydrates. The main causes of death were starvation, accidents and natural disasters. In the agricultural period (10,000 years ago until 200 years ago) "people were able to drop nomadic habits and settle in groups to grow food and raise animals" (Blair, 1988, p. 76), while the first cities made their appearance (Malina, 1988). Physical activity levels remained high and the diets simple. The period of industrial revolution (200 years ago until about 1945) was characterized by intense immigration of people into the cities to work in factories. Populations were subject to inadequate medical care, unhealthy diets and pollution from accumulated waste. Blair (1988) identified malnutrition and infectious diseases as the main causes of morbidity and mortality. For industrialized countries, the final evolutionary period, which Blair (1988) labelled as nuclear / technological and Malina (1988) as biomedical / technological, marked the rapid development of labour saving devices, computers and significant medical advances. As a result, populations in the industrialized world have now substantially better health and increased life expectancy compared with previous generations, attributed mainly to reductions in infant and child mortality and medical control of infectious diseases (Statistisches Bundesamt[1], 1993; Smith and Jacobson, 1988). However, premature death and physical suffering are still present although in smaller proportions. They are now mainly caused by degenerative diseases which have been linked with environmental conditions and individual lifestyles. Some examples are diseases of the cardiovascular system, cancer, diabetes, obesity, osteoporosis, alcoholism and road accidents (Smith and Jacobson, 1988). For several reasons, diseases of the cardiovascular system and obesity are of particular importance today.

Diseases of the cardiovascular system account for about 50 per cent of the total number of deaths in the countries of the European Community (Statistisches

[1] Statistisches Bundesamt is the central statistical office of the Federal Republic of Germany.

Bundesamt, 1993) and the USA (Nieman, 1986). Atherosclerosis of the coronary arteries is the underlying etiology for more than half the deaths attributed to the diseases of the cardiovascular system. Thus, coronary atherosclerotic heart disease accounts for about one third of the total number of deaths, being the single leading cause of premature mortality in the industrialized countries. The cost of coronary atherosclerotic heart disease to the community is enormous. For example, it was estimated that in 1979, it was responsible for the loss of 26 million working days in Britain while in 1985 / 86 it cost the national health service nearly 390 million British pounds (Smith and Jacobson, 1988). The atherosclerotic process probably begins during childhood and is closely associated with the presence of adult risk factors for atherosclerosis such as elevated cholesterol levels and hypertension, which appear to track into adulthood (Gidding, 1993). Importantly, the development of atherosclerosis seems to be determined mainly by individual lifestyles compared to other major health hazards. For instance, environmental factors and heredity are estimated to contribute substantially to the development of cancer (53 per cent of the variation) while heredity alone is a very important determinant of diabetes (60 per cent of the variation). In contrast, 54 per cent of the variation is attributed to lifestyle factors for coronary atherosclerotic heart disease and only 33 per cent to environment and heredity. The remaining 12 per cent is attributed to the quality of the health care services (Haskell, 1988).

Obesity is highly prevalent in industrialized countries. In Britain, 40 per cent of men and 32 per cent of women were considered to be overweight[1] in 1981 (Smith and Jacobson, 1988) while the recent Allied Dunbar National fitness survey, which used the same definition of overweight (Health Education Authority / Sports Council, 1992), revealed that the problem was on the rise, with 48 per cent of the men and 40 per cent of the women falling in the overweight category. In adults, obesity is linked with coronary atherosclerotic heart disease, hypertension, diabetes, certain forms of cancer and premature mortality (Nieman, 1986). In children, obesity clusters with adult risk factors for atherosclerosis, in particular unfavourable blood lipoprotein profiles and elevated blood pressure (Rowland, 1990). However, of major concern for children may be the psychosocial consequence of obesity which "powerfully affects the self-image and social standing of the overweight child during critical phases of emotional development" (Rowland, 1990, p. 135).

Obesity is also highly prevalent in children. In Britain, 6 per cent of boys and 10 per cent of girls are overweight by the age of 11 years and this figure approaches 12 per cent at 20 years (Smith and Jacobson, 1988). Similarly, Lohman (1992) re-

---

[1] Individuals were defined as overweight if they weighed 20 per cent more than their ideal body weight for height and age.

evaluated skin fold thickness data from national surveys done in the USA and concluded that about 10 per cent of male and 40 per cent of female adolescents had more than 25 per cent and 32 per cent of body fat respectively. Greek children probably are the most overweight in the world. Kafatos and associates (1981) presented comparative data from 11 countries based on the distribution of body mass index of 13 year old children. In Greece, 24 per cent of the boys and 32 per cent of the girls had body mass index over 23 kg / $m^2$, the selected cut off point to characterize obesity in this research. These proportions were almost twice as high as the respective data from the USA and six times higher than German and Dutch figures. Obesity is partially determined by genetic factors but recent evidence suggests that their contribution is relatively small, accounting for about 5 to 25 per cent of the variance (Lohman, 1992; Bouchard, 1990). It is suggested that lifestyle factors account for the largest proportion of variation (45 to 65 per cent).

It follows that from a public health point of view, coronary atherosclerotic heart disease and obesity share crucial common features. They are highly prevalent, they constitute major health hazards with severe consequences for people's well being and finally, they are largely determined by individual lifestyles that makes them an attractive target for interventions. "Lifestyle comprises the aggregate of an individual's behaviors, actions, and habits which can affect personal health" (Bouchard et al., 1990, p. 7) and includes tobacco use, dietary habits, alcohol consumption, sexual behaviour, road safety and physical activity (Smith and Jacobson, 1988).

Physical activity is an aspect of lifestyle which in the past has received minimal attention in maintaining health. Conditions of contemporary society mean that people are less active today and this change has been linked with a parallel increase in the prevalence of coronary atherosclerotic heart disease and obesity (Kafatos and Mamalakis, 1993). Biddle and Mutrie (1991) concluded that people have now adopted lifestyles which were unknown until recently in terms of human evolution and Blair (1988, p. 76) added that "we are not evolutionary prepared for a sedentary existence with excess food supplies cheaply and readily available". Recent evidence (Health Education Authority / Sports Council, 1992) shows that in Britain, 7 out of 10 men and 8 out of 10 women are not engaging in adequate levels of physical activity to maintain health. Similar conclusions come from other countries and especially from Greece where levels of inactivity are very high (Kafatos et al., 1991). Now, research evidence which is considered sound (Smith and Jacobson, 1988) has been gathered to illustrate the benefit to health of an active lifestyle (Bray et al., 1992; Berlin and Golditz, 1990, Bouchard et al., 1990). As a result, position statements from various organizations have appeared in the literature proposing that there is a need to increase population physical activity levels; for instance, from the World Health Organization

(Bijnen et al., 1994), the American Heart Association (Fletcher et al., 1992) and the Royal College of Physicians of London (1991). The British government has demonstrated its determination to increase physical activity levels across all age groups (Smith and Jacobson, 1988). Not surprisingly, major health outcomes deriving from such actions are related to decreased prevalence of obesity and coronary atherosclerotic heart disease.

However, it is difficult for adults to change their sedentary lifestyles and even more difficult to adhere to such an attempt on a long term basis. For example, Dishman (1990) estimated that the typical dropout rate from exercise programmes reaches 50 per cent within one year. Providing appropriate physical activity for young children has thus been seen as a solution for developing skills, attitudes, values and establishing active habits that are likely to persist into adulthood (Simons-Morton et al., 1988). At the same time, this approach is considered capable of correcting or preventing childhood obesity and incidence of adult risk factors for atherosclerosis, such as elevated blood pressure and unfavourable lipoprotein profiles (Rowland, 1990).

The American College of Sports Medicine (1988) recommended that efforts to shape the physical activity habits of youngsters should be directed toward school physical education, parental / home influences, health care professionals' involvement and advice and finally, organized community opportunities for physical activity. The present thesis focuses on one element, that is, organized community physical activity programmes.

**The Specific Problem**

Community physical activity programmes have several advantages over traditional school physical education. They offer scheduling flexibility, freedom of choice in selecting curriculum content and opportunities to embrace activities not generally available in schools (Connor et al., 1986). A major disadvantage however, is that such programmes are voluntary in nature and therefore, their success depends on the number of participants who choose to attend. Substantial efforts for planning and provision may be in vain if participation rates are low. For instance, an exercise programme targeting black families resident in the USA was characterized as unsuccessful because of the unexpectedly low number of participants (Baranowski et al., 1990).

The British government (Smith and Jacobson, 1988), the American Heart Association (Flethcer et al., 1992), the American College of Sports Medicine (1988) and individual researchers (Korsten-Reck et al., 1993; Rowland, 1990), favour the

promotion of non-competitive enjoyable physical activities for young children, along with the existing system of sports. As a result, small scale community activity programmes have been developed, which have omitted sports and emphasized playful physical activities in their curriculum (Korsten-Reck et al., 1993; Ferguson, 1992, personal correspondence). The success of large scale schemes obviously depends on the number of participants they are able to attract, and thus, the idea of influencing participation rates seems particularly appealing. This idea is strengthened by initial research evidence suggesting that while general physical activity levels carry a strong genetic component, participation in sports or other organized voluntary activity programmes does not seem to depend on any inherited mechanism (Bouchard, 1990). Thus, participation in community activity programmes is largely subject to change as a result of promotional efforts.

Nevertheless, "Although a relatively powerful and flexible technology for behavior change has been developed, the application of many techniques to the area of exercise promotion is not yet adequately tested" (Knapp, 1988, p. 203). In agreement with Sallis and Hovell (1990), Knapp (1988) identified three stages in the process of acquiring active habits. These are: (a) the initiation of exercise, (b) the early stages of behaviour change and (c) the maintenance of the new behaviour. Knapp (1988) favoured the examination of each of these stages through theoretical models of behaviour, but Sonstroem (1988) remarked that to date, research has been largely atheoretical in nature and results have been much more descriptive rather than explanatory or predictive. Presumably, if, as the World Health Organization (Bijnen et al., 1994) suggests, the priority is to encourage inactive people to change their lifestyles instead of increasing the activity levels of the active individuals, it is vital that the process of initiation of exercise is studied in detail through existing theory.

This is especially true for young children, where nothing is known about the process of their initial enrolment in community physical activity programmes. Such programmes are organized and voluntary and these are common features with youth sports. A logical step would be to search in the youth sport literature and borrow ideas about how children first become involved in youth sports. In this area, *socialization into sport* "refers to the social and psychological influences that shape an individual's initial attraction to sport" (Brustad, 1992, p. 60). However, it is unfortunate that on this subject, field research is lacking. It has been argued that

> "...the research conducted to date on children and adolescents has focused on children only after they have chosen to become engaged in sport and, thus, does not accurately describe socialization into sport but rather examines the forces" (Brustad, 1992, p. 72) "that maintain children into sport once they have become actively involved" (Lewko and Greendorfer, 1988, p. 295).

McPherson and Brown (1988) summarized the situation stating that influential social systems to which a child may be exposed are parents, siblings, relatives, peers, teachers, coaches and the mass media. Field research has shown that parents are a very strong socializing agent for sport participation especially in the case of young children (Anderssen and Wold, 1992; Wold and Anderssen, 1992; Godin and Shephard, 1986; Patriksson, 1981; Greendorfer and Lewko, 1978). In the same vein, Brustad (1992, p. 73) suggested that "it would be useful to better understand how children come to value particular aspects of sport involvement within their family structure".

Parents have been considered to exert their influence on children's sport participation and physical activity through role modelling (Dempsey et al., 1993; Wold and Anderssen, 1992), or by communicating their beliefs, attitudes and values about sport to their children (Brustad, 1993; Brustad, 1992; Eccles and Harold, 1991). However, recently, it has been proposed that parents may play a more direct role in the sport and physical activity participation of children under the age of 11 years (Jambor and Weekes, 1994, abstract). Parents provide financial support, transportation to and from the activities and they also register their children in organized forms of activity (Jambor and Weekes, 1994, abstract; Walker, 1993; Sallis et al., 1992). It seems reasonable to hypothesize that young children's participation in sports or physical activities is associated to a large extent with these parental actions.

Indeed, Sallis and associates (1992) examined 148 girls and 149 boys aged 9 years on average, as well as their parents. Assessment of children's activity levels was done with a caltrac accelerometer and self reports. Among others, parents were asked to indicate the frequency with which they encouraged their children to take part in physical activities or play sports, the frequency with which they actually took part physical activities or sports with the children and finally, the frequency with which they transported their children to places where they could engage in physical activities or play sports. A series of multiple regression analyses revealed that parental frequency of transportation to places where children could take part in physical activities or play sports was a significant independent predictor of physical activity levels for children of both genders. It was concluded that "interventions to increase children's physical activity should involve increased parental support of physical activity to children. The most effective type of support for pre-teen children appeared to involve facilitating their participation in organized physical activities and sports" (Sallis et al., 1992, p. 1387). As a result, the authors suggested that "parents should be instructed to identify specific and concrete actions they can take to make it easier for their child to participate in games, sports or other physical activities" (Sallis et al., 1992, p. 1387).

Thus, children's participation in organized forms of activity may relate back to parental actions such as registration in the activity, transportation and finance. It is

reasonable to assume that to register their children in any activity, parents assess logically the required investment in time, effort and money and inevitably, evaluate and make judgments about its quality on behalf of their children, especially when they are under 11 years of age. Ultimately, it is reasonable to assume that involvement of children under 11 years in some kind of organized community activity is a product of parental decisions and constitutes a form of parental behaviour. Presumably, organized community physical activity programmes are no exception. In the same vein, whether young children become involved in a community physical activity programme which emphasizes playful physical activities rather than sports, will mainly be determined by parental behaviour. Under these assumptions, it is legitimate to apply theoretical models of behaviour to predict and explain children's initial involvement in community physical activity programmes (Ajzen, 1992, personal correspondence), be it general, or emphasizing playful physical activities rather than sports.

The theory of planned behaviour (Ajzen, 1991; Ajzen, 1988; Ajzen and Madden, 1986; Schifter and Ajzen, 1985) is a modern theory in the area of social psychology, aimed at predicting and explaining virtually all forms of behaviour. Its forerunner, the theory of reasoned action (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975) was fruitful in predicting and explaining volitional forms of behaviour (Sheppard et al., 1988). The theory of planned behaviour was developed in order to explain and predict behaviours that are beyond an individual's complete control (Ajzen, 1991; Ajzen, 1988). In brief, the theory of planned behaviour maintains that a person's behaviour is determined by his or her intention to perform the behaviour. In turn, intention is determined by a combination of the person's attitudes toward performing the behaviour, his or her perception of social pressure for performing or not performing the behaviour and the perception of how easy or difficult performance of the behaviour is likely to be. Among others, the theory of planned behaviour has been applied to predict and explain exercise participation (for instance, Theodorakis, 1992). In accordance with the rationale of the present thesis (although on a different topic), the theory of planned behaviour has been applied to predict intentions of mothers to limit their infants' frequency of sugar intake (Beale and Manstead, 1991). In addition, it has been applied to predict mothers' intentions to use oral rehydration therapy in rural African children suffering from diarrhoea (Hounsa et al., 1993). However, prediction and measurement of the behaviour of the mothers was not attempted in these two studies.

The theory of planned behaviour is a new theory which needs verification with further studies. No research has used the theory of planned behaviour to predict and explain parental behaviour which has a direct impact on an aspect of children's lifestyles. The influence of parental behaviour on children's initial involvement in

organized community physical activity programmes has been a neglected area until now. Whether parents would like their children to become involved in community activity programmes which emphasize playful physical activities rather than sports is another unexplored issue. Finally, there is no indication of whether community activity programmes delivered to children could enjoy any success in Greece, a country where obesity and coronary atherosclerotic heart disease are highly prevalent and physical activity levels very low. It was felt that these issues could be examined simultaneously, in a single experiment.

## Purpose of the Thesis, Research Hypotheses, Delimitations, Assumptions and Limitations

The dependent variable in this study is the *initial involvement of young children in organized community physical activity programmes*. It is *operationally defined* as *registration* of first grade (aged about 6 years) elementary school children, in an organized community physical activity programme taking place in Heraklion, the capital of the Greek island Crete.

This thesis is based on the *assumption* that ultimately, the dependent variable as operationally defined, *constitutes a form of parental behaviour*.

The purpose of the thesis is threefold:

1. The first purpose is to explore the usefulness and the validity of the theory of planned behaviour in predicting and explaining the defined parental behaviour.
2. The second purpose is to examine whether more children become initially involved in an organized community physical activity programme when parents are informed that it would emphasize playful physical activities rather than sports.
3. The third purpose is to evaluate whether a community physical activity programme can attract registration of young Greek children.

In connection with the purpose of the thesis it is hypothesized that the theory of planned behaviour is valid and useful in predicting and explaining the behaviour under consideration. In addition, it is hypothesized that parents would register their children in an organized community physical activity programme in spite of being informed that it emphasizes playful physical activities rather than sports. However, it is expected that any negative or positive reactions toward this kind of programme will be reflected through the framework of the theory of planned behaviour. Finally, it is hypothesized that registration of Greek children in an organized community physical activity programme will be high enough to justify the launching of large scale programmes in Greece.

The delimitations of the present thesis and the assumptions accompanying them are as follows:

1. The literature reviewed for the purposes of the thesis, restricted to English, Greek and a limited number of German sources, contained information that is adequately representative of the body of scientific knowledge tangible to the topic of the thesis.
2. The author of the thesis is adequately capable of understanding, summarizing and transferring in abstracted written form the findings of other researchers.
3. The Greek population does not significantly differ from the populations of other countries, where the majority of principles, theories and methods governing the present thesis have been developed.
4. The delimitations and the resulting restrictions imposed on the study are not so confining as to destroy the external validity / generalizability of the findings of the thesis.

As a result, this study is limited to the extent that, the delimitations and the assumptions stated, represent adequately what they are supposed to represent (Thomas and Nelson, 1990).

**Significance of the Study**

Thomas and Nelson (1990, p. 67) stated that "to a large extent the worth of the research study is judged by whether it is basic or applied research". The present thesis is actually a mix of basic and applied research. It aims to contribute to the verification of the validity of the theory of planned behaviour in predicting and explaining social behaviour. The theory of planned behaviour is a relatively new theory in the area of social psychology that needs wide application to confirm its usefulness. From this point of view the findings of this thesis relate to the area of basic research. On the other hand, the present research probably has practical applications. It aims to test a theoretical framework, that is, the theory of planned behaviour, for designing more effectively, community physical activity programmes. If predictions could be made about the number of children enrolling in a programme, planning and implementation would be much easier and efficient in terms of recruiting employees, buying necessary equipment and hiring or booking activity areas. Additionally, if the theory of planned behaviour proves useful in making predictions, it could be used as a guide to target parents who might be unlikely to register their children in the programme and thus, try to influence their decisions.

Since community activity programmes are voluntary in nature, people may be seen as consumers of a service offered to them. Thus, because it was assumed that, in the main, parents decide about registration of their children in activity programmes, it is reasonable to suppose that the actual consumers are the parents. As mentioned, the government and other organizations may be in favour of community activity programmes that emphasize playful physical activities rather than sports. A question which arises is whether the prospective consumers like the product they are offered. The importance of a possible negative reaction from the parents would be self evident. Appropriate programmes could be provided for small children but there may be small numbers of participants because parents were put off because sports were not included in the programme. As basic marketing theory recommends (Torkildsen, 1992), if promotion of recreational products must be consumer-oriented instead of product-oriented, it is vital that this issue is examined.

Finally, as already mentioned, coronary atherosclerotic heart disease and obesity are highly prevalent in Greece, and adult physical activity levels continuously decline (Kafatos et al., 1991). The launching of a community physical activity programme for children, aimed at influencing physical activity in the long term, would thus be very timely, since a similar scheme is at present lacking (Dramytinos, 1993, interview). Of major significance in this study is whether an adequate number of children would enrol in a community physical activity programme delivered to the Greek community, to justify investment of governmental effort and money for larger scale attempts.

**Structure of the Thesis**

It was felt that it would be necessary to outline in more detail and by means of a review of literature, a few salient issues that were covered superficially in the present chapter. Chapters 2 through 5 contain this background information.

Chapter 2 presents definitions of the terms physical activity, exercise and sport, briefly describes instruments for the assessment of physical activity and reviews evidence related to the physical activity levels of children and adults.

Chapter 3 is concerned with coronary atherosclerotic heart disease and its relation with physical activity and exercise. It describes the atherosclerotic process and identifies mechanisms through which physical activity in the form of exercise may affect its progression or regression. In addition, it examines the effects of exercise regimens on these mechanisms, considering adults as well as children.

Chapter 4 examines in detail the effects of physical activity in the form of exercise on obesity, through the energy balance equation. It also contains a review of the effects

of exercise regimens on the body composition of adults, in studies that used the method of hydrodensitometry. Finally, it presents a review of the effects of exercise regimens on obesity in children. This section contains an innovative interpretation of literature on this topic since it distinguishes between treatment with exercise alone, exercise combined with nutrition education and exercise combined with dietary modification. Until now, other reviews (for example Epstein, 1992; Rowland, 1990) considered treatment with exercise alone and treatment where exercise is combined with nutrition education as one category of treatment, thus, implying that nutrition education has no effect in altering body composition parameters of children.

The literature review indicates that active lifestyles throughout adulthood are advisable to maintain optimum health. One way of encouraging lifelong activity may be through participation in childhood physical activity programmes. Chapter 5 reviews evidence to throw light on the optimum method of designing childhood physical activity programmes. It will be seen that, taken macroscopically, chapters 2 through 5 may partially provide a rationale for introducing community physical activity programmes which emphasize playful physical activities rather than sports, along with the existing system of youth sports.

Chapter 6 describes the theory of planned behaviour in detail, it makes a comparison with the theory of reasoned action and identifies problems related to its application. As a result, it makes specific recommendations that find application in the research of the thesis described in subsequent chapters.

Chapter 7 contains a statement of the specific research hypotheses, operational definitions and assumptions that govern this research. Finally, following the traditional style of thesis format, chapters 8, 9, 10 and 11 concentrate on the methods, results, discussion and conclusions related to the implementation and findings of the field research.

# Chapter 2

## Physical Activity Levels

### Definitions and Introduction

Representing a large number of scientists in the area of physical activity and health, Bouchard and associates (1993) offered the following definitions in their consensus statement:

"Physical activity comprises any body movement produced by the skeletal muscles that results in a substantial increase over the resting energy expenditure" (Bouchard et al., 1993, p. 11). Physical activity may vary in respect of intensity, frequency, duration and type of activity.

"Exercise is a form of leisure time physical activity that is usually performed on a repeated basis over an extended period of time (exercise training) with a specific external objective such as the improvement of fitness, physical performance, or health" (Bouchard et al., 1993, p. 12).

The same authors stated that in North America "sport implies a form of physical activity that involves competition" (Bouchard et al., 1993, p. 13) but that in Europe "the term sport may also embrace exercise and recreation" (Bouchard et al., 1993, p. 13). However, more recent positions from European researchers followed the definitions advocated by their North American colleagues. Biddle (1992) stated that sport "refers to competitive contexts" (Biddle, 1992, p. 99) whereas exercise is used to refer to non-competitive activities targeting the promotion of health related objectives.

Bouchard and associates (1993) made a sharp distinction between leisure time physical activities and occupational work or household chores. Bouchard and associates (1993) stated that leisure time physical activity embraces exercise as well as sport, is undertaken in the individual's discretionary time and is personally chosen according to perceived needs and interests. Occupational work refers to the activity required for the transportation to and from the work and the physical demands of the job. Household chores are associated with the activity required for the maintenance of the household.

Baranowski and associates (1991) remarked that a concern for health provides ways of characterizing physical activities in order that they correspond to particular health objectives. In respect of obesity and coronary atherosclerotic heart disease, precise assessment of activity levels is important to physiologists who try to

understand the mechanisms involved in the progression of disease, to discover levels of activity over which health benefits may accrue and to quantify the effects of interventions (Sallis et al., 1991). It is of additional benefit to behaviourists who try to understand the determinants of physical activity and to design effective interventions.

The purpose of this chapter is to review studies that have assessed the activity levels of the population. Developmentally, it is important to consider the activity levels of both children and adults, because it is often assumed that childhood experiences determine adult involvement in physical activities (Simons-Morton et al., 1988).

Before proceeding with the review of the available evidence, a brief description of the instruments developed for the assessment of physical activity will be given.

**Instruments for Assessing Physical Activity**

Several excellent reviews have appeared summarizing what is known about the methods for assessing physical activity (Freedson, 1992; Durnin, 1990; Saris, 1986; Saris, 1985; Montoye and Taylor, 1984). Physical activity has been assessed by self reports, motion sensors, heart rate recorders, observations and the doubly labelled water method. A general impression is that what is gained in validity, accuracy and reliability of measurement is lost in time, effort and feasibility of application.

Self reports have been the most widely used instruments for assessing physical activity basically because of their low cost and easy implementation. National health and fitness surveys as well as epidemiological studies have relied heavily on the use of self reports to calculate energy expenditure during physical activity for a given period of time, or for distinguishing individuals and assigning them to groups according to their level of activity. Self reports may consist of self completed questionnaires, time diaries and interviewer conducted forms (Baranowski, 1988). Freedson (1992) remarked that instruments aiming at assessing physical activity should be considered within the context of the definition of physical activity. In this respect self reports probably perform poorly in assessing physical activity. It is likely that they capture more successfully the domains of sport and exercise, but even in these cases there are serious problems of validity and reliability (Lamb and Brodie, 1990; Washburn and Montoye, 1986). For example, some people may overestimate or underestimate time devoted to these activities (Klesges et al., 1990). However, despite the problems accruing from their use and considering that there are at the moment no alternatives for estimating the physical activity of large segments of the population, self reports will probably continue to be the first choice in epidemiological surveys and for this reason intense efforts are being made to improve their quality (Baranowski, 1988). Particular

concern exists over the use of such instruments with children (Baranowski and Simons-Morton, 1991). Saris (1985) commented that

> "Below the age of 10-12 years children can give only limited information about their activity pattern. The time is especially difficult to recall. In general, children overestimate the time spent in vigorous activities like playing outside and underestimate it in regular activities like going to school, eating etc." (Saris, 1985, p. 44).

Parental recalls have been utilized to compensate for children's inability to provide accurate information but Freedson (1992) and Saris (1985) concluded that these methods are equally inappropriate except when they refer to children's participation in organized sports and exercise.

Various types of motion sensors exist such as pedometers, actometers and the large scale integrated motor activity monitor (LaPorte et al., 1979). A recent advance is the caltrac accelerometer which is capable of measuring intensity of effort in counts of vertical acceleration and subsequently, to transform them into units of energy expenditure. In general, these devices have not achieved perfection yet. For example, caltrac, which is considered to be the best in its category is not capable of assessing activity of the limbs when the trunk is not moving since it is worn on the hip. It is hoped that recent technical advances and probably its combination with an embodied heart rate monitor will eliminate many of the problems present at the moment (Freedson, 1992; Montoye, 1990).

The use of heart rate monitors is based on the principle that energy expenditure during physical activity is linearly related to heart rate. Heart rate monitors are widely acceptable instruments since they are reliable and their measurements are compatible with the definition of physical activity. Their basic problem is the assumption of linearity between energy expenditure and heart rate. Freedson (1992), Saris (1986) and Montoye and Taylor (1984) commented that heart rate may be influenced by other factors independent of physical activity. Characteristically, it was stated that "Dancing raises the heart rate as a result of increased energy expenditure, but how high it goes may be as much a matter of who our dancing partner is" (Montoye, 1990, p. 73). An additional problem with heart rate monitors is that individual curves relating energy expenditure with heart rate have to be established. As a result heart rate monitors have been used primarily in small scale studies as well as a criterion for validating simpler methods.

A yet unstudied issue with motion sensors and heart rate monitors is whether they produce any reactions to individuals who, consequently, may change their usual physical activity levels. This problem may be of particular relevance when studying children. Kafatos (1992, personal correspondence) mentioned that attempts to assess

physical activity of rural Cretan children failed, because on the one hand many of them kept the motion sensors at home to play with and some others reacted by being involved in physical activity obviously more than usual.

Promising methods for assessing physical activity are observations and the doubly labelled water technique. The doubly labelled water technique (Schoeller and Santen, 1982) measures total energy expenditure accurately and reliably. To derive the energy expended during physical activity, the scores of resting metabolic rate and the thermic effect of food have to be subtracted from the overall energy score. It is the assessment of the resting metabolic rate and the thermic effect of food that introduces errors when assessing the energy expended during physical activity with this method. Furthermore, because the score derived is only a measure of energy expended during a specified period of time, it is not possible to identify activity patterns, unless the method is combined with a diary or a questionnaire. An additional problem involved is the very high cost of purchasing the equipment needed for its application. However, despite the problems encountered, the doubly labelled water is regarded as a standard for validating other methods. The fact that it does not restrict the daily activities of the subjects, it is non-invasive and probably produces minimal reactions, makes it a possible solution for the assessment of physical activity of young children (Goran, 1993; Blaak et al., 1992).

Probably, the most detailed information about the physical activity levels of young children comes from observations. Adults are difficult to observe because it is unlikely that they would allow researchers to follow them for substantial periods of time. With observations, detailed account of the frequency, intensity and pattern of activity can be made, depending on the length of the observation, the measuring instrument and the experience of the researcher. A number of observational instruments have been developed and validated (McKenzie, 1991) but their use is restricted to relatively small samples probably because of the cost involved in recruiting observers (Freedson, 1992).

In conclusion, there is at the moment no perfect method adaptable to all situations where assessment of physical activity is desirable. Researchers face the challenge of making conscious judgments for the suitability of instruments, considering the scope of their research, the dimension of physical activity they want to measure and the cost involved.

**Further Problems of Research**

Besides the problems encountered with the instruments for assessing physical activity, surveys face threats of external validity because the samples chosen may not be representative of the population under consideration and thus generalization of the results may not be appropriate. This issue was tackled by selecting national random samples in some cases but for various practical reasons such a manipulation is rare. On the other hand, because information about the physical activity levels of both children and adults is generally limited, attention has to be paid to the majority of the research done, with the hope that, although the samples of individual efforts may not be representative of the referent population, the conclusions drawn from the studies taken altogether may offer an adequate picture of the situation. Comparisons between surveys may not be advisable however, because of the differences in the instruments for assessing physical activity utilized by researchers.

A major concern relates to the level of physical activity needed to characterize an individual as active or inactive. Physical activity is measured in energy levels but there are other qualities such as intensity, frequency and duration. Reflecting this issue, some researchers have chosen to label individuals as active or inactive based on a threshold level of energy expended during physical activity in a specified period of time, usually a week. For others, "active" individuals were frequent exercisers that is, people participating more than once or twice a week in some kind of sport or exercise. A different approach comes from researchers who have defined appropriate physical activity levels in relation to a particular health objective and categorized their subjects according to this level.

The variation in the threshold levels of physical activity chosen by different researchers is an expression of the inability of the medical and the exercise physiology sciences to offer a clear etiology of various health hazards and to describe at the molecular level the effects of physical activity on their progression.

An interesting case is that of coronary atherosclerotic heart disease. It has been documented that an inverse association exists between clinical complications of coronary atherosclerotic heart disease and levels of aerobic fitness[1] as well as physical activity. Aerobic fitness is partially determined by physical activity and thus it is not yet certain whether the relationship between physical activity and complications of coronary atherosclerotic heart disease is mediated by aerobic fitness. Alternatively, it could be proposed that the correlation between aerobic fitness and coronary atherosclerotic heart disease is a spurious one in the sense that activity may produce

---

[1] The term aerobic fitness is used here to describe the maximal aerobic power factor of the cardiorespiratory component of health-related fitness as defined by Bouchard and associates (1993).

both, aerobic fitness and protection from atherosclerosis. In such a case, fitness would not be a prerequisite for protection from atherosclerosis. Until the molecular mechanisms of the effects of physical activity on the progression and regression of atherosclerosis are fully understood, it is unlikely that satisfactory answers can be offered and research will be tentative rather than confirmatory.

Having these pitfalls in mind, a compilation of studies done with adults and children is presented. An effort was made to select studies done in a number of different countries with the aim of offering a more complete picture.

**Physical Activity Levels of Adults**

For adults, the best available information comes from surveys that have used self reports in assessing activity levels.

Powell (1988) summarized the results from 9 principal national surveys done in the USA and observed that the percentage of people characterized as active ranged from 9 per cent to 55 per cent depending on the definition of active. However, the author accepted the conclusion of Blair and associates (1987) that probably 20 per cent of the population in the USA engaged in optimal amounts of physical activity, 40 per cent were essentially sedentary while the remaining took part in sufficient physical activity to enjoy some health benefits.

These conclusions are in general agreement with data from individual surveys. For example, Lee and associates (1991) studied the physical activity levels of 20,775 Harvard alumni aged 47 years on average. The alumni were categorised as active if they spent more than 2,500 Kcal per week in physical activities, moderately active if they spent between 1,000 Kcal and 2,500 Kcal and inactive if their weekly energy expenditure did not exceed the 1,000 Kcal threshold. The data were obtained by means of a questionnaire that quantified overall activity levels, including stairs climbed, blocks walked and sports and exercise undertaken. It was found that about 30 per cent of the alumni were sedentary, 39 per cent were moderately active and the remaining proportion were highly active. Generalizability of the findings may be limited however since it is unlikely that Harvard alumni were adequately representative of the US population.

Brooks (1987) studied a representative sample of about 1,000 US Americans aged over 18 years. Time diaries were utilized to obtain weekly levels of leisure time energy expenditure. Attention was paid to the seasonal variation of activity levels and thus, diaries were administered in winter and in summer. The author prepared for each individual a "synthetic week", which represented weekly physical activity levels on the

aggregate, taking into account seasonal differences. Then, she examined how many individuals could be classified as active according to different definitions. When 1,600 Kcal per week was selected as the cut off point, 14 per cent of the sample were found to be active. This proportion declined to 10 per cent when the criterion was participation in exercise 3 times per week for over half an hour each time at an intensity of 60 per cent of the maximal aerobic capacity. In this study it was not known however, to what extent the "synthetic week" prepared for each subject gave a satisfactory estimation of physical activity levels throughout the whole year. Probably, an acceptable degree of precision was achieved on aggregate but it is unlikely that individual scores were accurate enough.

Some disagreement may exist between surveys in respect of the exact number of people who are active, but a point of agreement is that a substantial proportion of the US population is sedentary or not active enough. Data from other countries confirm the notion that in the industrialized world the problem of inactivity is highly prevalent. In Britain, only limited data were available a few years ago, but recently four large scale surveys appeared in the literature.

Shaper and Wannamethee (1991) reported data from the British regional heart survey for 7,630 men aged 40 to 59 years, resident in 24 towns and cities of Scotland, Wales and England. Leisure time physical activity was measured by means of a questionnaire and the final score was expressed as an index corresponding to energy units. On this basis, 7 per cent of the men were highly active and another 31 per cent were active to a level that they could enjoy health benefits. The remaining took part in very little physical activity and could be classified as sedentary. This research was limited since the sample was confined to men only and to quite a narrow age range. Furthermore, sampling was done from records of one general practice and thus representativeness may have been quite limited with reference to the general population.

Similarly, Silagy and associates (1993) utilized a questionnaire in examining the physical activity levels of 5,803 people aged 35 to 64 years. People undertaking vigorous activity during their work or at least once a week during their leisure time were considered as active. Only 28 per cent of the sample could be classified as active using this definition. Precision in the assessment of individual physical activity levels was probably low because the questionnaire was very simple. In addition, as in the research by Shaper and Wannamethee (1991), subjects were selected from general practices and probably constituted a relatively biased sample.

In the national survey of health and development (Kuh and Cooper, 1992), the inquiry was inverted and the authors aimed at examining the proportion of highly inactive adults in a stratified sample of 3,500 British men and women. A questionnaire

was administered for this purpose and it was concluded that 32 per cent of the men and 42 per cent of the women could be classified as highly inactive. A particular strength of this research was the sampling procedure, since subjects had been randomly selected at birth from the total population of legitimate births that occurred during the week 3 to 9 March 1946 in England, Wales and Scotland. While representativeness of this sample may be unquestionable, it was restricted to individuals aged 36 years at the time the study was conducted. Furthermore, physical activity levels were assessed during April to September in 90 per cent of the cases and probably, the number of inactive individuals was underestimated. For example, it is likely that, during winter, outdoor activities decline drastically and as a result, physical activity levels diminish, a point which was admitted by Kuh and Cooper (1992) as well.

The recent Allied Dunbar survey (Health Education Authority / Sports Council, 1992) confirmed the findings of the separate surveys already mentioned. A random sample of 6,000 adults aged 16 years and over was interviewed about their physical activity levels using a detailed questionnaire. Target levels of activity were set for each age group based on a six point activity level scale that considered duration, intensity and frequency of participation. It was concluded that 7 out of 10 men and 8 out of 10 women fell below the age-appropriate activity necessary to achieve health benefits. Results from this survey may be considered as especially valuable to the extent that age-appropriate activity levels were correctly established. Since experimental research has not yet arrived at pertinent conclusions with much confidence (Bouchard et al., 1993) this might be a serious limitation of the study. Similar limitations were shared by research conducted in other countries. For example, in Finland, Tuomilehto and associates (1987) selected a random sample of 3,975 men aged 25 to 64 years and questioned them about their physical activity levels. They derived an activity score corresponding to energy units and concluded that only about 25 per cent of the people could be classified in the more active categories. Different results come from Germany. Hübner and Kirschbaum (1993) and the Deutscher Sportbund (1986) agree that about 60 per cent of the German population may be characterized as active. However, the definition they employed for active refers to a once a week participation in some type of sport or exercise which is much more relaxed than the definitions employed in the Allied Dunbar survey (Health Education Authority / Sports Council, 1992) for instance.

In Greece, data are generally lacking, with only three reports assessing the physical activity levels of the population. Chatzicharistos and associates (1989) questioned 200 first year students in a department of physical education about their parents' participation in sports. It was found that 14 per cent of the fathers participated in some type of sport, usually football. The respective proportion for the mothers was 1.5 per

cent. Certainly, there can be little confidence in these findings since the selected sample was probably biased and not representative of the Greek population.

Vassilakis and associates (unpublished data) used a standardized questionnaire and interviewed 155 medical students about their leisure time physical activity. They transformed individual scores into Kcals and their conclusions were quite disappointing. Only 16 per cent of the men and 18 per cent of the women were involved in some type of physical activity. Seventy five per cent of the students could be classified as highly inactive since their weekly energy expenditure did not exceed 500 Kcal. The average weekly energy expenditure related to physical activity was 182 Kcal for boys and 197 Kcal for girls. As in the case of Chatzicharistos and associates (1989), the sample of Vassilakis and associates (unpublished data) was probably biased since it was restricted to medical students. In addition, its size was relatively small and thus, it is likely that this research offers little significance in respect of the Greek population.

Kafatos and associates (1991) used the same questionnaire as Vassilakis and associates (unpublished data) and interviewed 387 Cretan bank employees. Men were aged 44 years on average and women 35 years. About 70 per cent of the sample were classified as inactive based on the 500 Kcal per week threshold point, 20 per cent reported walking 1 to 2.5 miles per day and only 10 per cent practised some form of exercise on a daily basis. The rural population of Greece is probably much more active (Aravanis et al., 1966) than the sample selected by Kafatos and associates (1991). However, about 70 per cent of the population in this country is resident in urban and semi urban areas (Chatzicharistos, 1990). In addition, it seems that a large proportion of the urban adult population is engaged in sedentary occupations (National Statistical Service, 1981) at least in the area of Crete where the survey of Kafatos and associates (1991) was carried out. Thus, the results of Kafatos and associates (1991) although not strictly representative, may be considered as indicators of a highly alarming situation.

Important factors to consider when examining activity levels are age and gender. The results are fairly consistent across studies that activity declines with age and males are more active than females. From the studies already mentioned, only Vassilakis and associates (unpublished data) reported higher involvement of females in physical activities, but the fact that in this case subjects were medical students who probably held different attitudes toward health and physical activity than the average population may serve as an explanation for the discrepancy. In the Allied Dunbar survey (Health Education Authority / Sports Council, 1992) 26 per cent of the men exercised at the higher levels of activity as compared to only 14 per cent of the women. About equal numbers of men and women were completely sedentary however. In the same survey,

the proportion of individuals classified as sedentary increased with age independent of gender. Thus, 8 per cent of the men aged 35 to 44 years were found to be inactive. This proportion increased to 29 per cent at the age range 55 to 64 years and to 44 per cent at the age range 65 to 74 years.

In conclusion, it seems that physical activity levels of adults are not adequate to maintain optimum health. The overall picture comprises a relatively small proportion of the population who are regularly active, a large segment who are relatively active but need to increase their activity and finally, a substantial segment of sedentary individuals. Variations may exist between countries, but on aggregate, the results are fairly consistent. Although much research needs to be done, the situation in Greece is probably a little worse than in other countries. There are indications that physical activity levels are rising slowly in the USA (Powell, 1988), Canada (Shephard, 1993) and Britain (Roberts et al., 1989), while in Greece there is a decline in the physical activity of the urban population compared to the 1960s (Kafatos et al., 1991).

**Physical Activity Levels of Children**

A variety of methods have been employed in studying physical activity levels of children. The most detailed data probably come from observations and heart rate monitoring while the most representative from large scale surveys that used self reports.

For the USA, representative data were reported in the national children and youth fitness surveys. Ross and Pate (1987) selected a national representative sample of 4,678 children aged 6 to 9 years. Their parents filled in a form, describing the physical activity pattern of their children. Almost all children were enrolled in physical education programmes offered by the school, whereas 84 per cent participated in physical activities through various community organizations. Nevertheless, such evidence should be examined cautiously, since the ability of parents to report reliably about physical activity levels of their children is often doubted (Saris, 1985). Covering a different age range, Ross and Gilbert (1985) questioned a national sample of 8,800 children aged 10 to 17 years about their physical activity patterns. Over 80 per cent of them were enrolled in school physical education programmes. Interestingly, however, the average child reported that almost 80 per cent of his / her physical activity came outside physical education. Taking the year as a whole, it was found that children spent an average of 760 minutes per week in sports, active games and exercises, while variations were apparent and were related to the season and the weather. Freedson (1992) estimated that in these samples 88 per cent of the girls and 94 per cent of the

boys expended over 3 Kcal / kg per day and could be classified as active. These proportions may be considered as quite high but were replicated in research from other countries. For example, in Australia, Jenner and associates (1992) used a simple questionnaire to assess the usual number of days per week that children participated in exercise or sport for more than 1 hour each time. Subjects were 1,311 children aged 7 years resident in Perth. A large number of children (95 per cent of the boys and 91 per cent of the girls) reported some kind of activity during the week. Sixty per cent of the boys and 60 per cent of the girls reported that they engaged in exercise or sport more often than 4 days each week. The validity of these findings is limited to the extent that children were able to recall their physical activity levels accurately. It has been suggested that children younger than 12 years of age often give incorrect and unreliable information. As a result, systematic attempts are being made to improve the quality of questionnaires administered to children and also to develop methods that may help them to recall their physical activity with greater accuracy (Baranowski, 1988).

A wealth of information comes from the Scandinavian countries. In Sweden, Sunnegardh and associates (1985) randomly selected 682 children from 4 different regions of the country. Children were either 8 or 13 years old. Physical activity was measured by a detailed questionnaire. About 60 per cent of the boys and 50 per cent of the girls reported regular participation in physical activity. On the other hand, for a large proportion of children, physical education was the only opportunity for regular exercise (for 31 per cent of the boys aged 8 years, 51 per cent of the girls aged 8 years, 37 per cent of the boys aged 13 years and 42 per cent of the girls aged 13 years). In Denmark, Andersen and associates (1989) selected a representative sample of Danish school children aged 16 to 19 years and examined their activity levels. On average, girls spent 357 minutes in sport and exercise activities every week while the corresponding figure for boys was lower, 299 minutes. About 40 per cent of the boys and 30 per cent of the girls reported that they were involved less than 1 hour per week in any sport or exercise activity. A particular limitation of research from Scandinavian countries lies in the inability of the research design to reflect seasonal variations of physical activity patterns. The weather which probably is a limiting factor for engagement in physical activities during winter and autumn, may interact with availability of resources and determine to a large extent childhood physical activity levels in these countries.

In Norway, Tell and Vellar (1988) surveyed 1,016 children from 6 Oslo schools. Subjects were aged 10 to 15 years. Information about frequency and duration of physical activity that made children out of breath for at least half an hour was obtained with a simple questionnaire. The researchers concluded that about 64 per cent of the

boys and 50 per cent of the girls exercised regularly, at least 2 to 3 times each week for half an hour at an intensity capable of making them out of breath or sweaty. When a similar questionnaire was administered to a random sample of 1,142 Finnish boys and girls aged 15 years, a slightly larger proportion of active children were found, since 72 per cent of the sample reported exercising more than 2 to 3 times per week (Marti and Vartiainen, 1989). These data are in agreement with another survey done in Finland which covered children aged 3 to 18 years (Telama, et al., 1985). However, given that the questionnaire utilized in these studies consisted of a single question, it is likely that data possessed limited validity. When a similar question was used in Greece combined with a detailed questionnaire (Atsalakis and Kafatos, in press) it was found that it was highly and significantly correlated with organized physical activity levels of 12 year old children but it was not correlated with spontaneous physical activity. It is possible to hypothesize that children's spontaneous physical activity does not reach levels of breathlessness or that it may not be reported by children when questionnaires such as that of Telama and associates (1985) are used.

Limited attention has been paid to the physical activity of Greek children. One report was concerned with the activity levels of a small but representative sample of 83 school children aged 12 years, resident in a semi urban area of Crete (Atsalakis and Kafatos, in press). Responses were obtained using a detailed questionnaire and covered one weekday and the weekend of the same week. The weekday was considered as representative of the other weekdays. The score was expressed in energy units. Boys reported an average of 355 minutes of activity of any type per week and girls 277 minutes. However, 40 per cent of the boys and 30 per cent of the girls were classified as inactive based on the 3 Kcal / kg / day threshold proposed by Freedson (1992). These results were indicative of a situation where a number of boys had quite high levels of activity whereas many others were engaging in very little activity. Limitations of this research were the relatively small sample size and also the extent to which the weekday assessed, represented all other weekdays adequately.

Finally, in Great Britain the most representative results come from Ireland (Riddoch et al., 1991) and from a study with Sheffield adolescents (Tancred and Gleeson, 1989). Within the context of the Northern Ireland health and fitness survey, Riddoch and associates (1991) selected a random stratified sample of 3,211 children, comprising 1,540 boys and 1,671 girls aged 11 to 18 years. Data about their physical activity were obtained by means of self reports. It was found that 75 per cent of the children exercised at least once a week but that less than half of them exercised more than 3 times per week. These data may not however be considered as representative for Britain although they may be generalizable to Northern Ireland. In the Sheffield study, Tancred and Gleeson (1989), randomly selected 412 children aged 15 years on

average. A three week recall was utilized, covering frequency, duration and intensity of physical activity. From these reports a combined activity index was derived. On this basis, the researchers claimed that only 20 per cent of the girls and 40 per cent of the boys were classified as active enough to enjoy benefits of the cardiorespiratory system. These proportions are small but it is important to note that the limits imposed by these researchers were strict compared to other surveys. Again, the most serious question concerns the cutoff point at which children are characterized as "active". Unless agreement is forthcoming, previous as well as future research should be considered as seriously limited.

Important factors to consider when studying children's activity levels are age and gender. Most surveys show that physical activity levels decline with age as for example in the Northern Ireland health and fitness survey (Riddoch et al., 1991). However, in these cases data were cross sectional and it was assumed that on average, the population did not change significantly from year to year. In terms of a longitudinal approach, the best available data come from Finland. Telama and associates (1994) obtained a representative sample of Finnish children aged 9, 12, 15 and 18 years and followed them for 9 years. Measurements were taken every 3 years. The method of data collection for physical activity was a questionnaire. After analysis, it was obvious that physical activity had declined, with the sharpest decrease occurring during the transition period from 12 to 15 years of age. Another sharp decrease was observed in the period from 21 to 24 years for girls and 18 to 21 years for boys. More or less similar results were reported by Andersen and associates (1984) who studied longitudinally a small sample of 25 girls and 27 boys from Germany, initially aged 14 years and followed up until the age of 18 years. Both, boys and girls reduced by a substantial degree the amount of their physical activity while this reduction was more prominent in girls. Sample size was small and constituted the most serious limitation of this research.

Most surveys also show that boys are on average more active than girls and this difference holds for every age. This notion was confirmed in a meta analysis of 90 pertinent citations covering an age range from birth to about 16 years of age (Eaton and Enns, 1986) which however included studies where assessment of physical activity may have presented methodological problems. Conclusions were similar even when quality of study was taken into account and thus, results could be treated with relative confidence. Nevertheless, it is interesting to note that the pattern of involvement in physical activities is different for boys and girls. For example, in the national fitness surveys done in the USA (Ross and Pate, 1987; Ross and Gilbert, 1985), girls participated more in swimming, bicycling, disco dancing, roller-skating and walking while favourite activities for boys were bicycling, basketball, football and baseball,

which are mainly team activities. As a result, Ross and Gilbert (1985) reported that the typical girl spends much more time in activities that are more likely to promote life long habits than the average boy (70 per cent of the activity time for girls and 55 per cent of the activity time for boys).

An important issue that researchers have investigated in small scale surveys is whether children obtain adequate amounts of appropriate physical activity. In these cases appropriate physical activity is defined as moderate to vigorous physical activity which is beneficial to children in respect of their cardiorespiratory health. Moderate to vigorous activity is usually defined as that which produces a heart rate in excess of 120 beats per minute. Heart rate monitoring and direct observations have been used to address this point. The bulk of the pertinent work has been carried out in the USA and in Britain.

Durant and associates (1992) studied 159 children aged 3 to 5 years resident in the USA, with heart rate monitors. Measurements were taken for 4 consecutive days, from Monday to Thursday. A cutoff point of 120 beats per minute was utilized. It was found that for a substantial proportion of the total time recorded, children had heart rates over this threshold (40 per cent of the time in summer, 30 per cent of the time in winter). There was no day to day variation within the same week. It was quite common for these children to have a heart rate greater than 120 beats per minute for periods longer than 10 minutes. The usual periods of the day that this happened were from 9.00 in the morning till noon and from 4.00 to 7.00 in the afternoon. Based on these findings, the authors suggested that the children were very active. Similar results were reported by Livingstone and associates (1992) who studied 36 children aged 7, 9, 12 and 15 years with heart rate monitors and the doubly labelled water method. In this study however, it was found that it was the younger children (aged 7 or 9 years) who spent substantial time in activities capable of raising their heart rate over a value corresponding to 50 per cent of maximal aerobic capacity. Older children were considerably less active. A major limitation of these studies was that heart rate recording was the exclusive method of physical activity assessment. Thus, it was not possible to state with confidence in which cases heart rate was raised as a result of physical activity or as a result of other factors.

Research in Britain has mainly focused on continuous activity in excess of 20 minutes that could raise heart rate above 140 beats per minute. It has been concluded that children in this country are surprisingly inactive. More specifically, Armstrong and associates (1990) randomly selected 266 children aged 11 to 16 years resident in Devon and recorded their heart rates over a 3 weekday period and a Saturday. A very small number of children (about 4 per cent of the boys and 1 per cent of the girls) experienced a daily bout of appropriate activity as defined by the researchers. On

Saturdays these proportions fell to 1 per cent for boys and 0 per cent for girls. About 20 per cent of all children experienced at least one such period of activity during the total time of heart rate recording. Similar results were reported from Biddle and Armstrong (1992) who examined 72 children aged 11 to 12 years and Armstrong and Bray (1991) who studied 67 boys and 65 girls aged 10 years on average. The protocol was identical for these studies. Along with the shortcoming of not assessing type of physical activity, these studies did not obtain a representative sample of the British population and thus, their generalizability may be limited to the area of study implementation. In addition, their definition of "active" was probably too strict for children. Observational studies from the USA (Simons-Morton et al., 1990; Baranowski et al., 1987) and Britain (Sleap and Warburton, 1992) generally confirm the notion that children seldom participate in bouts of moderate to vigorous physical activity of 20 minutes duration. A suggestion has been made that it is not natural for children to engage in long bouts of sustained activity. Saris (1992, personal correspondence) reported that his research team reached similar conclusions to Armstrong and associates (1990) when studying Dutch children with heart rate monitors and employing cutoff points of 140 beats per minute in defining moderate to vigorous activity. However, when they applied the doubly labelled water method with the same children, they found them to be very active judging from the overall levels of energy expenditure during physical activity.

The conclusions reached by different researchers may sometimes contradict each other but the results are essentially similar. In the study of Armstrong and associates (1990) the majority of the children frequently experienced bouts of physical activity between 5 and 10 minutes in duration that raised heart rate over the desired level. Thus, the question is whether a type of interval activity may be beneficial for health. If it could be shown that this is indeed the case, it would be important to count total time devoted to activity instead of being concerned with the number of bouts of sustained activity (Saris, 1992, personal correspondence; Simons-Morton, 1992, personal correspondence). Data from observations of children resident in the USA (Baranowski et al., 1987) agree with the results of heart rate monitoring in that although few children experience long bouts of activity, on average, they exhibit frequent short spurts of activity.

In the study of Sleap and Warburton (1992) this issue was addressed in deep detail. The researchers selected 56 children from different regions of England, aged 5, 8 and 10 years. The children were observed during school break time, lunch time, physical education lessons and during free time. It was interesting that, of total time observed, children spent about 32 per cent of it engaged in activities that raised their heart rate over the specified 140 beats per minute limit. It was calculated that

> "...the sum total of average time in MVPA for morning break, lunch break, afternoon break and weekday evening was 88.52 min. This amount of physical activity would clearly surpass the minimum requirements for the maintenance of heart health" (Sleap and Warburton, 1992, p. 242)[1].

Certainly, observations may involve systematic errors for transforming recorded movements into heart rate scores but their particular strength is that, detailed account of the type of activity experienced each time may be made. Thus, Sleap and Warburton (1992) warned that one fourth of total moderate to vigorous physical activity was experienced during brisk walking in journeys to and from school which "although valuable in itself, it does not constitute freely chosen activity..." (Sleap and Warburton, 1992, p. 242). A limitation of the research by Sleap and Warburton (1992) may have been the relatively small and probably unrepresentative sample, but more recent efforts from the same researchers (Sleap and Warburton, 1994) generally corroborated earlier findings. If larger scale research confirms these conclusions, it is likely that the major issue to address in the future will not be the extent to which children are engaged in physical activities but whether this involvement maintains their health or influences adult physical activity levels. In the same vein, two detailed reviews of the literature on physical activity levels of children aged 3 to 11 years (Cale and Almond, $1992_a$) and over 11 years (Cale and Almond, $1992_b$) reached the conclusion that children were generally inactive but admitted that sample sizes used to date were small and insufficient for firm conclusions to be drawn. Also, they stated that much emphasis has been placed on the issue of intensity of physical activity in order to develop and maintain the cardiopulmonary system, while authors in the studies reviewed often adopted different definitions for optimal physical activity levels as a result of this limitation.

## Conclusions

Much more research needs to be done in the area of physical activity levels of children. In Europe, a large proportion of children seem to engage in regular exercise and sports but at the same time a large segment of the population is essentially inactive. As in the case of adults, the proportion of children categorized as active or inactive depends on the definition of "active". Observations indicate that prepubertal children are quite active but larger scale efforts are needed to confirm this notion. In addition, it is likely that the activities in which children participate do not always have qualities that promote establishment of active lifestyles. Activity levels seem to

---

1 MVPA means moderate to vigorous physical activity.

diminish throughout the age span and there are periods when this reduction is more prominent, as for example during the period from 12 to 15 years of age. The reduction is observable for both genders although boys are generally found to be more active than girls at every age.

Most surveys show that adults are inactive. A small proportion participate in adequate amounts of physical activity but a large percentage are essentially sedentary. A third segment is engaged in physical activity but only to a limited extent. Adult activity patterns tend to follow those observed with children; men are more active than women and activity levels continuously diminish with advancing age.

From a medical point of view, there are major issues over whether an increase in the physical activity of adults may help in the prevention and treatment of obesity and coronary atherosclerotic heart disease and whether similar benefits may be obtained by increasing the physical activity levels of children.

These are important questions because conclusions could guide interventions delivered to the population. If an increase in physical activity is beneficial for children and adults in respect of obesity and risk for atherosclerosis, interventions should aim at maximizing participation in all age groups. Instead, if children do not derive such benefits but adults do, interventions delivered to children should aim at optimizing their participation in activities that promote life long activity habits, with the target of maximizing their participation in physical activities during adulthood.

Chapters 3 and 4 examine the effects of increasing physical activity levels through exercise, on obesity and coronary atherosclerotic heart disease, in children and adults.

# Chapter 3

## Physical Activity and Coronary Atherosclerotic Heart Disease

### Introduction

The definitions advocated by Hurst and King (1978) will be adopted in this thesis. These authors stated that coronary atherosclerotic heart disease is the correct term for the widely used coronary heart disease and indicates the existence of a specific form of heart disease namely coronary atherosclerosis. The term is used when the practitioner has evidence that "the atherosclerotic process has reached a degree of severity that is sufficient to cause certain clinical syndromes or pathologic abnormalities which are the result of inadequate myocardial perfusion" (Hurst and King, 1978, pp. 1094, 1095). The term coronary atherosclerosis does not imply that the blood supply to the cardiac muscle has been interrupted.

Coronary atherosclerotic heart disease (CAHD) is the single leading cause of death in Europe and in USA. It manifests itself through myocardial ischemia (Elliot and Edwards, 1978) which is responsible for angina pectoris, sudden death or acute myocardial infarction.

Physical fitness and physical activity at work or in leisure time have all negatively correlated with clinical manifestations of CAHD. Blair and associates (1989) indicated that individuals exhibiting maximal aerobic capacity over 35 ml/kg/min are at significantly reduced risk of experiencing CAHD related syndromes and death. Similarly, Paffenbarger and associates (1993) estimated that physical activity related expenditure around 2000 Kcals per week offers substantial cardioprotective benefits. Berlin and Golditz (1990) reviewed meta-analytically all the studies reported to date which examined the association of CAHD related clinical symptoms with physical activity levels. They concluded that overall there is a strong negative association between physical activity levels and CAHD related symptoms. Interestingly, studies of better design showed stronger negative associations. Some studies showed that such a correlation was absent but it is worth underlying that no report found a positive association.

Inversely, no experimental trial has assessed the effects of exercise or physical activity on the incidence and manifestations of CAHD. The lack therefore of a solid research background for the cardioprotective effects of increased energy expenditure, has led the medical community to ask for hard evidence linking physical activity and

exercise with the atherosclerotic process and/or its clinical manifestations (Cotton, 1991).

The aim of this section is to describe briefly the atherosclerotic process and to identify mechanisms that could affect its initiation, progression or regression. Furthermore it will present evidence that links physical activity and exercise with those mechanisms. Where possible, children will be considered in addition to adults.

## The Atherosclerotic Process

Angina pectoris, acute myocardial infarction or sudden death appear when the blood supply to the cardiac muscle has been interrupted by occlusion of the coronary arteries. This is a result either of thrombosis or of severe obstruction by atherosclerosis. However, atherosclerosis should be considered as the necessary initial process, since luminal narrowing, intimal haemorrhage leading to artery spasm or to thrombosis, or thrombosis in the absence of rupture of the atheroma are described as its intra-arterial complications in the medical literature (Elliot and Edwards, 1978).

The initial forms of atherosclerosis are fatty streaks which are completely reversible. Some of them process to fibrous plaques which in turn may become complicated lesions with haemorrhage, ulceration and thrombosis. The reversibility of these latter forms of atherosclerosis is largely limited.

Intense efforts have been made by researchers attempting to understand, prevent and treat atherosclerosis. Currently the most widely accepted mechanism of atherogenesis is incorporated in the infiltration theory proposed very early by Vitschow (Elliot and Edwards, 1978) and recently modified by Ross (1986) to become the response to injury hypothesis. According to Ross (1986) and Ross and associates (1990), an injury caused at the endothelium surface of the arteries operates as an inflammatory stimulus, attracting circulating monocytes to migrate into the intima. There they become phagocytic acquiring amounts of lipoprotein particles that cross the endothelium easily because of its injury altered permeability. Monocytes phagocytize large amounts of lipids and turn to lipophages creating the first form of atherosclerotic lesion the fatty streak. Fatty streaks develop further by continuous migration of more monocytes and lymphocytes into the injured area while smooth muscle cells of the arterial wall proliferate and migrate toward the intima under the influence of monocyte released growth factors. If the injury persists lesions progress forming a capillarized fibrous cap (Elliot and Edwards, 1978) and a necrotic centre (Wissler, 1980). The fibrous cap contains smooth muscle cells, collagen, intracellular and extracellular lipid, while the necrotic centre is composed of cell debris, cholesterol crystals, cholesterol

esters and calcium. Wissler (1980) underlined that fibrous caps are dangerous because of their size and tendency to rupture and ulcerate, while the necrotic centres are dangerous because of their size, consistency and their increased content of thrombogenic material. When an atherosclerotic plaque ruptures the thrombogenic material is exposed to the blood and often causes thrombus formation which may be fatal.

The cause of plaque rupture is not known but is speculated to occur "incidentally, when the plaque has become so vulnerable that it can no longer withstand the ever-changing haemodynamic and physical influences" (Falk, 1992, p. 204). In addition, Nakamura (1990) proved that coronary artery spasm in animals could cause intimal haemorrhage suggesting an additional mechanism. Hessel and Kluft (1986) and Falk (1992) stated that ultimately, ruptured plaques cause occlusive thrombi depending on the thrombogenic material released, local blood flow haemodynamics and the thrombotic-thrombolytic equilibrium. Loskutoff and Curriden (1990) corroborating this position, added that normal as well as pathological thrombi are usually cleared by the fibrinolytic system of the vessel wall and the blood, but sometimes the activity of a factor known as plasminogen-activator inhibitor that is present in the plaque, may inactivate this system. Interestingly, Brommer and associates (1992) observed that the plasminogen content of the thrombi increased during their first days or weeks making them susceptible to thrombolytic therapy. Inversely, in the course of months the decreased concentration of fibrin and plasminogen made the thrombi resistant to thrombolysis.

Ip and associates (1991) observed that microthrombi may form after endothelial injury but, in the absence of plaque rupture, classified the injuries of the endothelium in three categories according to their severity. In type I injury alterations of the endothelial cells are apparent without significant morphological changes. In type II injury the endothelium and the intima are injured while in type III the injury reaches the media. In the latter type of injury fibrillar collagen is exposed to the blood and platelets aggregate creating mural thrombi. In accordance with Elliot and Edwards (1978), Ip and associates (1991) suggested that type I vascular injury initiates the atherosclerotic process and that type II and III injuries of the fatty plaques along with thrombus formation contribute to its progression.

Sueishi and associates (1990) mentioned that various kinds of arterial injury may be caused by biochemical, immunological, viral and mechanical factors. For example Murota and associates (1990) reported extensive endothelial injury caused by arachidonic acid metabolites in vitro. Similarly, Kummerow (1985) observed that oxidative derivatives of cholesterol -being present in the beef tallow that is used to prepare French fries in fast food shops- altered the permeability of the endothelium and

caused cell degeneration and focal intimal edema in the arteries of rabbits. In addition, it has been shown that injury may be caused by materials released from mural thrombi in the presence of hypercholesterolemia (Sumiyoshi and Asada, 1990), but because some areas of the arteries become atherosclerotic and others seem to be resistant, it was speculated (Elliot and Edwards, 1978; Yoshida et al., 1990) that haemodynamic forces are contributory factors in the initiation and progression of the disease. Yoshida and associates (1990) reported that local blood flow patterns may initiate injury of the endothelium while, according to Steinberg (1990) elevated blood pressure may have a similar effect .

Whatever the cause of the injury, the progression of atherosclerosis seems to depend on the morphological changes that the injury caused to the vascular wall as well as on the continuous presence of the factor that caused the injury. Moore (1985) reported an experiment where two types of injury were caused. In the first case, a catheter placed in the aorta of a normal fed rabbit produced injury by repeated contact, while in the second a balloon catheter removed the endothelium of the aorta. Both types of injury were characterized by deposition of platelets on the vessel wall and migration and proliferation of smooth muscle cells into the intima. However, the injury produced by contact regressed upon removal of the stimuli while in contrast, removal of the endothelium caused a continuously progressive lesion with smooth muscle cell proliferation and lipid accumulation.

Steinberg and associates (1989) formulated a hypothesis about the development of the fatty streak lesion "that is based solely on the presence of elevated plasma LDL levels plus the oxidative modification of LDL within the artery wall" (Steinberg et al., 1989, p. 918). This hypothesis complements the response to injury hypothesis in its initial steps. It postulates that in the presence of high plasma LDL-C (low density lipoprotein-cholesterol) levels the concentration of LDL-C in the intima is increased, facilitating its oxidation. Subsequently, oxidized LDL-C attracts circulating monocytes, prevents their migration from within the artery back to plasma, enhances the uptake of native LDL-C by these cells and finally, because it is cytotoxic, it causes endothelial denudation. Apparently, oxidation of LDL-C is a necessary process for the development of the fatty streak, since native LDL-C, playing a major role in the extrahepatic cell cholesterol equilibrium is considered innocent (Ginsberg 1990). Oxidation of LDL-C is inhibited in the human serum and therefore Steinberg and associates (1989) proposed that the oxidation process probably takes place within the arterial wall. Indeed, Ginsberg (1990) underlined that both smooth muscle cells and monocytes are capable of oxidizing LDL-C. Thus, it was suggested that native LDL-C levels are a matter of concern in respect to atherosclerosis because "they provide

increased substrate for modification to lipoprotein forms that are directly associated with foam cell formation" (Ginsberg, 1990, p. 223).

Alternatively, it was observed that certain subclasses of LDL-C may be particularly atherogenic. Austin and associates (1988) investigated the relationship between LDL-C subclass patterns and incidence of non-fatal myocardial infarction in a population derived sample of 235 subjects, consisting of 113 cases and 122 controls. Multiple logistic regression analysis showed that increased levels of the small, more dense LDL-C subclass were associated with a three fold increased risk for myocardial infarction independent of sex, age and relative weight. In addition, increased concentrations of this LDL-C subclass were connected to increased triglycerides[1], VLDL-C (very low density lipoprotein-cholesterol) and IDL-C (intermediate density lipoprotein-cholesterol) and reduced levels of LDL-C. It was important that the association of small LDL-C levels with incidence of myocardial infarction was reduced when adjustments were made for HDL-C (high density lipoprotein-cholesterol) levels and was reduced to insignificance when controlled for triglycerides.

Two excellent contributions confirmed the role of triglycerides in atherosclerosis. In the first one Olsson and associates (1986), studied the effects of a one year serum lipid lowering treatment on the development of femoral atherosclerosis in 63 asymptomatic male subjects. Treatment with nicotinic acid for six months, after a six month healthy lifestyle advisory period, helped 3 subjects to regress their degree of stenosis. In 8 individuals the atheroma progressed and in the others the situation remained stable. Regression of stenosis correlated inversely but strongly and significantly with reductions of the triglyceride content of all lipoproteins. In the second study, Nakamura and associates (1990) investigated the relation between hypetriglyceridemia and sites of coronary arterial lesion in patients with heart disease, who underwent coronary angiography. It was concluded that patients with elevated cholesterol levels had mostly long or multiple stenoses in the coronary arteries, while subjects with elevated triglycerides appeared to have atherosclerosis at the proximal sites of the arteries. Overall, these results suggest that triglyceride levels as well as triglyceride content of the lipoproteins are important contributors in the progression and regression of CAHD, but also, strong agents for the regulation of the activity of the other lipoproteins in relation to atherosclerosis.

Triglycerides from the diet are taken up by chylomicrons at the intestine and are delivered to the various tissues of the body. Lipoprotein lipase (LPL) is the enzyme regulating the uptake of triglycerides from the blood to the tissues. The result of the reaction is that free fatty acids enter the tissue and a cholesterol rich chylomicron remnant remains in the blood and travels to the liver. Ginsberg (1990) reviewing pertinent

---

1 Triacylglycerols is the correct name, but the term triglycerides is used here for simplicity.

data concluded that chylomicrons and their remnants can be taken up by cells being present in the artery wall. Thus prolonged plasma residence times of chylomicrons may increase the probability of cholesterol delivery to the arterial wall. Situations of reduced LPL activity or increased plasma VLDL-C levels -which competes with chylomicrons for LPL mediated delivery of triglycerides to the tissues- would prolong plasma residence times of chylomicrons contributing to the progression of atherosclerosis. VLDL-C particles are synthesized by the liver from fatty acids, cholesterol, apoproteins and phospholipids. During the interaction with LPL, VLDL-C lose triglycerides and the products of this reaction are distinguished either as IDL-C to express the intermediate state toward LDL-C synthesis in the liver, or as VLDL-C remnants to indicate that those particles are catabolized and removed from the plasma. VLDL-C remnants are cholesteryl ester enriched and have been found to interact with macrophages and smooth muscle cells of the arterial wall to form foam cells. IDL-C are also cholesteryl ester enriched and may contribute to atherosclerosis in contrast to the native VLDL-C which is not considered atherogenic itself (Ginsberg, 1990). The enzyme hepatic lipase (HL) is synthesized by the liver and resides at the luminal surface of endothelial hepatic cells playing a role in removing triglycerides from partially catabolized VLDL-C or IDL-C, regulating therefore their conversion to LDL-C. The major role of LDL-C is cholesterol transport to extrahepatic tissues an activity that is regulated basically by the LDL receptor pathway (Brown and Goldstein, 1985). Ginsberg (1990) estimated that 60 to 70 per cent of the LDL-C catabolism occurs via the LDL receptor pathway while "the remaining tissue uptake is non receptor mediated" (Ginsberg, 1990, p. 221). The same author underlined however, that about half of the plasma LDL-C is taken up by the liver itself and that this process probably is LDL receptor regulated. Additionally, Brown and Goldstein (1985) stated that the LDL receptor also recognizes the IDL-C and therefore suppressed LDL receptor activity causes increased LDL-C production from IDL-C that would otherwise be removed from plasma. Thus the LDL receptor activity seems to play a major role in the regulation of plasma LDL-C levels. Ginsberg (1990) warned that in addition "the initial rates of entry of VLDL-C into plasma and the efficiency with which VLDL are converted to LDL will also play crucial roles in determining steady state LDL concentrations in plasma" (Ginsberg 1990, p. 221).

The main role of HDL-C is the so called reverse cholesterol transport from the tissues back to the liver for catabolism. HDL-C has two major subclasses. The HDL3-C accepts peripheral cell membrane free cholesterol. Under the activity of the enzyme lecithin: cholesterol acyl transferase (LCAT), cholesterol is esterified allowing for more free cholesterol uptake by the HDL3-C. The subsequent enlargement and embracement of apoproteins C-II and C-III contributes to the formation of the larger but less dense

HDL2-C, the major HDL-C subclass. HDL2-C either transfers its esterified cholesterol to other lipoproteins and cells through the action of the cholesterol ester transfer protein (CETP) or transfers its apoproteins to the liver. Because of its role in reverse cholesterol transport and its greater content of free and esterified cholesterol, HDL2-C is considered to be particularly antiatherogenic (Wood and Stefanick, 1990). Ginsberg (1990) underlined that regulation of HDL-C levels should be studied in connection with LPL activity. Indeed, higher LPL activity has been well associated with HDL-C levels in a number of studies (Weintraub et al., 1989; Sady et al., 1984; Kantor et al., 1984). Reduced transport of cholesterol to triglyceride rich lipoproteins and low plasma levels of these lipoproteins attributed to higher LPL activity, seems to be the possible explanatory mechanism for the relation of HDL-C and LPL. In addition, it has been speculated (Ginsberg, 1990) that reduced catabolic rate of the apoprotein apo A-I -the major constitutory part of HDL-C- and the higher plasma residence time of the apo C-II and apo C-III associated with enhanced LPL activity, may eventually determine the higher HDL-C plasma levels. Furthermore, low HDL-C levels are associated with abnormal levels of the other lipoproteins that carry HDL-C derived cholesteryl esters back to the peripheral tissues and presumably to the vessel wall, but Ginsberg (1990) warned that from existing data, the role of HDL-C in the progression of atherosclerosis is not fully clarified.

However, it is legitimate to speculate that such a relationship indeed exists. Firstly, cross sectional studies show a strong negative relationship between HDL-C levels and coronary stenoses (Naito, 1985), and with incidence of clinical complications of CAHD (Nikkila, 1986). Secondly, regression of atherosclerotic lesions correlates well with optimal manipulations of lipoprotein levels and more specifically with increased concentration of HDL-C and reductions in LDL-C, VLDL-C and triglycerides (Daoud et al., 1985). Thirdly, recent preliminary in vitro data (Ming-Peng et al., 1990) suggest that increased HDL-C levels may inhibit the penetration rate of LDL-C into the intima and the combination rate of LDL-C with endothelial cells that produces oxidized LDL-C. Fourthly, biochemical analysis of early life fatty streaks revealed that they are primarily composed of free cholesterol, while as they progress to become fibrous plaques their cholesteryl ester content increases in proportion to the free cholesterol (Ylä-Herttuala, 1991). Since HDL-C is capable of removing only free cholesterol from peripheral cells and extrahepatic tissues (Gupta et al., 1993), these results suggest that reverse cholesterol transport could be particularly effective in the regression of the early atherosclerotic lesions (Glueck, 1986). This position is strengthened by the observation that fatty streaks are completely reversible while such an effect cannot be fully expected for progressed plaques and complicated lesions (Elliot and Edwards, 1978).

So far the discussion has aimed to provide a background for the mechanisms and the factors that may initiate or influence the atherosclerotic process. In summary, initiation of atherosclerosis begins either with an injury of the endothelium or under the influence of oxidized LDL-C. Progression of atherosclerosis seems to depend on the continuous presence of the injurious stimulus and the consequent formation of mural microthrombi. Finally, regression of atherosclerosis probably depends on HDL-C levels and the related reverse cholesterol transport. Many risk factors have been identified to affect the atherosclerotic process. DiGirolamo and Schlant (1978) provided an impressive list of 57 risk factors for CAHD but as the same authors underlined, it is lipoprotein levels, lipoprotein metabolism and hypertension, the primary biological parameters, around which all of the others exert their influence. There has been speculation that increased physical activity and exercise affect many aspects of lipoprotein metabolism as well as blood pressure levels. In addition, monocyte function and the thrombotic-thrombolytic equilibrium seem to undergo training induced changes, that might be important in respect of formation and clearance of arterial thrombi. Since these mechanisms were identified as primarily important in the atherosclerotic process, the remaining part of this chapter will present and evaluate links between physical activity and exercise with those parameters in adults and where possible in children.

## Effects of Physical Activity and Exercise on Lipids and Lipoproteins in Adults

The description of the atherosclerotic process reveals that blood lipids and lipoproteins play a central role in the initiation, progression and regression of atherosclerosis. The aim of this section is to present evidence concerning the effects of exercise on lipids and lipoproteins.

Not all studies report alterations of the lipid profiles as a result of participation in exercise programmes. In order to establish any association between exercise and lipid profiles, well designed and usually expensive trials are required. Thus, many reports present methodological flaws that make interpretation of the results a difficult task, especially when comparisons with other studies are attempted. Weaknesses usually involve lack of control groups, inadequate number of subjects, high attrition rates during the regimen, failure to control for the effects of the last bout of exercise on the lipoprotein levels, failure to distinguish the net effect of exercise from body composition influences and, finally, inadequate control of dietary intake. In women's trials, oral contraceptive use and phase of menstrual cycle are confounding variables that are rarely well controlled. It can be expected that those primary drawbacks in association with difficulties in measuring energy expenditure accurately during physical

activity and exercise, make the existence of a perfect study doubtful. On the other hand, a number of trials that have used appropriate control groups, may be assumed to have controlled for many of the confounding factors mentioned. Lokey and Tran (1989) reported that 149 studies had been published so far, examining the effects of exercise on lipoprotein parameters. For the purposes of this thesis around 50 studies were selected, based on the appropriateness of research design and/or the contribution of findings in understanding the exercise-lipoprotein levels relationship. Studies that examined the effects of exercise on the lipoproteins of post-myocardial infarction patients are not considered because the medication usually taken by these individuals strongly contaminates the relationship (Wood and Stefanick, 1990).

Cross sectional studies involve two additional flaws, heredity and self selection bias. On the other hand, these designs permit the evaluation of the effects of long term participation in exercise and physical activity which is very difficult to achieve in clinical trials.

In a large scale epidemiological study done in Finland, Tuomilehto and associates (1987) examined the physical activity patterns of 3,975 men in relation to their HDL-C levels. They used a questionnaire to estimate the frequency and duration of physical activity and combined the indexes to obtain a rough measure of energy expenditure. Taken separately, intensity and frequency of participation in physical activity were both associated with lower serum cholesterol, but not with higher HDL-C levels when adjustments for body mass index were made. The combined estimate of energy expenditure was associated with lower cholesterol and higher HDL-C only above a certain level of energy expenditure. Similarly, Drygas and associates (1988) studied 146 healthy men aged 30 to 55 years and observed that persons expending more than 1,500 Kcal per week during physical activity as estimated by a questionnaire, had significantly higher HDL-C compared to their less active counterparts. However, Tuomilehto and associates (1987) suggested that individuals expending over 2,000 Kcal should not expect an additional benefit.

Apparently, adherence to a life long active lifestyle is as important as the amount of current exercise undertaken. Marti and associates (1991) studied four groups of men in a 15 year follow-up: runners that exercised regularly in 1973 and 1988, former runners exercising in 1973 but who had interrupted or reduced training during that period, a group of athletes engaged in strength training and a sedentary control group. The control group exhibited higher total cholesterol, VLDL-C, higher triglyceride content of the major lipoproteins as well as lower HDL-C and apo A-I compared to the group of runners only. Former runners did not differ from the other runners in 1973 but in 1988 their triglyceride and apo-B levels were significantly higher and correlated significantly with body fat gain. For subjects who were non-runners in 1988, amount of

physical activity correlated positively and significantly with HDL-C and apo A-1 levels and inversely with triglycerides and the ratio LDL-C/HDL-C. The results agree with those of Blair and associates (1985) who found that changes in physical activity over a 1 year period, as detected by a questionnaire, were positively and significantly correlated with changes in HDL-C levels in subjects exposed to a health education intervention. Marti and associates (1991) concluded that "in both the presence and the absence of an athletic predisposition, behavioral factors tend to influence the atherogenic risk of the serum lipid profile, predominantly via alterations in body composition" (Marti et al., 1991, p. 115). The results of Cook and associates (1986), although consistent with the first part of this statement, are in contrast with the proposition that body composition parameters are entirely responsible for the relationship between exercise and physical activity and lipoprotein profiles. These authors studied 35 active postal carriers and calculated a significant correlation coefficient between objective measures of physical activity obtained by a movement counter and levels of HDL-C and HDL2-C. No association was found for HDL3-C. Controlling for age, alcohol consumption and body mass index, the strength of the relationship was not reduced.

The association of training status with the HDL2-C subfraction is of particular interest because it is this subfraction that is considered to be particularly antiatherogenic. In several studies endurance athletes were found to exhibit significantly higher HDL-C and HDL2-C levels (Sutherland et al., 1993; Giada et al., 1988), compared with higher LDL-C and apo-B levels of the sedentary controls (Gupta et al., 1993; Sutherland et al., 1993; Giada et al., 1988). Differences in the lipoprotein profiles of active and inactive people are especially prominent with increasing age. Frey and associates (1990) found that active and inactive men aged less than 35 years had similar lipoprotein profiles. On the other hand, when compared to active counterparts, it was shown that older untrained subjects had increased concentrations of LDL-C, VLDL-C and triglycerides while HDL-C and HDL2-C were lower.

Cross sectional studies indicate that allowing for heredity, participation in aerobic pursuits is the only effective method of altering lipoprotein profiles. For example, Giada and associates (1991) compared aerobic trained, anaerobic trained and mixed trained (following aerobic as well as anaerobic training) elite athletes with sedentary controls. It was found that only the aerobic trained and mixed trained athletes had lower triglycerides than the sedentary controls along with slightly elevated HDL-C and lower LDL-C and apo-B. Besides, cross sectional data indicate that sex may mediate the physical activity-lipoprotein relationship. In the study of Sallis and associates (1988), 88 males and 180 females were examined for lipoproteins, physical activity levels and maximal aerobic capacity. Physical activity levels were assessed with a 7 day

recall questionnaire. Maximal aerobic capacity was positively associated with HDL-C and the ratio HDL-C/LDL-C for both sexes, but the seven day recall was related to those parameters only in females.

Women generally have healthier lipoprotein profiles than men in respect of health risk and therefore it is not surprising that studies which have examined women are inconsistent in their results. For instance Perry and associates (1992) found no differences in the lipoprotein profiles of female distance runners, aerobic dancers, recreational joggers and inactive controls. Reggiani and associates (1984) in contrast, found that active women matched for age and blood pressure with inactive controls and taking no oral contraceptives, had higher HDL-C values than the controls although they did not differ in the other lipoproteins. The difference between the two studies may well lie within the very high HDL-C values reported in the study of Perry and associates (1992) for their inactive control group. Finally, age seems to be an important factor to consider in studies of women. Rainville and Vaccaro (1984) examined 20 pre menopausal and 20 post menopausal women who were taking no oral contraceptives or hormones. Each age category included active and inactive subjects. The pre menopausal active women exhibited lower LDL-C values than their counterparts while the levels of the other lipoproteins were essentially the same. In the post menopausal women, training status was associated with an additional increased HDL-C concentration. Interestingly, no differences were detected between the trained post and pre menopausal women. In contrast, pre menopausal untrained women had lower total cholesterol and LDL-C than the untrained post menopausal ones. The authors suggested that menopause may cause changes in the composition of lipoproteins that may be countered at least partially by regular exercise participation.

All in all, cross sectional observations offer attractive suggestions for the relationship between physical activity levels, exercise participation and lipoprotein profiles of both sexes and it seems that these differences become increasingly prominent with advancing age. Nevertheless, firm conclusions cannot be drawn from the data since the correlational nature of the studies does not imply a cause and effect sequence. To complement the picture, reference to experimental trials is necessary.

From the controlled trials selected to be reviewed in this thesis concerning the effects of aerobic exercise on the lipoprotein profiles of men, table 3.1 was constructed to show the effect of exercise training on the major lipoproteins.

**Table 3.1: Changes of Lipoproteins as a Result of Exercise Training: Number of Studies Falling in Each Category of Change**

| *Lipoprotein* | *Reduction* | *Increase* | *Stable* |
|---|---|---|---|
| Total cholesterol | 2 | 1 | 6 |
| HDL-C | 2 | 5 | 6 |
| LDL-C | 3 | 0 | 5 |
| VLDL-C | 0 | 0 | 2 |
| Triglycerides | 2 | 0 | 8 |

Judging from the number of studies in each category of change, it seems that exercise is not effective in altering total cholesterol, LDL-C, VLDL-C or triglyceride levels. In respect to HDL-C the results are apparently contradictory.

Total cholesterol levels are not an important factor to consider. Measurements of total cholesterol include cholesterol carried by LDL-C as well as HDL-C and therefore although total cholesterol might be stable, its composition may well be altered (Haskell, 1986). Instead, it is important to underline that a series of very well designed trials appear to show no alterations in fasting triglyceride levels as a result of training (Smutok et al., 1993; Suter et al., 1990; Tanabe et al., 1988; Savage et al., 1986; Thomas et al., 1984; Wood et al., 1983; Weltman et al., 1980; Milesis et al., 1976) with few contradictions (Schriewer et al., 1983; Kiens et al., 1980).

Because triglycerides are mainly carried by VLDL-C in the fasting state, no changes would be expected in the VLDL-C levels as a result of training. Indeed, Weltman and associates (1980) and Wood and associates (1983) confirmed this hypothesis. In the study of Weltman and associates (1980) sedentary males were assigned to groups receiving a moderate exercise treatment with or without diet plus a sedentary control group. The duration of the study was 10 weeks and men were exercising 4 times per week for 45 minutes per session. In that of Wood and associates (1983) subjects were followed for a substantial period of 1 year and were exercising at an intensity of 70 to 85 per cent of their maximal aerobic capacity, 4 times per week. The duration of each session in this trial was 25 minutes. After the completion of the programmes no changes in VLDL-C levels were noted in either study. Because triglycerides and VLDL-C are so closely related, VLDL-C levels are often estimated, instead of being measured directly. This is the reason why, in this review these are the only two studies to have measured the effects of training on VLDL-C.

Weltman and associates (1980) reported that although VLDL-C levels of their subjects did not change, training had a significant effect in reducing LDL-C. These results were in agreement with two uncontrolled studies (Després et al., 1990; Boldt et

al., 1987, abstract) but were contradicted by a series of well designed experiments that did not show such an effect (Aellen et al., 1993; Smutok et al., 1993; Tanabe et al., 1988; Schriewer et al., 1983). Nevertheless, it is unlikely that the numerous changes happening within the body during exercise will leave LDL-C totally unaffected. In their study, Wood and associates (1983) reported that, overall, LDL-C did not change after 1 year of training, being in agreement with the majority of trials mentioned. When however, subjects were classified according to mileage run per week, it was revealed that LDL-C was reduced significantly in persons who ran over 4 miles per week on average. These results suggest that there might be a threshold of caloric expenditure over which exercise and physical activity may be of value. Moreover, it does not seem that the effect of exercise on LDL-C is influenced by changes in body composition. Wood and associates (1983) found that LDL-C and apo-B changes did not correlate with changes in percentage body fat as measured by the hydrostatic weighing method.

Recent research suggests that additional alterations may occur with LDL-C subfractions. Stucchi and associates (1991) studied the effects of exercise on LDL-C subclass composition in animals, after two years of training. They concluded that exercise had a significant adaptive effect, reducing the triglyceride content of all LDL-C subclasses and reducing the cholesterol content of the more dense LDL-C subclass. In the same vein, data from humans (Baumstark et al., 1993), reveal that a single bout of prolonged exercise reduces significantly the triglyceride content and concentration of the more dense LDL-C subfraction. A longitudinal trial has shown that such an effect was also noticeable after a year of aerobic training (Williams et al., 1989). These results are of particular importance since, as it was mentioned in the second part of this chapter, both triglyceride content of the lipoproteins and concentration of the more dense LDL-C subfraction were shown to contribute most to progression of the disease. Therefore it can be suggested that, although exercise generally may not influence levels of LDL-C, its effects may be manifested either over a certain threshold dose, or on the level of subfractions.

It is unfortunate that no research has examined the effects of exercise on the oxidation rate of LDL-C by monocytes, endothelial cells and smooth muscle cells of the arterial wall. It is equally unfortunate that the activity of LDL receptors in the arterial wall as well as in the liver has not yet been investigated. The significance of these mechanisms for the progression of atherosclerosis has been demonstrated in the medical literature and therefore any effect of exercise would be of upmost importance for prescribing pertinent regimens.

Several authors reported that HDL-C values increased as a result of exercise (Aellen et al., 1993; Suter et al., 1990; Schriewer et al., 1983; Kiens et al., 1980), but others found a stable pattern (Smutok et al., 1993; Tanabe et al., 1988; Savage et al.,

1986; Thomas et al., 1984; Weltman et al., 1980). Wood and Stefanick (1990) warned however, that plasma volume increases significantly and for a long period after exercise, suggesting that although total circulating HDL-C mass may change, its concentration may remain stable. Adjustments for plasma volume changes were not made in the studies reviewed here although they were well designed otherwise. Such a manipulation would in fact boost the concentration of HDL-C in higher levels so that it can be safely concluded that aerobic exercise training has the ability to increase HDL-C. On the other hand there might be a threshold dose of activity over which HDL-C seems to change. In the study of Wood and associates (1983) this threshold was determined to be over 8 miles of running at a moderate intensity every week. Young and Ruderman (1993) added that any effect of exercise cannot be seen with a few sessions but long term commitment to training is required to achieve benefits. Indeed, Després and associates (1990) observed that at 25 and 50 days of training HDL-C was unchanged and it increased only at the end of a 100 day programme in 5 young men. The same authors observed that apo A-I levels did not change, suggesting that the increase in HDL-C was entirely due to its increased cholesterol content and could not be attributed to increased number of HDL-C particles. Although sample size was small, this proposition agrees well with the finding of Wood and associates (1983) that the HDL2-C subfraction was increased in their regimen, while HDL3-C was reduced, and with Aellen and associates (1993) who reported stable HDL3-C and increased HDL2-C levels after training.

The trial of Aellen and associates (1993) deserves particular attention because these authors used direct measurements of the anaerobic threshold by blood lactate concentrations to label their regimens as aerobic or anaerobic[1]. Sixteen subjects trained at an intensity above the anaerobic threshold and 17 below it, for about 30 minutes, 4 times per week, for a total of 9 weeks. Adaptations occurred during training and workloads had to be readjusted from session to session to keep the intensity as required. Subjects training below the anaerobic threshold exhibited elevated post training HDL-C values primarily due to alterations in the HDL2-C subfraction. An unexpected result was that in subjects training above the anaerobic threshold -and thus at higher intensities- HDL-C levels were significantly reduced along with reduced HDL2-C levels. Because blood samples were taken two and three days after the last exercise bout, the residual effect of exercise could not account for these alterations. In addition, because this trial was very well controlled it can be suggested that the unfavourable lipoprotein alteration seen in the high intensity group was the net effect of training at increased workloads. The authors concluded "Our results strongly suggest that hobby exercisers who train for short periods with high intensity would in fact improve their

---

1 Anaerobic threshold was defined as blood lactate concentration 4 mmol / l.

cardiovascular fitness but not benefit from atherosclerotic prevention" (Aellen and associates, 1993, p. 399).

In their meta-analyses Tran and associates (1983) and Tran and Weltman (1985) suggested that changes in lipid and lipoprotein profiles were closely associated with changes in body weight. Weintraub and associates (1989) examined whether alterations seen in lipoproteins with training, were mediated by changes in body weight. Six normolipemic men participated in a 7 week training programme for a total of 29 sessions. Training involved 30 minutes jogging each time and totalled an average distance of 15.2 miles per week. During the experiment caloric intake of the subjects was raised to compensate for the increased caloric cost of exercise. As a result, body weight did not change from baseline values. Triglyceride levels were significantly decreased. In contrast, the levels of the other lipoproteins changed toward favourable directions but these changes did not approach significance. These results support the conclusions of the meta-analyses mentioned above but are clouded by lack of control groups. Nevertheless, this experiment was unique in manipulating dietary intake thus attributing any effect to the exercise stimulus independent of body weight changes. Perhaps the most interesting finding reported from Weintraub and associates (1989) was the substantial 32 per cent reduction in postprandial triglycerides. It was seen that the majority of the studies reported that fasting triglycerides did not decrease as result of training. The study of Weintraub and associates (1989) although uncontrolled, revealed the existence of a possibly important mechanism for the cardioprotective effect of exercise. The authors concluded, "we speculate that the initial effect of exercise is to increase lipolysis and lower fasting and postprandial triglyceride levels and that the increase in HDL concentration is a later event that may reflect changes in body composition" (Weintraub and associates, 1989, p. 1012). However, this may be a spurious conclusion. The existence of high correlations between variables does not imply a cause and effect relationship.

Changes in body composition or body weight may not provide a satisfactory mechanism to explain alterations in lipoprotein levels seen with training, since it does not refer to the adaptive responses of the human body to the increased demand for the supply of energy imposed by the working muscles. In the study of Weintraub and associates (1989) the activity of the enzyme lipoprotein lipase (LPL) correlated highly with changes in postprandial triglyceride levels. Muscle LPL activity has been shown to increase substantially as a result of exercise training in humans and in animals (Giada et al., 1988; Kantor et al., 1987; Kiens and Lithell, 1989; Bagby et al., 1986; Budohoski, 1985). Furthermore, cross sectional studies reveal that LPL activity is elevated in trained runners compared to sedentary controls (Herbert et al., 1984; Kuusi et al., 1982). LPL exists in large quantities in the muscles, the adipose tissue and the heart

and plays a central role in the uptake of free fatty acids -and thus energy- by these organs. Exercise has been found to alter the activity of three other enzymes, the hepatic triglyceride lipase (HL), the cholesterol ester transfer protein (CETP) and the lecithin: cholesterol acyl transferase (LCAT). More specifically, it has been found to reduce the activities of CETP (Seip et al., 1993; Sutherland et al., 1993) and HL (Kantor et al., 1987; Kantor et al., 1984; Sady et al., 1984; Kuusi et al., 1982). and to increase the activity of LCAT (Gupta et al., 1993; Sutherland et al., 1993). For reasons that were mentioned briefly in the second part of this chapter, these changes would theoretically result in increased uptake of triglycerides by peripheral tissues, in increased filling of HDL2-C with free and esterified cholesterol, in decreased transfer of cholesterol from HDL-C to LDL-C and finally in decreased catabolic rate of HDL-C by the liver. Taken altogether these effects theoretically mean that exercise training would produce alterations of HDL2-C levels, and reduced triglyceride content of the LDL-C and VLDL-C lipoproteins. From the review of the studies already presented it seems that these alterations indeed occur. Thus, it can be proposed that the mechanism that could best explain the relationship of exercise and lipoprotein levels is the exercise induced alterations in these enzymes. It is felt that this mechanism is likely because it links a primary need imposed by exercise, that is the increased demand of energy in the form of fatty acids to the working muscles, with accompanying alterations of lipoproteins that happen to be of value in respect to atherogenesis.

In contrast to aerobic exercise, resistance training is regarded as relatively ineffective in achieving the same results. For example, Kokkinos and associates (1991) subjected 16 untrained men at high risk for CAHD to 20 weeks of resistance training and observed no changes in their lipoprotein profiles as compared to a control group. In their reviews, Hurley (1989), Goldberg (1989) and Stewart (1992) proposed that aerobic exercise is more effective than resistance training in altering lipoprotein levels. On the other hand it is likely that resistance training that brings about aerobic adaptations may be quite effective in altering lipoproteins. Recent research by Wallace and associates (1991) indicated that one bout of resistance exercise at high work loads and few repetitions left lipoprotein levels unchanged, while favourable alterations were seen in subjects that exercised with more repetitions, lower workloads and shorter intervals. Furthermore, excellent research by Kiens and Lithell (1989) proved that it is the adaptations that occur on the level of skeletal muscles that are responsible for the alterations seen in lipoproteins. These researchers trained the knee extensors of one leg only, in a group of six healthy men aged 23 years on average, while the other leg of the subjects served as a sedentary control. After an 8 week period of training, increased production of HDL2-C was observed in the trained thigh concomitant with increased LPL activity and enhanced VLDL-C uptake from the muscles.

It may be suggested that individuals with favourable lipoprotein profiles should not expect to alter their values easily, while those at higher risk should expect to benefit more. In the meta-analyses of Tran and associates (1983) and Tran and Weltman (1985) it was proved that this was indeed true. A similar pattern was found in the meta-analysis of Lokey and Tran (1989) who reviewed studies of women. In addition, in the latter paper it was observed that it was more difficult for women to alter their lipoproteins than men. The difference in the response to exercise was attributed to the more favourable lipoprotein levels of the women, since after adjustment for initial levels, no differences were found between men and women.

Nevertheless, women may experience significant changes in their lipoprotein levels if they engage in long term exercise training. For example, Tremblay and associates (1991) trained 4 obese women for 15 months with aerobic exercise, and noted significant reductions in LDL-C and apo-B levels. Similarly, Després and associates (1991) observed significant reductions in total cholesterol, LDL-C and apo-B and significant increases in HDL-C, apo A-I and HDL2-C in 13 obese pre menopausal women who trained for 14 months, 4 to 5 times per week, for 90 minutes each time, at a moderate intensity of 55 per cent of their maximal aerobic capacity. Menstrual cycle phase was well controlled in this experiment. In contrast to the above, studies of shorter duration did not produce any alterations in the lipoproteins of women (Hinkleman and Nieman, 1993; Williford et al., 1988) although they utilized similar regimens. Overall, these results corroborate findings from studies that used resistance training in women. For example, Manning and associates (1991) did not report any changes accruing from a 12 week period of resistance training, but Boyden and associates (1993), following a similar in nature but longer in duration 5 month regimen, observed significantly decreased LDL-C and total cholesterol values, although HDL-C and triglycerides remained unaltered.

Very often, manipulation of lipoprotein levels is attempted through dietary manipulation. Exercise is apparently a useful complement to these attempts. For instance, Kanaley and associates (1993) noted significant increases in HDL-C in obese women who participated in a dietary regimen complemented by exercise 3 times per week, 30 minutes per session at an intensity of 60 to 80 per cent of maximal aerobic capacity. In a similar trial by Weltman and associates (1980) HDL-C remained stable but LDL-C decreased significantly, whereas Ready and associates (1991) did not note any alterations at all. The results of this latter study should be interpreted with caution because of the very high -49 per cent- attrition rate during the regimen. Well designed studies consistently show that dietary modification complemented with exercise contributes to favourable alterations of lipoprotein profiles (Wood et al., 1991; Tremblay et al., 1991). In a more natural setting, Faber and associates (1992) reported

that sustained changes in nutrition and the significant increase in daily physical activity caused by participation in a hiking expedition in South America, brought about significant, favourable lipoprotein changes. Moreover, in the excellent diet and moderate exercise trial, Singh and associates (1993) proved that a programme combining diet with exercise was superior to dietary modification alone. Two groups composed of persons at risk of atherosclerosis were formed randomly, with one receiving a lipid lowering diet and the other adding moderate exercise designed to increase daily caloric expenditure by 200 Kcal per day to its dietary regimen. After 20 weeks of adherence to the programme, subjects receiving exercise in addition to diet, showed a significant decrease in total cholesterol, LDL-C and fasting triglycerides, concomitant with increased HDL-C as compared to the diet only group.

A crucial issue is whether changes in lipoprotein profiles demonstrated in experimental trials prevent or regress atherosclerosis. In a thorough review of the pertinent medical literature based primarily on data from animals, Moncada and associates (1993) concluded that atherosclerosis can be prevented but also it may regress when pharmacological treatment is employed. In addition, they demonstrated convincingly that with the currently available laboratory methods, regression of atherosclerosis is measurable with acceptable accuracy. In humans, high quality cross sectional data (Gupta et al., 1993) demonstrated that athletes have an increased rate of reverse cholesterol transport as compared to sedentary subjects.

A unique trial examined the effects of lifestyle modification on the progression and regression of coronary atherosclerosis, as well as on its clinical manifestations. The lifestyle heart trial (Ornish et al., 1990) included 28 patients with established coronary atherosclerosis and assigned them to an experimental group undergoing moderate exercise, cessation of smoking, stress management and a low fat vegetarian diet, and to a control group receiving regular treatment. The duration of the study was 1 year and progression or regression of atherosclerosis was measured by quantitative coronary angiography. The training programme involved low intensity efforts for ischemic patients, while for non ischemics an intensity corresponding to 50-80 per cent of their age predicted maximum heart rate was prescribed. Training was done for a minimum of 3 hours per week and patients spent at least 30 minutes per session exercising within the prescribed heart rates. Adherence to the programme was closely monitored and the authors established scores corresponding to the degree of adherence to the prescribed regimen. In general, adherence to the programme was excellent. After 1 year of intervention the experimental group had lower total cholesterol and LDL-C compared to the control. HDL-C did not change significantly. More importantly, average coronary stenosis regressed significantly in the experimental group while in the control group it progressed even more. Similarly, patients in the experimental group reported a

91 per cent reduction in the frequency of angina pectoris, 42 per cent reduction in its duration and 28 per cent reduction in its severity. Degree of adherence to the programme was strongly associated with the changes seen in the experimental group, implying a dose response relationship between intensity of treatment and outcome. This research suggests that comprehensive lifestyle changes may help in the regression of atherosclerosis after only 1 year. The independent role of exercise in achieving these benefits was not assessed however.

It could be speculated that it would be easier to achieve the changes seen in the study by Ornish and associates (1990) if interventions were started during early childhood, when atherosclerotic lesions are in the form of reversible fatty streaks. Angiographic data or autopsy studies are not available to consider the effect of physical activity and / or exercise in relation to atherosclerosis in children. Thus, the potential of exercise in preventing atherosclerosis if introduced during early childhood has to be evaluated on the ground of lipoprotein alterations that accrue as a result of participation in exercise programmes.

## Effects of Physical Activity and Exercise on Lipids and Lipoproteins in Childhood

Studies in this area may be divided into cross sectional surveys and experimental trials.

In a cross sectional comparison, Välimaki and associates (1980) studied a small sample of 37 schoolchildren aged 11 to 13 years. Nine boys and 7 girls were participating in track and field events while 12 boys and 9 girls were not participating in any form of organized training. Blood analysis revealed no significant differences in total cholesterol, fasting triglycerides, LDL-C and VLDL-C between the two groups and these results held independent of sex. Instead, trained boys and girls had significantly higher HDL-C values than their untrained counterparts. Atomi and associates (1986) corroborated these findings studying 21 trained and 21 untrained Japanese boys aged 10 to 12 years. Their analysis showed that higher HDL-C values found in the trained group could be attributed to the higher HDL2-C concentrations. Moreover, Mácek and associates (1989) reported that in their sample of adolescent girls and boys aged 16 years on average, lower LDL-C, apo-B and fasting triglyceride levels and higher HDL-C and apo A-I levels were found in the trained subjects as compared to the untrained group.

In contrast, correlational surveys of larger scale show either a weak or a lack of association between blood lipid levels and indices of physical activity or fitness. For

instance, Marti and Vartiainen (1989) selected 1,142 boys and girls aged 15 years, from 40 Finnish schools. Physical activity was assessed with a single question asking about frequency of participation in vigorous physical activities. No differences were found in total cholesterol between highly active and very inactive children. The authors speculated that the lack of any apparent association could be explained by the high prevalence of leisure time physical activity prominent in this particular sample. Although this proposition might be true, it is likely that the one item questionnaire used in this survey could not assess accurately the physical activity levels of the children. Another study that used the same single item questionnaire (Tell et al., 1988) with 413 boys and 372 girls from Norway, noted that girls exercising more frequently had lower fasting triglyceride levels than their schoolmates but no other differences were apparent. In the same study, maximal aerobic capacity was positively and significantly associated with the ratio HDL-C/total cholesterol in boys, while in girls it was positively associated with HDL-C and the ratio HDL-C/total cholesterol and negatively with fasting triglyceride levels.

Sallis and associates (1988) studied 148 boys and 142 girls from California. The ratio of HDL-C/LDL-C was significantly but weakly correlated with a simple activity rating while the significant and strong correlations between maximal aerobic capacity and HDL-C and HDL-C/LDL-C were reduced to insignificance when corrected for body mass index. These results have been replicated in adolescents with low to moderate levels of fitness (Fripp et al., 1985) while others have found very weak correlations between fitness and lipoprotein parameters (Wilmore and McNamara, 1974; Gilliam et al., 1981). Taken altogether these results show that the association between fitness and lipoproteins in children is probably strongly mediated by body composition parameters. No association seems to exist between lipoproteins and physical activity levels although in the studies reviewed the latter variable was poorly assessed. However, in a very recent study (Suter and Hawes, 1993) that assessed more carefully the physical activity levels of 39 boys and 58 girls using a detailed 7 day recall questionnaire, physical activity levels were positively associated with HDL-C in both sexes. In addition it was inversely associated with VLDL-C, the ratio total cholesterol/HDL-C and fasting triglycerides in boys. It has to be underlined that the correlations reported in this study were generally weak but importantly, they held even after adjustments for body composition variables as assessed from skin fold thickness.

Experimental trials consistently show that exercise programmes are ineffective in altering lipoprotein levels in boys. Linder and associates (1983) randomly assigned 50 boys aged 11 to 17 years to an exercise or a sedentary control group. The experimental group participated in an 8 week progressive exercise programme that included walking and jogging 3 times per week, 30 minutes per session at an intensity of 80 per cent of

the maximum heart rate. In addition, experimental subjects participated once a week in a soccer or a rugby game for at least 1 hour. No differences were found between the two groups in weight, triceps skin folds, total cholesterol, fasting triglycerides, HDL-C, LDL-C and VLDL-C, before and after the regimen. These results have been replicated in several other studies that included a larger number of subjects but shorter duration regimens (Linder et al., 1979, abstract), longer duration -12 weeks-programmes (Gilliam and Freedson, 1980), subjects possessing risk factors for coronary atherosclerotic heart disease (Bryant et al., 1984) and different mode of training in the form of soccer (Deveaux et al., 1986).

Furthermore, Savage and associates (1986) convincingly demonstrated that exercising at low or high intensities were equally ineffective in altering lipoprotein levels of boys. These authors studied 10 boys assigned to a sedentary control group, 10 assigned to exercise at 40 per cent of maximal aerobic capacity and 12 assigned to exercise at 80 per cent of maximal aerobic capacity. The duration of the study was 10 weeks and involved walking or jogging for a total distance of 1.6 km per session, 3 days per week. Holding the distance equal between the experimental groups meant that any differences apparent after the programme could be attributed to different intensity efforts. However it was revealed that HDL-C, LDL-C and fasting triglycerides did not change as a result of training.

It may be concluded that exercise does not have any effect on the lipoprotein profiles of young boys. It remains to be examined whether alterations may occur as a result of long term participation in exercise. Alternatively, alterations may occur on the level of lipoprotein subfractions or lipoprotein triglyceride content, but no trial is known to have considered these issues.

In contrast to boys, girls, although they were shown not to alter their total cholesterol levels after 1 month (Cohen et al., 1991) or 6 weeks (Gilliam and Burke, 1978) of aerobic training, they were found to alter their HDL-C levels (Gilliam and Burke, 1978). In this study 14 girls aged 8 to 10 years followed an exercise programme 5 times per week for 40 minutes per session. Measurements of HDL-C values were taken 1 and 9 days following the last exercise session. A repeated measures analysis showed that alterations seen in HDL-C one day after the last bout of exercise were still prominent on the ninth day, showing that adaptive responses occurred as a result of training.

No studies have assessed the potential of exercise to influence lipoprotein subfractions. Such changes have been noted however in the study of Endo and associates (1992) who combined diet with exercise to manipulate the lipoproteins of 7 boys and 6 girls. Four weeks of adherence to the prescribed regimen was adequate to reduce total cholesterol, fasting triglycerides and apo-B levels. HDL-C remained stable but reductions in the apo A-I indicated an increased cholesterol uptake from the HDL-C. Simi-

larly, Epstein and associates (1989) treated obese children with diet and exercise and found that the observed weight reduction was accompanied by increased HDL-C and decreased fasting triglycerides and total cholesterol. Furthermore, Becque and associates (1988) demonstrated that adding exercise to a dietary regimen is of additional benefit for obese adolescents. In this trial exercise involved 50 minutes of aerobic activity at 60 to 80 per cent of maximal heart rate, 3 times each week. The total duration of the programme was 20 weeks. The trial was well controlled by random assignment of the 36 subjects to control, diet only and diet plus exercise groups. Total cholesterol was reduced in both experimental groups but these changes did not reach significance. However, HDL-C was increased significantly only in the group that participated in the exercise programme.

The influence of exercise on the lipoproteins of children is a relatively under researched area. There is a lack of information in respect of duration and frequency of exercise required to achieve any changes. Serious gaps exist and therefore it is not possible to answer the question of how exercise affects the lipoproteins except HDL-C, particularly on the subfraction level. Since cross sectional studies do show some differences in lipoprotein profiles between active and inactive children while experiments in most cases do not support this notion, it may be suggested that differences may reflect self-selection bias. Alternatively, it is possible that a lifelong active lifestyle may favourably alter lipoprotein levels while a short experiment may not elicit similar changes. Very few studies have considered girls as subjects. Finally, no trial has combined nutrition education with exercise in manipulating lipoprotein parameters of both sexes.

**Physical Activity, Exercise and Hypertension**

Hypertension is widely recognized to be a major risk factor of CAHD. No cutoff point is agreed as a threshold for lower incidence of CAHD clinical manifestations however. Instead, a continuous distribution shows that the higher the blood pressure the higher the risk. It was mentioned in the second part of this chapter that elevated blood pressure may injure the coronary artery endothelium but it is well known that "hypertension accelerates atherosclerosis only if hyperlipidemia is present" (Elliot and Edwards, 1978, p. 1107). Thus, efforts aimed at preventing or treating hypertension would be of particular value for certain subgroups of the population that exhibit abnormalities in their lipoprotein levels as well as abnormal blood pressure.

Exercise has long been considered for its hypertensive effects. Several experimental studies have shown that aerobic exercise training performed 3 or more times per

week for over 30 minutes at a moderate intensity, is capable of reducing significantly the systolic and diastolic blood pressures of individuals exhibiting mild hypertension (Hagberg et al., 1989; Sasaki et al., 1989; Nelson et al., 1986; Duncan et al., 1985; Roman et al., 1981; Bonanno and Lies, 1974) with rare controversies (Blumenthal et al., 1991; De Plaen and Detry, 1980), but only recently a powerful, authoritative summary statement was published by the American College of Sports Medicine (ACSM, 1993) that considered the bulk of experimental data in this area. The American College of Sports Medicine (ACSM, 1993), defining hypertension as blood pressure above 140/90 mm Hg (systolic/diastolic blood pressure), stated that hypertensive persons should consider regular participation in exercise regimens similar to those recommended for achieving and maintaining cardiorespiratory fitness. An exercise oriented, blood pressure lowering programme, should incorporate 20 to 60 minutes of aerobic training, 3 to 5 days each week, at an intensity 40 to 70 per cent of the maximal aerobic capacity. Resistive exercise is recommended only as complementary to aerobic training. The ACSM (1993) concluded that following the recommended regimen, individuals exhibiting mild hypertension -between 140/90 and 180/105 mm Hg- should expect to reduce both systolic and diastolic pressure by 10 mm Hg. Individuals exhibiting severe hypertension should add exercise to their treatments only after an initial phase of blood pressure lowering with pharmacological agents.

The ACSM (1993) statement, although it is authoritative and powerful, does not mention the effects exercise may exert on the blood pressure of children. Normal blood pressure ranges for children are considered to be between 100/75 mm Hg and 120/85 mm Hg, while hypertension has a blood pressure over 140/90 mm Hg (Bell et al., 1986).

Vaccaro and Mahon (1989) and Baranowski and associates (1991) did not find an inverse relationship between blood pressure measurements and estimates of childhood physical activity or indices of children's physical fitness in the cross sectional studies that they reviewed, although Rowland (1990) reached different conclusions. Recent investigations with large and well sampled cohorts show an inconsistent picture for the relationship between fitness and blood pressure. Andersen and associates (1989) studied a representative sample of 124 boys and 169 girls from Denmark, measuring their aerobic capacity. They found no correlation between this measure and levels of blood pressure, corroborating the findings of Jenner and associates (1992) who studied a large sample of 1,311 Australian children aged 11 to 12 years. Fripp and associates (1985) documented an inverse association between blood pressure and physical fitness of 10th grade adolescents, which was reduced to insignificance when body weight was held constant. Similarly, Sallis and associates (1988) found that in 148 boys and 142

girls aged 11 years on average, blood pressure was inversely associated with maximal aerobic capacity, but correlations were insignificant after controlling for body mass index. However, this effect was more prominent in boys, since in girls correlations were reduced but remained significant after the adjustments. Gutin and associates (1990) observed that in a sample of 215 children aged 5 and 6 years, diastolic blood pressure was inversely related to fitness in boys and girls. This effect was not noted for systolic blood pressure.

It is not easy to explain why some studies show a correlation between blood pressure and fitness while others do not support such a proposition. Undoubtedly there are many confounding factors. For example, aerobic fitness is to some extent determined by heredity, a fact that is probably true for blood pressure as well. Differences in the protocols for measuring maximal aerobic capacity may be decisive in documenting the existence of a relationship. For example Fripp and associates (1985) used a field test to measure fitness while Sallis and associates (1988) used a laboratory method. Differences in the mean body composition between cohorts could explain some of the discrepancies but no study has used highly accurate methods for measuring body composition parameters. Finally, sex may be a strong additional mediator. In the study by Sallis and associates (1988), adjusting for body mass index did not counter the inverse association between fitness and blood pressure in girls. Body composition may not be an important determinant of the relation between fitness and blood pressure in girls but the mechanism is unknown. It is also unknown why such an effect is not documented in boys.

Physical activity estimates show no correlation with blood pressure levels in the majority of well designed cross sectional studies. The correlational studies of Baranowski and associates (1988), Jenner and associates (1992), Sallis and associates (1988) and Klesges and associates (1990) were consistent in documenting that no relationship existed between levels of childhood physical activity and blood pressure.

Experimental trials show a different picture. Several reviews (Baranowski et al., 1991; Rowland, 1990; Vaccaro and Mahon, 1989), concluded that aerobic exercise training seems to reduce the blood pressure of hypertensive and/or obese children, but it is not effective in reducing the blood pressure of normotensive children. Indeed, Linder and associates (1983) subjected a group of 50 normotensive boys to an 8 week aerobic exercise regimen including 30 minutes of jogging at 80 per cent of maximum heart rate 4 days each week. This trial was very well designed since subjects were randomly assigned to experimental and control groups and adherence to the regimen was very high. No changes were reported for either systolic or diastolic blood pressure at the end of the trial, in agreement with Bryant and associates (1984) who did not observe any differences in the blood pressure of normotensive children trained in a

similar regimen for a period of 12 weeks. Following a similar 12 week programme, Danforth and associates (1990) demonstrated significant reductions in the blood pressure of 11 hypertensive black children aged 8 to 12 years. In the same way, McKenzie and associates (1984) found that a 7 week residential camping programme incorporating at least 2 hours of daily exercise, 6 days per week, was effective in reducing significantly the systolic and diastolic blood pressure of 35 obese males, aged 13 years on average. These results support the proposition that exercise may be an effective means of lowering the blood pressure of children in higher risk categories.

Blood pressure was related to fitness levels in some cross sectional studies but this relationship was sometimes mediated by body mass index or body weight especially in boys. Hagberg and associates (1983) provided evidence that the reductions in the systolic and diastolic blood pressure observed after a 6 month training programme were not accompanied by weight and skin fold thickness reductions in 25 male adolescents aged 16 years. Thus, the authors suggested that exercise is effective in reducing blood pressure of hypertensive and/or obese boys independent of changes in indirect indexes of body composition. In addition, a well controlled study (Fripp and Hodgson, 1987) showed that resistive training was not effective in altering the blood pressure of 14 boys aged 14 to 17 years. The programme included weight training 3 times per week, 60 to 80 minutes per session for a total of 9 weeks.

Much more research is needed to establish whether these effects hold for girls or when body composition is measured with more accurate methods. Judging from available data it can be concluded that the pattern of influence of increased physical activity on the blood pressure of adolescents and children resembles that of adults. The blood pressure of normotensive adults is not reduced as a result of training (Rowland, 1990), while individuals exhibiting mild hypertension derive substantial benefits (ACSM, 1993). These effects are independent of sex in adults while in children the issue is under researched. Resistive training may be of value when supplementary to aerobic exercise, but alone it does not reduce blood pressure of normotensive or hypertensive persons. Finally, in the absence of experimental data it cannot be speculated whether exercise, if initiated during childhood, could prevent hypertension.

**Physical Activity, Exercise, Fibrinolysis, Coagulation and Monocytes**

It is generally assumed that severe imbalance between coagulation and the fibrinolytic system could predispose to increased risk of thrombosis or tendency to develop bleeding diathesis (Loskutoff and Curriden, 1990). Thrombus formation is a critical event in the expansion and progression of the atherosclerotic plaque (Elliot and

Edwards, 1978). In addition, thrombosis leading to clinical manifestations of CAHD is usually observed over ruptured atherosclerotic lesions. Thrombolytic therapy is often applied to compensate for these acute complications (Collen and Lijnen, 1991), but exercise has long been considered for its potential to enhance fibrinolytic activity and thus, possibly, to prevent progression of atherosclerosis caused by the formation of mural thrombi.

The coagulation-fibrinolytic system is very complex and its detailed description goes beyond the aims of this thesis. It is sufficient to mention that the major factors contributing to coagulation are fibrinogen, thrombin and thromboplastin, while the respective fibrinolytic-thrombolytic agents are plasminogen and plasminogen activators. In addition, the presence of plasminogen-activator inhibitor partially inactivates the fibrinolytic-thrombolytic system (Marieb, 1989).

Apparently, a single bout of strenuous exercise enhances the activity of the coagulation system. For example, Herren and associates (1992) observed that 1 hour of exhaustive running increased the concentration of thrombin-antithrombin complexes in the plasma of 10 conditioned young men training regularly at least twice weekly. In an earlier experiment, Wheeler and associates (1986) had reported similar results for 19 healthy males subjected to a maximal progressive treadmill test, being in agreement with Röcker and associates (1986) who observed 16 runners after a marathon race. Dufaux and associates (1991) concluded that changes taking place in the coagulation system as a result of exhaustive exercise, are no longer observable after a 30 to 60 minutes rest. Changes in the coagulation system of the subjects in the trials of Herren and associates (1992) and Wheeler and associates (1986) correlated positively and significantly with blood lactate concentrations, suggesting that initial level of training as well as intensity of exercise are important mediators of the relationship. In the trial of Herren and associates (1992), an additional group of 10 untrained young males were subjected to 1 hour of slow jogging and the response of their coagulation system was not as exaggerated as that observed in the trained subjects that underwent exhaustive running. In contrast, Drygas (1988) found that one bout of prolonged moderate exercise did not cause any changes in the coagulation system of 47 healthy males, but it enhanced significantly the activity of their fibrinolytic system.

Several other reports generally agree that a single bout of exercise enhances the activity of the fibrinolytic system of sedentary and trained men (De Paz et al., 1992; El Sayed, 1990; Röcker et al., 1990; Ferguson et al., 1987; Ohri et al., 1983; Hawkey et al., 1975) and of sedentary and trained women (Martin et al., 1985). Andrew and associates (1986) found that this response depended on intensity and duration of effort in 5 males, but another study utilizing a larger sample of 47 subjects did not support such a difference (Drygas, 1988). In their review, Bourey and Santoro (1988)

concluded that a bout of exercise may cause a 5 to 10 fold increase in plasma fibrinolytic activity. Such an increase is achievable by moderate exercise at 50 per cent to 65 per cent of maximal aerobic capacity but it is short lived since it has a half life of 2-5 minutes. According to the same authors these results were valid independent of the methods used for the measurement of coagulation or fibrinolytic system activity.

An early cross sectional survey examined 722 men (Korsan-Bengtsen et al., 1973) and concluded that individuals engaged in higher levels of physical activity at work and in leisure time had shorter blood clotting times without exhibiting higher fibrinolytic activity. These data suggested that participation in exercise and physical activity would not decrease the risk of thrombosis. A more recent experimental trial (Williams et al., 1983), subjected adult men and women aged 25-69 years to a 10 week physical conditioning aerobic programme. The regimen included training 3 days per week, 30 to 45 minutes walking or jogging per session, at an intensity that corresponded to the 70-85 per cent of the baseline maximal aerobic capacity. The authors found that the fibrinolytic response of the subjects at rest declined significantly as a result of training, but a striking difference was noted in the fibrinolytic response to venous occlusion. The increase in fibrinolysis in the presence of thrombogenic stimulus was more noticeable in women and in persons who initially had lower levels of maximal aerobic capacity. The results of Williams and associates (1983) indicated that the fibrinolytic system of subjects after a conditioning period that elicited significant improvement in maximal aerobic capacity, acquired the ability to enhance clot clearance from vessel walls when such a requirement was raised. Similar results were reached from a different point of view by de-Geus and associates (1992), who concluded that 4 months of training were adequate to decrease the activity of the plasminogen-activator inhibitor in a group of previously sedentary subjects.

An interesting link was demonstrated to exist between the function of the coagulation system and the activity of circulating monocytes in respect to atherosclerosis. Osterud and associates (1989) observed 12 men and 9 women members of the Norwegian national cross country ski team and 19 men and 6 women just below the national level, before and after a ski race competition. A marked increase in the white blood cell count was noted and it was attributed to the duration of the strenuous exercise undertaken. Importantly, monocyte susceptibility to stimulation was increased after the race and was associated with increased synthetic rate of thromboplastin, an important coagulant. In other studies, exercise stimulated monocytes of sedentary individuals have been shown to produce increased amounts of interleukin-1 (Mackinnon, 1992; Haahr et al., 1991). In well trained runners submaximal exercise reduces or does not affect production of interleukin-1 from monocytes (Mackinnon, 1992), but maximal efforts do have such an effect (Lewicki et al., 1988).

Interleukin-1 production from monocytes is a very important factor to consider. Firstly, attraction of monocytes is the initial response of the arteries to an injurious stimulus (Ross, 1986) and secondly interleukin-1 is thought to attack arterial wall smooth muscle cells and cause them to proliferate (Dinarello and Wolff, 1993). Relatedly, although monocytes have been long ago implicated in the progression of atherosclerosis (Elliot and Edwards, 1978), the work of Daoud and associates (1985) supports the proposition that monocytes-macrophages that migrate into the intima may be considered as friends when they function optimally, phagocytizing cellular and extracellular debris and removing them outside the arterial wall. These authors warned that excessive secretion of monocyte released factors that under normal circumstances help in the regression of atherosclerosis and the healing of the injured artery, may in fact accelerate the progression of the disease. Ortega (1993), suggested that exercise is capable of enhancing all the faces of the phagocytic process but Shepard and associates (1993) and Northoff and Berg (1993) warned that training at higher intensities is not advisable. On a similar theme the second International Symposium of Immunology and Exercise (Paderborn, Germany, 15th October, 1993) stressed the notion that moderate exercise is of substantial benefit while high intensity efforts may be detrimental to the immune system.

The implications of these data to exercise participation are obvious and important when atherosclerosis is considered. People should not exercise at high intensities that could provoke production of interleukin-1 by monocytes. Since monocyte function is related to the coagulation system whose function in turn correlates well with blood lactate levels after exercise, the optimal intensity of training may well be below the anaerobic threshold. Life long adherence to regular physical activity and exercise may help so that moderate loads of effort may not be perceived as exhaustive, leading to reduced interleukin-1 production. In addition it seems that increased workloads cause substantial activation of the coagulation system while moderate intensities do not have such an exaggerated effect. Fibrinolysis is enhanced after a single bout of exercise but this beneficial effect is sustained for a very short time. Instead, aerobic conditioning associated with a long term training regimen, probably brings adaptive increases of the fibrinolytic response to thrombogenic stimulus irrespective of sex. All in all, there are adequate data to suggest that moderate exercise may be particularly beneficial for the prevention of atherosclerosis. Firm conclusions however should await results from studies that directly examine the incidence of atherosclerosis in relation to fibrinolysis, coagulation, monocyte function and exercise. Only one trial is underway at the moment (ODES Investigators, 1993) but results have not been published yet.

## Conclusions

Judging from data available to date, it can be concluded that exercise alone is not the method of choice for altering the lipoproteins of young boys. Girls might benefit more from participation in exercise regimens by increasing their HDL-C, while a combination of diet and exercise seems effective irrespective of sex. Thus, to a large extent, unless results from more definitive studies report differently, prepubescent children and adolescents should be directed toward life long adherence to active lifestyles through participation in enjoyable pursuits, without the need for engagement in physically exhausting activities. The possibility exists that exercise may alter lipoprotein subfractions, or that longer regimens may be more effective than the ones used to date.

It was seen that adults and in particular those with least favourable lipoprotein profiles may benefit from exercise by raising their HDL2-C levels, lowering the concentrations of the more dense LDL-C subfraction, lowering the triglyceride content of all lipoproteins and possibly lowering the level of postprandial triglycerides. These results could be expected if aerobic exercise is the selected method of training at generally low intensities. Exercising at intensities over the anaerobic threshold may in fact be harmful, shifting lipoprotein levels in undesired directions. Resistance training should be considered in treatment as long as adaptations occur in the skeletal muscles resembling those observed by participation in aerobic exercise. The same guidelines apply when exercise is considered as an agent for increasing fibrinolysis, optimizing monocyte and general immune system function and reducing hypertension.

More high quality research is needed in the field of exercise and atherosclerosis. Particular attention should be paid to the influence of exercise on LDL receptor activity, on the oxidation rate of LDL-C by cells of the arterial wall and the function of the immune system in the repair process of the arterial wall. Finally, the potential of exercise in preventing initiation and progression of atherosclerosis if introduced during early childhood should be studied in longitudinal, controlled trials.

# Chapter 4

## Physical Activity and Obesity

### Introduction

Obesity is a condition (Bouchard et al., 1993) characterized by an increased size of the adipose organ relative to the fat free mass (Rosenbaum and Leibel, 1988) to the extent that it endangers or impairs health (Young and Ruderman, 1993; Lohman, 1992).

Health is the keyword in the above definition. Health is defined (Bouchard et al., 1993) as a positive physical, psychological and social state of the individual. According to the same authors "negative health is associated with morbidity and in the extreme with premature mortality. Morbidity can be defined as any departure, subjective or objective from a state of physical or psychological well being short of death" (Bouchard et al., 1993, p. 18, 19). These definitions suggest that although the clinical examination may show that the individual is healthy, feelings of dissatisfaction with his or her body constitute an impairment of health. Medical research has largely neglected this point, defining obesity on the basis of cut off points over which risk for disease statistically increases. Nevertheless, cut off points serve well in evaluating the incidence of obesity in the general population and stimulating intervention efforts. Coronary heart disease, stroke, cancer and psychosocial disability are a number of medical complications associated with obesity (Rowland, 1990; Lerman and Cave, 1989).

Assessing body composition is not an easy task. Lukaski (1987) evaluated the available methods in an extensive review of literature. It was concluded that what is gained in validity and accuracy of measurement is lost in money, time and sample size. Thus, accurate techniques such as hydrodensitometry and neutron activation analysis have been used primarily in small scale studies as well as in establishing criteria for validating other methods. In large epidemiological studies estimates of body composition such as ideal weight for height, skin fold thickness and body mass index have been widely used.

The inadequacy of the methods used to date is reflected in two major gaps in knowledge. First it is not clear "to what extent the adverse effects of obesity are due to an increased fat per se, rather than to the other metabolic disorders associated with obesity such as non insulin dependent diabetes mellitus, hypertension, hypercho-

lesterolemia, hypertriglyceridemia and hyperinsulinemia" (Young and Ruderman, 1993, p. 282). Second it is possible to set only arbitrary cut off points over which an individual is said to be obese. Lohman (1992) accepted 25 per cent body fat for men and 32 per cent for women as indicators of excessive accumulation of fat. For children and adolescents normal values of percentage body fat are less than 15 per cent for boys and less than 25 per cent for girls (Bell et al., 1986). Rowland (1990) suggested that excessive accumulation of fat is indicated by percentages over 20 per cent and 25 per cent for boys and girls respectively.

Calls appeared recently (Lohman, 1992) favouring the use of more accurate methods for assessing body composition in epidemiological studies, but until this is adopted, the prevalence of obesity will be estimated on the basis of body mass index, weight for height tables and skin fold thickness.

Obesity is triggered by social, psychological and environmental factors that build on a hereditary background (Grilo and Pogue-Geile, 1991). However, the ultimate cause of obesity lies within the so called energy balance equation. One part of the equation is energy intake, determined solely by the ingestion of energy in the form of food. The second part of the equation is labelled energy expenditure and is more complex, being the sum of basal metabolic rate, thermic effect of feeding, energy expenditure during physical activity and thermogenesis at rest stimulated by factors such as cold exposure, ingestion of caffeine and smoking (Poehlman, 1989; Jéquier, 1987; Bray, 1983).

Physical activity in the form of exercise may influence the energy balance equation in two ways. First, exercise itself, depending on its duration and intensity, requires substantial amounts of energy expenditure above resting standards (Ainsworth et al., 1993). Second, exercise may affect other components of the energy balance equation.

In this chapter the adaptive response of the human body to exercise will be examined in respect to food intake, resting metabolic rate and thermic effect of feeding. Subsequently, the role of exercise in altering body composition parameters of adults and children will be evaluated.

**Exercise and Food Intake**

This section examines the effects of exercise on the first component of the energy balance equation. For simplicity the terms food intake, energy intake and caloric intake will be used interchangeably.

Katch and associates (1979) proved in a well designed experiment that male rats decreased food intake as a result of exercise. But the most important finding of this study was that intensity of effort was a vital factor to consider when studying the relationship between exercise and food intake. Rats exercising at high intensity ate less than those at low intensity but had equal caloric expenditure, whereas both groups consumed fewer calories than a control group. However, a defendable hypothesis cannot yet be formulated since in female rats strenuous exercise increased caloric intake (Thompson et al., 1982).

It is the case that human studies need to consider both duration and intensity of exercise besides other factors that might mediate or confound the exercise-food intake relationship. Thompson and associates (1982) listed sex, body fat level and exercise history as potential mediating variables while Pi-Sunyer and Woo (1985) warned against methodological flaws such as lack of control groups, inappropriate experimental design and imprecise assessment of energy expenditure and food intake. In fact the data base of human studies is quite limited.

Staten (1991) studied the effects of a 5 day acute exercise programme on caloric intake of 10 men and 10 women, all being sedentary, non smokers, healthy and within 10 per cent of their ideal body weight for height. Subjects formed two groups consisting of 5 men and 5 women each. One group exercised for 5 days before 5 days of usual sedentary lifestyle and the other exercised for 5 days after 5 days of usual sedentary lifestyle. Each exercise session lasted 1 hour while intensity averaged 68 per cent of maximal aerobic capacity. Food was obtained from the research centre and instructions were to eat ad libitum. Nine out of 10 men increased their food intake while this happened to only 4 out of 10 women.

Woo and Pi-Sunyer (1984) reported an experiment longer in duration than the one undertaken by Staten (1991). They studied 5 normal weight women for three 19-day treatment periods. One period did not involve exercise, while the other two involved exercise training on a treadmill, which raised energy expenditure to 110 per cent and 125 per cent of sedentary levels. To ensure accurate quantification of energy expenditure and intake, subjects were hospitalized for the duration of the study. The authors concluded that normal weight women increased their energy intake to match their increased energy expenditure.

Their results are in contrast with those reported by Staten (1991). The differences between the findings of the two studies may reflect different protocol duration. In the experiment by Staten (1991) the exposure to the exercise stimulus was only of 5 days duration thus not allowing the subjects to adapt properly by increasing their food intake. Supportive of this thesis is the fact that in this study 4 out of 10 females actually increased their energy intake. It is not known whether the remaining subjects might have done the same if the protocol was of longer duration, as in the case of Woo and Pi-Sunyer (1984). On the other hand since in Staten (1991), 4 out of 10 women increased their energy intake while mean energy intake remained virtually the same - 1,830 Kcal versus 1,831 Kcal -, it is reasonable to assume that some or all of the other 6 subjects decreased their energy intake. Thus, other factors should be examined and controlled to resolve this controversy. For example, in Staten (1991) subjects exercised at a fixed level of 68 per cent of their maximal aerobic capacity while in Woo and Pi-Sunyer (1984) the target was to raise energy expenditure to a certain level independent of time. This last point brings in the issue of exercise intensity and whether or not it affects energy intake.

Thompson and associates (1988) addressed this issue in an experiment that examined the acute effects of two different intensities of exercise on the appetite and energy intake of 16 healthy, non-obese, non smoking, young men. Low intensity exercise was set at 35 per cent and high intensity exercise at 68 per cent of their maximal aerobic capacity. Total energy expenditure for both exercise sessions was 4.1 Kcal / kg of body weight. Subjects were assigned randomly to one of three counterbalanced orders of the three experimental conditions to control for confounding variables. High intensity exercise suppressed perceived hunger ratings while low intensity exercise did not. However, total caloric intake remained stable across conditions. An interesting finding of this study was that although caloric intake remained stable, exercise of both intensities stimulated a shift in the composition of the diet, favouring carbohydrates from liquid sources.

The study of Thompson and associates (1988) confirmed the observations of Janssen and associates (1989). These researchers followed a group of 9 female and 18 male athletes who started a programme with the goal of running a marathon. After 18 months of training male subjects increased their energy intake while females did not. However, the composition of the diet changed in both sexes favouring carbohydrates instead of fats. In addition, Brouns and associates (1989) showed that extremely strenuous and prolonged cycling which simulated the Tour de France, did not lead trained subjects to compensate for the increased energy expenditure by increasing food intake. The composition of the diet remained stable during exercise days but shifted toward carbohydrates during recovery days.

High fat diets are suspected of increasing vulnerability to obesity (Flatt, 1987) but to date exercise in obese subjects has been related to total energy intake only. Woo and associates ($1982_a$) studied the effects of increased physical activity on energy intake in six voluntarily hospitalized obese women - 167 per cent of their ideal weight for height. Each subject was studied for 62 days, divided in an initial 5 day adaptation period and three treatment periods; sedentary, mild exercise and moderate exercise. Walking was the selected method of exercise. No change in ad libitum food intake was observed. A second investigation by Woo and associates ($1982_b$) confirmed the results of the first one using a similar research design. Thus, the authors concluded (Pi-Sunyer and Woo, 1985) that overweight women eat at a caloric level which is set by factors other than physical activity and hypothesized that "these might include palatability, variety and availability of food or other sensory and psychological factors" (Pi- Sunyer and Woo, 1985, p. 988).

Pi-Sunyer and Woo (1985) tested this hypothesis studying 4 obese men over four 20-day periods in a similar research design. The difference was the appearance of food which was served in a much tastier gourmet form. Energy intake remained stable throughout the different periods of treatment at levels in excess of energy expenditure. The authors concluded the while exercise still had no effect on the intake of the obese, the palatability of the diet did. "The gourmet foods that were used seemed to drive the intake to a point considerably higher than was the case in the women that had much plainer fare" (Pi-Sunyer and Woo, 1985, p. 989).

It is however premature to conclude that exercise has no effect on the appetite of obese subjects. For example, as Pi-Sunyer and Woo (1985) suggested, glycogen-depleting exercise - with higher intensity efforts - might prove valuable by suppressing the appetite of the obese patient.

In conclusion the research carried out to date does not permit powerful statements to be drawn. Evidence is not overwhelming but offers some support to the notion that while on an exercise programme lean males respond with an increase of energy intake to compensate for the increased energy expenditure. Females seem to respond similarly but doubt exists and further study is needed.

Obese subjects are not sensitive to exercise stimulus, showing stability in their energy intake throughout the duration of the regimen and thus being in a negative caloric balance that favours weight loss. However, this equilibrium might not be stable since it might depend on the palatability and other sensory features of food.

Intensity of exercise is a relatively under researched issue that merits consideration in longitudinal studies. Initial evidence offers support to the prescription of high intensity exercise to control appetite, but research should consider hormonal secretion

- for example cortisol secretion during exercise in obese patients - as a limiting factor for identifying optimal levels.

Finally, a neglected aspect is the relationship of exercise and its properties with energy intake in young children. This issue should be considered in future efforts if exercise is to play a role in preventing rather that treating obesity.

**Exercise and Resting Metabolic Rate**

Resting metabolic rate (RMR) is defined as the amount of energy needed to maintain the structure and function of the human organism (Calles-Escandón and Horton, 1992). RMR is measured in predefined conditions: at a temperature of 20° to 25° Celsius, after an overnight fast of 12-14 hours, before ingestion of any meal and with the subject lying comfortably in a bed or a chair without any muscle movement (Marieb, 1989).

RMR represents the largest portion - 60 to 70 per cent - of total energy expenditure in sedentary humans. To compare energy expenditure in people of different sizes, metabolic rates should be standardized to metabolic body size Ravussin and Bogardus (1989) warned. However, as the same authors remarked, there are no accurate methods available for measuring the metabolically active body mass. Fat free weight correlates best with RMR but Meijer and associates (1991) noted that no techniques exist to assess the relative contribution of the different compartments of fat free mass to metabolic rate. Moreover, Ravussin and Bogardus (1989) proposed that it is not correct to divide RMR directly by fat free weight. The correct action would be to divide RMR, by fat free weight minus the algebraic X intercept of the regression line of RMR as the dependent variable and fat free weight as the independent one. This last point has largely been neglected in exercise related research and therefore any conclusions have been drawn with the assumption that the values used to correct RMR are relatively accurate estimates of an existing metabolically active body mass, of unknown size.

Having these pitfalls in mind it is legitimate to say that RMR decreases as a result of caloric restriction in absolute terms and when expressed per unit of body weight or fat free weight (van Dale and Saris, 1989). This "side effect" of dieting makes the control of body weight a difficult task for the obese (Rowland, 1990). Exercise is often assumed to counteract this effect and thus its relation with RMR has received considerable attention.

This section aims to examine whether exercise has an adaptive effect on RMR. Pertinent research falls into two broad categories. The first is composed of cross

sectional studies that compare groups of trained and untrained individuals on the basis of their RMR. The second embraces trials where RMR is measured before and after a longitudinal training regimen. Cross sectional designs are of value because they may indicate how long term participation in exercise influences RMR.

Poehlman and associates (1988) studied 18 men aged 18 to 37 years, all being non smokers and of stable weight for at least 6 months prior to the study. Subjects were classified as trained and sedentary based on their maximal aerobic capacity. Their maximal aerobic capacity was assessed on a treadmill and their RMR by indirect calorimetry. Trained subjects were lighter, had lower percentage of fat mass and their maximal aerobic capacity was higher than that of the sedentary subjects. RMR of the trained group was slightly higher than the RMR of the sedentary group, reaching borderline significance. When corrected for fat free weight the RMR of the trained group was found to be significantly higher than the RMR of sedentary subjects. To control for differences in body composition the authors compared a subgroup of 5 trained individuals with 5 sedentary matched for percentage body fat. Once more, trained men demonstrated higher RMR than untrained men.

These results are in contrast with the findings of LeBlanc, Mercier and Samson (1984) who studied 7 trained and 7 untrained young men matched for weight, height and body fat content. Trained men had higher maximal aerobic capacity on average but RMR expressed per kilogramme of body mass did not differ between groups. Similarly, Tremblay and associates (1983) found no difference in the absolute RMR of trained and untrained subjects differing in their maximal aerobic capacity but not in percentage body fat. These results are in agreement with the findings of Lundholm and associates (1986) and LeBlanc, Diamond, Coté and Labrie (1984) who studied old men and young women respectively.

Recently, Gilbert and Misner (1993) suspected that type of training might mediate the association between exercise history and RMR. Thus, they studied 3 groups of 8 subjects each, constituted of sedentary, resistance trained or endurance trained men. The groups did not differ in age, height, weight and percentage body fat but the endurance trained men had significantly higher maximal aerobic capacity than the other groups. Nevertheless, no differences were found between groups either in absolute RMR or when corrected for body mass or for fat free weight.

In an effort to explain the apparent discrepancies, Poehlman (1989) suggested that studies failing to find an increased RMR in trained subjects, may have examined individuals exhibiting low maximal aerobic capacities. Alternatively, the small sample sizes used were suspected as inadequate by the same author.

Indeed these arguments are legitimate in most cases. For example in the study by Gilbert and Misner (1993) the aerobic trained group had a maximal aerobic capacity

averaging a moderate 60 ml/kg/min, while in the study of Tremblay and associates (1983) the total sample size was very small (n=8).

On the other hand there is at least one well designed study including individuals from a wide range of fitness levels, with adequate sample size that did not find any difference in the RMR of trained and untrained groups. Broeder and associates ($1992_a$) examined the RMR of 69 subjects in relation to their training status. Three fitness groups were formed - low, moderate and high fitness group - with maximal aerobic capacities ranging from 32.8 ml/kg/min to 78.1 ml/kg/min. RMR did not differ between groups either in absolute terms or corrected for fat free weight.

However, the correlational nature of cross sectional studies cannot support causal relationships. For example, Poehlman (1989) suspected that the relationship of RMR with training status and/or maximal aerobic capacity may be influenced by hereditary factors. Indeed Poehlman and associates (1986) examined the effects of a 22 day training programme on the RMR of 6 pairs of monozygotic twins. Subjects were healthy and sedentary prior to the experiment. The exercise treatment included prolonged effort on an ergo cycle at 58 per cent of maximal aerobic capacity, designed to produce a 4.2 megajoules deficit in addition to the habitual daily energy expenditure. Caloric intake was well controlled throughout the duration of the experiment. The principal finding of this study was that "genetic variation may play a role in regulating the thermogenic response to short term exercise training" (Poehlman et al., 1986, p. E715).

In the same experiment the RMR of the 12 subjects did not increase as a result of exercise. In fact a tendency toward decreased RMR was observed. Meijer and associates (1991) corroborated these findings. They reported that in a sample of 15 men and 13 women who participated in an exercise programme with the goal to run a marathon, RMR expressed per unit of fat free weight remained statistically stable but it showed a tendency to decrease. Poehlman and associates (1986) suspected that the lowering of the RMR as a result of training might represent an adaptive response of the human body to the caloric deficit induced by exercise.

It could be argued that results from these two studies are suspect because a control group was not provided. Indeed a well designed trial from Broeder and associates ($1992_b$) reported different findings. Sixty four volunteers assigned randomly to a resistance training, an endurance training and a sedentary control group were studied for 12 weeks. Subjects' age ranged from 18 to 35 years. Resistance trained subjects significantly declined in percentage body fat by increasing fat free weight and reducing fat weight compared to the control condition. Endurance trained subjects also declined in percentage body fat by preserving fat free weight and reducing fat weight. The authors, using dietary recalls, had established that the endurance training group

was in negative energy balance as a result of exercise participation. RMR measured 48 hours after the last exercise bout did not change across treatment conditions, even when corrected for fat free weight or body mass. Thus, the authors concluded that both endurance and resistance training may help to prevent an attenuation in RMR normally observed during extended periods of negative energy balance, by maintaining and increasing fat free weight respectively.

Thus, a further question would be whether exercise has the potential to counter the reducing effects of dietary restriction on RMR.

Pavlou, Whatley and associates (1989) assigned 31 obese women, being on a 1,000 Kcal diet per day, to an exercise and a sedentary group. Exercise lasted 8 weeks and included strength training exercises complemented with 30 to 40 minutes walking, at an intensity 60-85 per cent of maximal aerobic capacity 3 times per week. After the treatment the exercise group had lost significantly more weight and fat, while it preserved lean body mass. Simultaneously, RMR in absolute terms and corrected for fat free weight remained stable for the exercising women while it decreased significantly for the dieters.

These findings agree with the report of Molé and associates (1989) who observed that the decline in RMR seen with dieting in moderately obese women, returned to pre experimental levels after the addition of daily exercise. Using a similar experimental design Henson and associates (1987) were not able to counter in full the reduction of RMR in dieting obese women with the addition of exercise. Van Dale and Saris (1989) corroborated these findings reporting that in obese women aged 20 to 45 years, the addition of exercise to a dietary regimen was partially able to prevent a reduction of RMR, concomitant with increases in the maximal aerobic capacity of exercisers.

With the exception of the trial of Pavlou, Whatley and associates (1989) all studies mentioned so far utilized very low calorie diets in treating patients. Nieman and associates (1988) tested a 1,300 Kcal per day diet which was considered a long term targeting diet. Twenty one women between 20 and 40 per cent overweight for age and height were assigned to an exercise and a sedentary group. The trial lasted 5 weeks and exercise included 45 minutes walking or jogging 5 days per week at about 60 per cent of maximal aerobic capacity. Pre experimentally, RMR was not different between groups. As a result of dieting, RMR decreased significantly in the diet only group, while exercise contributed to a slight increase of RMR in the exercise group. The change in RMR observed in the exercise group correlated very well with changes in the maximal aerobic capacity of the respective subjects.

However, these results did not replicate in a trial of similar design by Hammer and associates (1989), where caloric restriction was kept at a minimum of 1,200 Kcal per day. The authors observed that exercising subjects lost slightly more fat and weight

than dieters only, but RMR dropped equally and significantly in all groups. Relatedly, Hill and associates (1987) found that very obese women who exercised while being on a 800 Kcal liquid diet per day, declined in their RMR by 19.1 per cent while dieters declined only by 17.3 per cent. In the same vein, Heymsfield and associates (1989) found that exercising subjects being on a 900 Kcal diet per day, decreased weight and body fat slightly more than a sedentary group and these changes accompanied a large 16 per cent reduction in RMR. Sedentary subjects declined in their RMR by 8 per cent only.

Trying to identify sources of variability to explain contradictions between reports is not easy because of differences in research design, dietary restriction, exercise programmes and initial body composition of the subjects. From the studies reviewed here it seems likely that exercise when added to a dietary regimen enhances fat loss, preserves fat free weight and increases maximal aerobic capacity. On the other hand those changes are not always concomitant with a preservation of RMR. Well controlled experiments with hospitalized patients showed that RMR declined as a result of exercise participation compared to dietary treatment only (Heymsfield et al., 1989; Hill et al., 1987). But in these studies exercise was done during an unspecified period of the day with the target of walking a particular distance. In contrast, trials which showed that exercise contributed to preserve RMR partially, the exercise regime was time and intensity specific (van Dale and Saris, 1989; Nieman et al., 1988; Molé et al., 1989; Henson et al., 1987). In addition, a striking difference found in the study of Pavlou, Whatley and associates (1989) - who showed that exercise fully preserved diet induced RMR reduction - was the inclusion of a progressive strength training programme along with the aerobic component. To what extent the inclusion of such a condition may have prevented the decline in RMR is not known but can be speculated.

Alternatively, Calles-Escandón and Horton (1992) suggested that severity of diet may interfere with the relationship between RMR and exercise and proposed that "the interaction of exercise and low calorie diet is best seen at levels of moderate diet restriction and seems to be lost when caloric intake is curtailed to very low levels" (Calles-Escandón and Horton, 1992, p. S536). Indeed it seems that the restriction to 1,000 Kcal per day utilized by Pavlou, Whatley and associates (1989) might be an optimal standard. In addition, it seems that very low calorie diets, if combined with exercise, may lower the RMR of very obese subjects. For example, in the study by Pavlou, Whatley and associates (1989) the exercise group had a mean percentage body fat of 32 per cent, while in the other studies this percentage exceeded 35 per cent. In the trial by Hill and associates (1987), where the exercise group decreased its RMR more than the diet only group, the range was from 37 to 50 per cent.

In conclusion, trained individuals do not seem to have elevated RMR compared to untrained ones. Resistance or endurance exercise training per se does not increase RMR, but it counters to a certain degree the decrease in RMR observed during exposure to moderate dietary restriction. However, exercise may not be able to preserve the sharp and substantial decrease in RMR during severe dietary restriction, particularly when subjects have a body fat content greater than 35 per cent. According to Dausch (1992) and Calles-Escandón and Horton (1992), in such a situation the body may become so calorie efficient, that exercise may have an adverse effect by further reducing RMR.

**Exercise and Thermic Effect of Feeding**

The concept of thermic effect of feeding emerged since it was observed that not all the energy ingested over and above the daily caloric requirement was stored as triacylglycerol in adipose tissue (Bray, 1983).

The difference between energy ingested and energy stored as triacylglycerol in adipose tissue is now thought to be the sum of the caloric expenditure for metabolizing the nutrients (Jéquier, 1987) and of an amount dissipated as heat by the brown adipose tissue (Himms-Hagen, 1983) or the muscle (Poehlman, 1989). This lost energy was once known as luxusconsumption (Bray, 1983) or specific dynamic action of protein (Danforth et al., 1983). Nowadays it is known as diet induced thermogenesis or thermic effect of feeding (Young and Ruderman, 1993; Poehlman, 1989).

Poehlman (1989) warned that the term thermic effect of feeding was often erroneously used to describe what is known as the thermic effect of a meal test. In this thesis the following definitions and descriptions will be adopted: Thermic effect of feeding is "the cumulative increase in energy expenditure after several meals and constitutes approximately 10 per cent of daily energy expenditure" (Poehlman, 1989, p. 516) in sedentary humans (Calles-Escandón and Horton, 1992).

The thermic effect of a meal test includes the energy cost of food absorption, metabolism and storage within the body and is divided into two distinctive components: the first component, the obligatory thermogenesis, is the energy cost of absorbing, processing and storing the nutrient (Young and Ruderman, 1993; Poehlman, 1989; Jéquier, 1987) while the second component, facultative thermogenesis is the energy expended in excess of obligatory thermogenesis probably in the brown adipose tissue (Himms-Hagen, 1983) or in the muscle (Poehlman, 1989). The facultative thermogenic component is probably mediated by the sympathetic nervous system activity (Poehlman, 1989; Himms-Hagen, 1983; Bray, 1983) while the

obligatory may be dependent on tissue insulin sensitivity (Young and Ruderman, 1993).

The thermic effect of a meal manifests itself as increased oxygen consumption and thus increased energy expenditure / metabolic rate for several hours following a meal and depends on the caloric content and composition of the meal, as well as on the antecedent nutritional status and degree of obesity (Danforth et al., 1983).

It is speculated that exercise increases the thermic effect of feeding to the extent that it affects the thermic effect of a meal (Poehlman, 1989). In particular, Young and Ruderman (1993) suggested that the obligatory thermogenic component of thermic effect of a meal is thought to be more sensitive to the exercise stimulus. Although this effect might be small it could be of significance for the long term control of body weight (Nichols et al., 1988) and possibly for the prevention of obesity.

Researchers have studied the concept of exercise induced, altered thermic effect of a meal both cross sectionally, comparing the thermic effect of a meal test in trained and untrained individuals and experimentally, by means of exercise testing before or after a meal and subsequent or simultaneous measurement of energy expenditure respectively. Trials assessing the response of the human body to the ingestion of food as mediated by adaptation to long term training are rare.

Lundholm and associates (1986) compared 10 old but very well trained men with age matched sedentary controls. Metabolic rate was measured for 30 minutes at rest and for 120 minutes after ingestion of a 500 Kcal liquid meal containing 24 per cent energy from protein, 20 per cent from fat and 56 per cent from carbohydrates. The thermic effect of the meal was calculated subtracting the resting metabolic rate from the metabolic rate after the meal. Results showed that trained individuals had a significantly higher thermic effect of the meal 30 and 60 minutes after the meal. At 90 minutes after the meal the difference was marginally significant. The differences persisted when expressed as a function of body weight and body surface area.

In contrast, LeBlanc, Mercier and Samson (1984) found a significantly lower thermic effect of a meal in 7 trained subjects not differing in weight, height and percentage body fat, but having higher maximal aerobic capacity scores than untrained ones. The difference persisted for at least 90 minutes after the ingestion of a 755 Kcal meal. Nevertheless, the meal offered to the subjects in this case consisted of a sandwich, a pie and a soft drink while in the study by Lundholm and associates (1986) the meal was in liquid form.

Lundholm and associates (1986) hypothesized that in addition, training the day before measuring the thermic effect of a meal test may explain the discrepancies between these two studies. Indeed in the study of Lundholm and associates (1986) subjects were instructed not to exercise two days prior to the experiment while

LeBlanc, Mercier and Samson (1984) did not mention such a precaution in their report. Young and Ruderman (1993) underlined that the main feature of obligatory thermogenesis is the insulin mediated storage of glucose as glycogen in muscle, an energy requiring process. It happens that the same process takes place for several hours after training (Klisouras, 1987; Horton, 1989) and possibly this coincidence does not allow the thermic effect of a meal to manifest itself as an extra increase in the metabolic rate.

However, Poehlman and associates (1988) advised their subjects to avoid exercise for at least one day before the experiment and therefore controlled for this pitfall when examining 18 young men classified either as trained or as untrained. Subjects were offered a liquid meal of 10 Kcal per kilogramme of fat free weight. The composition of the meal was similar to that used in the experiment by Lundholm and associates (1986). The results showed that trained men had a significantly lower thermic effect of a meal than untrained ones corroborating the findings of LeBlanc, Mercier and Samson (1984). The differences persisted when expressed per kilogramme of fat free weight. Even more, to control for body composition differences, the authors compared a subgroup of the trained men with untrained controls matched for percentage body fat and fat free weight. Again the thermic effect of a meal was significantly lower in trained subjects.

Similar results were reported in an earlier study by Tremblay and associates (1983). The meal offered in this case was substantially larger containing approximately 1,600 Kcal but similar in composition to that used by LeBlanc, Mercier and Samson (1984). The authors reported a significantly lower thermic effect of a meal in trained compared to untrained individuals. An additional finding was a concomitant lower respiratory quotient in trained subjects indicating greater efficiency in lipid oxidation.

Apparently, trained individuals have a greater efficiency in utilizing nutrients. Poehlman (1989) suggested that such a hypothesis is very attractive since it implies the existence of an "adaptive mechanism in the highly trained individual who seeks to preserve energy in the face of high levels of energy output generated by exercise training" (Poehlman, 1989, p. 521).

Subsequently, this hypothesis was tested in a cross sectional design (Poehlman et al., 1989) that embraced individuals from a wide range of maximal aerobic capacities. Subjects with moderate levels of fitness exhibited the highest thermic effect of a meal test while those being at the highest extremes of the maximal aerobic capacity continuum exhibited the lowest. The authors suggested that an inverted U relationship exists between maximal aerobic capacity and the thermic effect of a meal.

A similar relationship was found in females by LeBlanc, Diamond, Coté and Labrie (1984) who examined the response to a mixed 812 Kcal meal in subjects differing in

their training history. Well trained women had higher maximal aerobic capacities than moderately trained, and moderately trained scored higher in this variable compared to untrained ones. Inversely, untrained subjects had significantly higher integrated thermic effect of a meal test over a period of 60 minutes. Although no statistical difference was apparent, moderately trained subjects tended to have a higher thermic effect of a meal test compared to trained ones. Relatedly, the respiratory quotient was lower in the trained subjects indicating enhanced lipid oxidation.

The use of lipids as a primary source of energy and the consequent glycogen sparing (Horton, 1989), probably result in an overall reduction in the energy expenditure produced by feeding in the trained individual since the transformation of glucose to glycogen for replenishment of muscle stores is energy consuming (Young and Ruderman, 1993; Newsholme, 1988).

If the inverted U hypothesis is correct, it might be expected that long term exercise training would increase the thermic effect of a meal of untrained individuals as they progress toward moderate fitness levels, but to reduce the thermic effect of a meal as they gradually reach their physiological limit of aerobic capacity.

An experiment by Tagliaferro and associates (1986) neatly illustrated the above point. Ten healthy women aged 22-34 years volunteered as subjects in a study that included a 10 week walking-jogging regimen, 3 to 5 times per week for 30 minutes, at a pace of about 70 to 80 per cent of their maximum heart rate. Body composition was assessed by means of hydrostatic weighing. Resting metabolic rate as well as the thermic effect of a meal test were measured before and after the regimen. On average thermic effect of a meal test increased slightly but large inter individual variations were observed. Subjects who improved more in maximal aerobic capacity also showed a greater increase in their thermic effect of a meal test. Inversely, women with minimal increase in maximal aerobic capacity showed a decline or no change in their thermic effect of a meal test. The authors calculated an index which they called "training effectiveness" dividing improvement in maximal aerobic capacity by the subjects' estimated energy expenditure during training. They underlined that this index represented an "operational definition of the effectiveness of training. That is a low effectiveness ratio would indicate that the subject was close to her physiological limit of aerobic capacity" (Tagliaferro et al., 1986, p. 706). Although not the primary target of this research the authors calculated a more than double training effectiveness index for women who exhibited an increase in their thermic effect of a meal test relative to the women that reduced or conserved their thermic effect of a meal test.

Relatedly, raw data provided in the published report by Tagliaferro and associates (1986) permitted the calculation of a Pearson correlation coefficient between training effectiveness index and change in the thermic effect of a meal test. The coefficient

calculated had a magnitude of 0.59 and was significant at the 0.05 level. These results suggest that women closer to their physiological limit of maximal aerobic capacity did not benefit in their training by increasing their thermic effect of a meal test. Because the test was done at least 24 hours after the last training session, it is probable that these results extrapolate and hold for the thermic effect of feeding as well. If this assumption is correct it is possible that training helped women far from their respective limit to increase their daily energy expenditure by increasing their thermic effect of a meal.

The research from Tagliaferro and associates (1986) offers support to the inverted U model proposed by Poehlman and associates (1988) and invites investigation of how individual responses to long term training may vary in respect to the thermic effect of a meal, as a function of their relative position in the high-low maximal aerobic capacity continuum.

If the association between thermic effect of a meal and maximal aerobic capacity is so close it is possible that there is a hereditary component present, determining the response of the thermic effect of a meal to training. Poehlman and associates (1986) calculated an intraclass coefficient of 0.72 for the thermic effect of a meal in 6 pairs of monozygotic twins subjected to 22 days of exercise training. These results indicated the existence of a strong genetic control as a determinant of the influence of exercise on the thermic effect of a meal.

Relatedly, Jéquier (1987) reviewed 16 studies that compared the thermic effect of a meal in obese and lean subjects. In 10 publications lean subjects exhibited significantly higher thermic effect of a meal test than the obese while in the remaining 6 studies the responses were similar. Nelson and associates (1992) failed to find a correction in the lower thermic effect of a meal in 24 obese women after weight loss. In addition, because thermic effect of a meal did not correlate with body composition indices in this research, it was concluded that the lower thermic effect of food in obese subjects was not a consequence of obesity. Instead it was thought to contribute to its development, being a constitutive factor of genetic origin (Jéquier, 1987).

The effects of a single bout of exercise on the thermic effect of a meal test are contradictory in normal weight subjects. Belko and associates (1986) reported that exercise did not magnify the thermic effect of a meal and this effect was independent of intensity of effort. Corroborating these findings Gilbert and Misner (1993) found that exercise had only an additive effect on the thermic effect of food manifested after the ingestion of a meal.

In contrast, Bray and associates (1974) found that eating a breakfast increased the energy cost of exercise in lean men. The work of Goben and associates (1992) and Nichols and associates (1988) offered support to this position. Goben and associates

(1992, p. 94) concluded that "the caloric requirement for the thermic effect of food might be 15 per cent to 40 per cent greater following a standard meal if eating and exercise were done in proximity rather at very different times". This additional increment was calculated by Goben and associates (1992) to be between 3 and 12 Kcal. Similarly, Nichols and associates (1988) calculated an extra cost of 18 Kcal as a consequence of having a meal after exercise and suggested that such an amount might be small but important for long term weight control. But Goben and associates (1992) contrasted this notion remarking on the discomfort of exercising immediately after a meal, or eating immediately after exercising, a warning which might be of particular relevance for the obese.

Relatedly, Segal and Gutin (1983), Segal and associates (1984) and Segal and associates (1985) showed that lean men and women might respond with an increased thermic effect of a meal to exercise, but obese subjects do not increase their thermic effect of a meal as a response to exercise.

However, as the research from Tagliaferro and associates (1986) showed, long term regular participation in exercise has the potential to increase thermic effect of feeding, particularly in individuals far from their maximal aerobic capacity upper limit. Because obese patients generally exhibit low maximal aerobic capacity values there is great potential for improvement (Rowland, 1990) and the applicability of this finding may be of relevance for them, thus contributing to long term weight control.

In conclusion, there is considerable evidence to suggest that the thermic effect of a meal test has an inverted U relationship with maximal aerobic capacity but inter-individual differences may carry a genetic component as well. Improving maximal aerobic capacity should result in an elevation of the thermic effect of a meal test and thermic effect of feeding. Such an elevation might accompany fat and weight loss (Tagliaferro et al., 1986) and because reduced thermic effect of feeding is thought to be an etiologic factor for the development of obesity (Nelson et al., 1992; Jéquier, 1987), regular exercise may constitute an effective way of maintaining body composition (Young and Ruderman, 1993), or prevent its impairment.

**Exercise and Obesity in Adults**

The aim of this section is to review evidence concerning the effects of exercise on body composition of adults. In this area a large number of research papers have appeared and therefore the review presented here will only consider studies that used the method of hydrostatic weighing to assess changes in body composition as a result of exercise participation. Exercise is characterized by its mode, that is, type of activity, frequency, duration and intensity (Bouchard et al., 1993) and these elements will be discussed during the review.

In a well designed trial Pollock and associates (1975) randomly assigned 26 sedentary men to a running, walking, bicycling and a control group. All exercise groups decreased in percentage body fat and abdominal girth compared to the control condition. The authors concluded that "training effects were independent of mode of training when frequency, duration and intensity of training were held constant" (Pollock et al., 1975, p. 144).

Relatedly, Gettman and associates (1982) compared the effects of a circuit weight training programme with a programme that combined running and circuit weight training. Subjects were men and women aged 28 years, randomized to experimental and control groups. The results showed that all groups significantly decreased in percentage body fat after training. In an earlier study Gettman and associates (1978) had shown that circuit weight training performed equally well as a running regimen in reducing percentage body fat of 70 males aged 21-35 years. More recently Broeder and associates ($1992_b$) confirmed that resistance training decreased percentage body fat equally to that achieved by aerobic training in men.

However, percentage body fat does not seem to decrease substantially. In a study by Hunter and associates (1987) where men and women were divided either in a strength training or in a strength training combined with endurance exercise programme, percentage body fat loss ranged from 0.8 per cent to 2.6 per cent. Similarly, Wilmore (1983) in an extensive review of literature calculated a mean percentage body fat loss of 1.6 per cent across all studies done since 1983. Inevitably, factors such as subjects' age may be decisive in respect to exercise effectiveness. For instance, Smutok and associates (1993) randomized 50 year old men at high risk for coronary heart disease to either a strength training, or aerobic training, or a control group. After 20 weeks only the aerobic training group reduced percentage body fat significantly. Similarly, Kokkinos and associates (1991) reported that men at high risk of coronary heart disease aged 46 years on average did not respond to a strength training regimen in terms of altering their body composition.

Apparently, exercise which mobilizes large muscle groups might be more appropriate than resistance training for sedentary individuals. Wood and associates (1983) subjected 48 sedentary men aged 30-55 years to a running programme while 33 remained as sedentary controls. After 1 year of 3 days per week training, exercising men became significantly fitter and leaner than controls although their caloric intake as measured by dietary recall had significantly increased. But again the difference in percentage body fat was not large. Programmes of shorter duration and of equal frequency of training produced similar alterations in body composition (Wilmore et al., 1970), while in the study of Leon and associates (1979) the increased frequency of 5 days training per week was accompanied by a large reduction of body fat 4.9 per cent after 16 weeks.

Pollock and associates (1969) examined the association of increased fat loss with increased frequency of training in a randomized design. Nineteen healthy sedentary men aged 28-39 years were assigned to a control group, to an experimental group exercising twice a week and an experimental group exercising 4 times per week. Caloric expenditure was equal for the experimental groups expressed on a weekly basis since duration and intensity of effort were manipulated appropriately by the researchers. At the end of the programme the control group had become significantly fatter, the experimental group exercising twice a week remained stable in respect of body composition and the experimental group exercising 4 times per week decreased in percentage body fat significantly. The authors concluded that increased frequency of training with caloric expenditure during exercise held equal, was a better stimulus for fat loss.

Similarly, Milesis and associates (1976) studied the effects of different duration exercise programmes on the body composition of healthy, sedentary men. Frequency of training and duration and intensity of effort were identical for the three experimental groups exercising for 15, or 30, or 45 minutes. After the programme all groups showed a significant decline in percentage body fat, but the group exercising for 45 minutes reduced its fat reserves significantly more than the others. Although this result was expected because of the increased caloric expenditure in this group, it was surprising that no differences were apparent between the groups exercising for 15 and 30 minutes, despite the higher caloric expenditure of the 30 minute group. Whatever the possible reason for this unexpected result it can be concluded that efforts of 45 minutes duration are capable of promoting fat loss more than efforts 30 minutes or shorter.

In contrast, increased intensity does not seem to offer an additional benefit in fat loss provided that caloric expenditure during exercise is held constant. Ballor and associates (1990) randomly assigned 27 dieting, sedentary, obese females either to a

high intensity or to an isocaloric low intensity exercise programme. High intensity exercise was set at 80 per cent-90 per cent while low intensity exercise at 40 per cent-50 per cent of maximal aerobic capacity. Subjects trained 3 days each week. After 8 weeks of training both groups exhibited a significant decline in percentage body fat, fat mass, body mass and fat free weight, with no differences between them. The authors suggested that "with regard to conservation of fat free mass, the selection of an exercise intensity for a diet and exercise regimen may be left to the preference of the clinician and/or dieter" (Ballor et al., 1990, p. 142).

Thus, high quality evidence suggests that exercise mode and intensity are not a matter of concern as long as sufficient calories are burned. This conclusion may make the work of the obesitologist easier since patients may select from a wider range of activities, thus preventing boredom and subsequent dropout. On the other hand duration of exercise should be around 45 minutes per session, while for optimal results a frequency of 4-5 times per week is recommended. However, individual characteristics may play a vital role mediating the relationship of exercise properties and subsequent alterations of body composition.

Men and women seem to respond differently to an exercise stimulus. Although in most cases women significantly decrease percentage body fat as a result of training (Meijer et al., 1991; Schaberg-Lorei et al., 1990; Tagliaferro et al., 1986; Cowan and Gregory, 1985), this is not always the case (Hinkleman et al., 1993; Williford et al., 1988). In addition, they seem to decrease their percentage body fat equally to men across a variety of exercise programmes, continuous or interval, of long or short duration (Thomas et al., 1986). However, the pattern of percentage fat loss is different between sexes. In the study of Gettman and associates (1982) for instance, reductions in percentage body fat were observed in both men and women and were of equal magnitude. But men decreased their percentage body fat by decreasing their fat mass and increasing fat free weight while women only decreased their fat mass. In addition, Després and associates (1988), reviewing evidence from their laboratory, suggested that non obese men tended to decrease their fat mass easier than non obese women and concluded that "as men generally have larger abdominal depots than women it is possible the caloric deficit induced by daily aerobic exercise could produce a greater mobilization of energy from adipose tissue in men than women" (Després et al., 1988, p. 208).

Significant reductions in percentage body fat were observed by Després and associates (1985) in obese men following an aerobic exercise programme whereas in a subsequent study from the same research group, Després and associates (1991) also observed significant reductions in weight and percentage body fat in obese women following a similar exercise regimen. These results suggest that the pattern of fat loss

due to exercise is not only mediated by sex, but changes with different pre treatment body composition values.

Data seem to indicate that the higher the initial body fat content the greater the reduction in percentage body fat may be anticipated as a result of exercise involvement. Boileau and associates (1971) subjected obese and lean men to isocaloric training. Although differences did not reach significance obese subjects tended to decrease their body composition variables more than lean subjects.

Very lean individuals do not lose fat easily. Kelly and associates (1978) observed that body composition did not change in wrestlers during a competitive season. These athletes had percentage body fat values as low as 12 per cent. Conversely, Meleski and Malina (1985) and Wade (1976) reported that swimmers having higher body fat content showed significant fat losses resulting from a season's training. In these cases body fat content was 18.3 per cent and 20.4 per cent and declined respectively to 14.5 per cent and 16.6 per cent after training.

Age is a factor mediating the amount of exercise induced fat loss in men but not in women. Schaberg-Lorei and associates (1990) studied differences in the responses of pre and post menopausal women to an aerobic exercise programme combined with strength training. Training was done 3 days per week for about 60 minutes per session for a total of 24 weeks. In both groups body fat content declined significantly compared to the control condition but experimental groups did not differ between each other. These results are in agreement with the report of Cowan and Gregory (1985) who, although they observed significant reductions in percentage body fat in two groups of pre and post menopausal women following an aerobic regimen, found no difference between the groups before or after the regimen.

In contrast, Schwartz and associates (1991) studied young and old men aged 28 and 67.5 years respectively following an endurance training programme. The programme was quite vigorous since it involved 5 sessions per week at 85 per cent of maximal aerobic capacity for 45 minutes. After 27 weeks of training both groups declined in body fat content, but the reduction was significantly higher in older men. In addition, older men maintained fat free weight while younger men increased fat free weight. Interestingly, older men showed significant reductions in central but not in peripheral fat depots while young men having a more widespread pattern of adipose tissue distribution lost less fat from central depots. The authors stated that young men exhibited a gynoid pattern of fat distribution which is more resistant to changes. This conclusion falls in line with the finding of Krotkiewski (1988) who reported that although women with gynoid type of obesity lost similar amounts of fat to women having android type of obesity following an exercise regimen, more fat was lost from central fat depots for the second group. Loss of fat from peripheral depots may be

explained by the higher lipoprotein lipase activity in this area of the body (Krotkiewski, 1988). Inversely, the higher fat loss from the abdominal region in subjects with android obesity may be explained by the higher local fat cell number (Krotkiewski, 1988) combined with the fact that exercise induced percentage fat loss correlates highly with concomitant fat cell weight reduction (Després et al., 1985).

Whatever the pattern of fat loss, exercise produces such an effect only if it creates a negative energy equilibrium. Sweeney and associates (1993) showed that where obese women compensated for the exercise induced energy deficit with a dietary supplement, no reductions in percentage body fat and fat mass could be anticipated. Similarly, Newsholme (1988) warned that, because exercise might enhance appetite, dietary restriction should accompany exercise prescription for the obese.

On the other hand diet alone is often accompanied by reductions in resting metabolic rate and substantial loss of fat free weight (Thompson et al., 1982). Addition of exercise in a dietary regimen is often used to counteract these effects and also to produce greater fat loss.

Evidence seems to be overwhelming that diet combined with exercise produces significant weight and fat loss (Molé et al., 1989; van Dale and Saris, 1989; Heymsfield et al., 1989; Hammer et al., 1989; Pavlou, Whatley et al., 1989; Ross et al., 1989; Henson et al., 1987; Hill et al., 1987; Thomas et al., 1986) with rare controversies (Ready et al., 1991) . The benefits of this combination persist even in the case of self administered diet-exercise-behaviour modification programmes (Miller et al., 1993) and where lifestyle exercise is introduced (Kanaley et al., 1993).

Hill and associates (1987) studied the effects of adding exercise to the diet of 5 obese women as compared to 3 women who were on a diet only. Walking was the selected mode and exercising women increased walking distance with 0.4 kilometre increments every 3 days until a distance of 5.6 kilometres was reached. Body fat content before treatment was 44.5 per cent and 44.7 per cent, while after treatment it decreased to 41.8 per cent and 43.2 per cent for exercising and non exercising women respectively. The difference between the groups was significant showing that exercise contributed to greater fat loss than diet alone. Weight loss was the same between groups because dieting women lost significant amounts of fat free weight. Heymsfield and associates (1989) corroborated these findings concluding that the addition of exercise to a diet failed to produce substantial weight loss in obese women after 5 weeks of treatment, because of reduced rate of water loss. However, the authors underlined that exercise training promoted fat loss significantly more than diet alone. In addition, Weltman and associates (1980) found that moderate exercise combined with diet did not enhance weight loss more than diet alone but it did enhance greater loss of body fat in a sample of 33 men. Finally, Pavlou, Krey and Steffee (1989) suggested

that the greater reductions in body fat content observed in their studies as well as in other exercise studies examining men, could be attributed to fat loss per se, concomitant with a preservation of fat free mass.

It can be concluded that exercise alone produces significant but moderate reductions in body fat content. Intensity of effort does not matter as long as sufficient energy is consumed to create a negative energy balance. Frequent - at least 4 times per week - and longer exercise sessions - about 45 minutes - may help individuals to alter their body composition. Non obese men respond to exercise training by losing fat mainly from the deep depots of the trunk and abdomen, while non obese women are more resistant to exercise due to their gynoid pattern of fat distribution. Male and female obese subjects may benefit from participating in regular exercise, tending to lose more fat than lean ones. Older men are more susceptible to body composition changes than younger men because of the greater amounts of fat accumulated in the abdominal region of their body. Age does not seem to be a factor on this issue for women.

Finally, the addition of exercise to a dietary regimen seems to increase fat loss and to preserve fat free weight.

**Exercise and Obesity in Children**

This section deals with the question of whether participation of children in exercise programmes enhances reductions in body weight and/or optimization of body composition.

Recent research has shown that nutrition education combined with fitness education may have a significant effect on physiological parameters of children, such as cholesterol levels and blood pressure (Walter et al., 1985). Moreover, nutrition education alone was capable of altering the composition of the diet of children toward foods containing carbohydrates instead of fats (Kafatos et al., 1991). Because high fat diets are liable to enhance the development of obesity (Flatt, 1987), results suggest that exposure of children to nutrition education might contribute to the prevention or treatment of obesity and therefore the effects of a programme combining exercise with nutrition education cannot be fully attributed to the exercise stimulus per se.

Based on the above rationale available studies were classified into three distinct categories: studies that treated children with exercise only, studies that combined nutrition education with exercise and finally studies that combined dietary restriction with exercise.

*Studies Involving Exercise Programmes Only*

Lussier and Buskirk (1977) assigned 26 children aged 8-12 years to either an experimental or a control group. The groups did not differ in chronological or physiological age nor in their participation in organized physical activity outside the regimen. Body composition was assessed by means of underwater weighing and skin fold thickness. The programme had a duration of 12 weeks and exercise was performed 4 times per week after school. A single session lasted 45 minutes. Two sessions per week included a continuous run that increased progressively from 10-35 minutes over the duration of the programme. The other two sessions included running games and various activities. The target intensity was 80 per cent of maximal aerobic capacity. The average total distance run over the 12 weeks was 94.5 km and the range from 63.3 to 126 kilometres. Mean body density before the treatment was 1.053 gr/cc and 1.057 gr/cc for the experimental and control group respectively. After treatment body density remained stable for the control group while for the experimental it increased to 1.055 gr/cc. The difference was not statistically significant. Similarly, non significant changes were observed for weight and skin fold thicknesses. The authors concluded that the programme lacked the necessary duration to produce measurable alterations in fat weight or lean body mass.

The inability of exercise to alter body composition parameters does not seem to depend on the type of training. For example Weltman and associates (1986) and Ramsay and associates (1990) examined the effects of circuit strength training on the body composition of prepubertal children. Both studies found no differences in the body composition of the experimental and controls before and after 14 and 20 weeks of treatment respectively.

Lohman (1992) warned that an exercise programme which aims to produce body composition alterations in children measurable with currently available methods, should be of at least 20 weeks duration. Indeed, Blackman and associates (1988) did not observe any significant decrease in percentage body fat in eight dancers after a 4 month summer training period. In this study training was done 4 to 5 times per week for 2 to 3 hours per session. No control group was provided.

It is often suggested that obese subjects might benefit more than those of normal weight in response to training. Blaak and associates (1992) subjected 10 obese boys aged 10-11 years to a 4 week exercise programme. The boys were selected by body composition as determined by hydrostatic weighing and total body water. The criterion was percentage body fat between 30 per cent and 40 per cent. The programme was performed 5 times per week. The duration of each session was of 1 hour divided in three bouts of 20, 15 and 10 minutes with 5 minutes interval between them. Exercise

was done on an electronic cycle ergometer in a laboratory. Intensity was set so that average energy expenditure varied from 1,230 kilojoules/session in the first week to 1,201, 1,331, 1,265 in the following weeks respectively. A control group was not used. Pre-treatment mean body fat was 32.4 per cent while post-treatment was 31.7 per cent. The reduction in percentage body fat was not significant. Weight also decreased but the reduction was not significant. Perhaps, these results might be partially attributed to the short duration of the experiment.

In a longer trial, Bryant and associates (1984) observed a significant decrease of skin fold thickness and relative weight in 16 children possessing at least one risk factor for coronary heart disease. The subjects followed a 12 week programme and exercise was of 1 hour duration at 75 per cent of predicted maximal heart rate. Although the alterations reported suggest that children possessing risk factors for coronary heart disease may benefit from an exercise programme, conclusions should be treated with caution because the trial of Bryant and associates (1984) was uncontrolled.

Well controlled studies report different findings, concluding that no alterations in body composition indices result from participation in exercise. For example, Labbé and Welsh (1993) randomly assigned 124 fourth and fifth grade children to an experimental condition and to a control group. The programme was of eight weeks duration and consisted of physical education classes three times per week. The experimental group ran for at least 20 minutes while the control participated in various activities such as jogging, volleyball, basketball and playground games. Analysis of covariance showed no significant treatment effects on weight, triceps or calf skin fold thickness a result which is in agreement with the findings of Deveaux and associates (1986) and Gilliam and Freedson (1980). Gilliam and Freedson (1980) used a similar exercise regimen to that adopted by Labbé and Welsh (1993) and also provided a control group. The trial of Deveux and associates (1986) contained football training but it was uncontrolled.

It could be concluded that, in the light of the existing evidence, exercise per se does not produce significant reductions in percentage body fat or other indirect indices of body composition. However, firm conclusions should await results from longitudinal studies of at least 20 weeks duration.

Nutrition education added to an exercise regimen seems to contribute to weight and skin fold thickness reductions in obese children. The next section reviews related evidence.

*Studies Combining Exercise with Nutrition Education*

Five studies are cited below which have used exercise combined with nutrition education in an effort to control body composition of obese children and adolescents.

These five studies share some common features. No study used hydrostatic weighing to assess body composition changes. Instead indirect indices such as body weight and skin fold thickness were used widely and thus, conclusions must be tentative. Another common feature is that most of the studies report significant reductions in the indices measured as a result of treatment. For example, Hills (1991) randomly assigned 20 obese prepubertal children to an experimental and a control condition. Experimental subjects received consultation by a dietitian as well as a programme of nutrition education. Meetings with the dietitian were arranged twice during the programme. Experimental subjects completed a 16 week exercise programme that consisted of a weekly supervised session of 90 minutes duration, plus 3 or 4 bouts of home based exercise lasting approximately 30 minutes each. The two groups did not differ before the programme in the anthropometric parameters. However, after treatment, significant reductions occurred in weight and triceps skin folds of the experimental subjects compared to the controls.

On the other hand Emes and associates (1990) were not so successful when studying 33 obese children aged 12-15 years for 12 weeks. Subjects were randomly assigned to three groups: a fast start group, a slow start and a control group. The fast start group received exercise sessions 5 times for the first four weeks, 4 times for the next four and 3 times for the remaining of the programme. The slow start group started with once a week aerobic exercise and increased gradually to three times per week at the end of the programme. All groups received nutrition education as well as leisure counseling. In addition, the slow start and the control group participated in games such as modified volleyball that did not reach aerobic intensity. The exercise component for the experimental group constituted of 10-15 minutes warm up and 20-30 minutes aerobic exercises followed by 5 to 10 minutes of strength training. Pre and post treatment measurements were obtained for a variety of parameters including body mass index, weight and skin fold thicknesses. Results were analyzed by means of one way analysis of variance which showed no significant treatment effects between groups.

The discrepancy between these two studies is of interest because the exercise programmes were very similar. Thus, other factors may account for the differences. For instance, Emes and associates (1990) mentioned that their control group participated in modified games not reaching high intensity levels. Intensity of exercise is not so important for controlling obesity as far as a negative energy balance exists and

therefore it might well be that there was an exercise effect for the control condition as well. This notion is supported by the fact that Emes and associates (1990) reported a decrease in body composition parameters for all groups. Alternatively, age may have been a decisive factor. In the study by Hills (1991) subjects were prepubertal while in the study by Emes and associates (1990) they were in the early adolescent period.

That adolescents and in particular girls may not respond to the stimulus of exercise combined with nutrition education was illustrated in the early work by Seltzer and Mayer (1970). Three hundred and fifty obese students aged 8-14 years selected from a number of elementary and junior high school formed an experimental and a control group. The length of the programme was 5 months during the school year. To assess growth and fatness changes, stature, weight and triceps skin fold thickness were measured at the beginning and at the end of the programme. The exercise programme was done three times weekly along with the biweekly physical education classes that were the school requirement. The duration of experimental sessions was 45 minutes and it included team games, competitive activities and endurance activities. Nutrition education was included although no attempt was made to reduce children's energy intake. At the end of the programme experimental elementary school obese boys gained significantly less weight than controls. Furthermore, triceps skin folds increased more in the controls. These findings did not replicate with elementary school girls or with junior high school girls since analysis showed no significant changes in weight or triceps skin folds as a result of treatment.

However, to draw firm conclusions about the effectiveness of a regimen it would be useful to assess the weight history of subjects particularly when a control group is not provided. For example Cohen and associates (1991) studied the effects of a 1 month YMCA lifestyle modification, nutrition education and exercise programme on the fitness of 12 sedentary and obese children aged 8-12 years. Weight and sum of skin folds served as indexes of body composition. The exercise component consisted of three sessions per week. These included 5 minutes stretching, 15 minutes walk or run, 1 minute sit-ups along with various activities such as gymnastics, swimming and ball games. A control group was not included. Overall the programme achieved a non significant reduction of weight and sum of skin folds but it is not known whether these non significant reductions would turn out to be significant if a control group was included, if the programme was longer in duration or if the weight histories of the subjects were assessed.

This point was neatly illustrated in a paper by Brownell and Kaye (1982) who offered a 10 week school based behaviour modification, nutrition education and physical activity programme to 63 obese children aged 5-12 years. The exercise intervention simply involved a change from competitive to non competitive activities

within the daily physical education lesson. Thus, obese children were able to participate without being teased by their schoolmates. A control group was included in this study although it was not drawn from the same population. Analysis of variance and covariance showed that children in the experimental programme lost significant amounts of weight while the controls gained weight. Another interesting finding of this study was the assessment of the weight history of the children. Thus, it was proved that participation in the programme helped the obese children to reverse their 3-year trend of weight gain.

It can be concluded that exercise combined with nutrition education reduces body composition indices of obese children. Prepubertal children and particularly boys seem to be more sensitive to such a regimen. Nutrition education seems to have an additive effect to that of exercise per se, justifying the review of respective studies as separate categories of treatment.

The next section considers the question of whether the addition of exercise to a dietary regimen substantially increases the loss of body fat and/or body weight in children and adolescents.

*Studies Combining Exercise with Diet*

Only two studies used densitometry to assess the combined effects of exercise and diet on body composition of children. The others used indexes such as body weight or skin folds.

Becque and associates (1988) studied the effects of a 20 week programme on selected adult coronary heart disease risk factors in 36 obese, adolescent boys and girls aged 12.7 years on average. The subjects were randomly assigned to three groups: control, diet therapy, diet therapy and exercise group. Body composition was assessed by hydrostatic weighing. The exercise training consisted of three sessions per week of 50 minutes duration. Each session included 10 minutes warming up and muscle strengthening exercises followed by aerobic activity. During aerobic activity heart rate was kept between 60 and 80 per cent of age-predicted maximum. Analysis of variance showed no significant effects of treatment, although changes occurred toward the hypothesized direction. Average percentage body fat for the control group was 39.8 per cent, for the diet and behaviour therapy group 38.3 per cent while for the exercise-diet-and behaviour therapy group 44.0 per cent. Those percentages changed to 40.5 per cent, 35.3 per cent and 40.5 per cent respectively after the treatment.

These results were not replicated in another report from the same laboratory. Rocchini and associates (1988) randomly assigned 72 obese adolescents to a diet only

group, to a diet and exercise group and to a control group. Exercise consisted of three 1-hour exercise sessions per week. These included stretching and strength training followed by aerobic exercise at 70-75 per cent of maximal heart rate. Body composition was assessed by means of hydrostatic weighing before and after the treatment. The duration of the programme was 20 weeks. Significant reductions were found for both experimental groups compared to the control group in percentage body fat and weight. However, no differences were found between the two experimental groups themselves indicating that treatments had an equal effect on the variables under consideration.

These results suggest that although diet alone or combined with exercise substantially reduces body fat content and body weight, addition of exercise may add little to dietary modification. Epstein and associates (1982) and Epstein, Wing, Koeske and Valoski (1985), in corroborating these findings, reported that neither programmed, nor lifestyle exercise significantly enhanced weight loss compared to diet alone in subjects aged 8-12 years, between 20 per cent and 80 per cent overweight for height and age, with no history of psychiatric problems. Following similar subject selection procedures Epstein and associates (1984) found that treating children with diet and exercise or diet alone produced significant decreases of percentage overweight compared to a control condition but no differences were found between the two treatments indicating that adding exercise to a weight control regimen did not significantly alter the result.

In contrast, Epstein, Wing, Penner and Kress (1985) examined the effects of adding exercise to a diet in two groups of obese girls. Both groups improved over time with the exercise group decreasing their percentage overweight significantly more than the diet group after six months of treatment.

Similarly, Reybrouck and associates (1990) treated 14 obese children and adolescents with diet and exercise and compared the results to those of a group of 11 subjects treated with diet only. The duration of the programme was 16 weeks. Age varied from 3.9-16.4 years. Diet was the same for the two groups. Energy intake was kept between 800 and 1,000 Kcal/day. Subjects in the exercise group chose their favourite daily activity from a list. Energy expenditure was about 250 Kcal/session, to balance feasibility, effectiveness and enjoyability. Treatment had a significant effect on weight loss in both groups. However, the exercise group lost significantly more weight than the diet-only group.

Interestingly, in the study by Epstein, Wing, Koeske and Valoski (1985) a 24 month follow up indicated the superiority of lifestyle exercise in maintaining the achieved weight. This may suggest that children either habituated to that form of exercise, or found it not so demanding, or actually liked it. In the report by Reybrouck

and associates (1990) children in the experimental group chose their favourite sport as a means of treatment while the authors underlined the liking of the activity as a primary target of the intervention. Possibly, involvement and adherence to the programmes may explain the discrepancies between the studies but a detailed assessment of such variables has rarely been assessed (Emes et al., 1990).

It can be concluded that dietary restriction combined with exercise produces significant reductions in percentage body fat and body weight. However, it is not clear whether exercise gives an additional benefit in reducing body fat content since in well designed studies such an effect was not observed. Initial evidence suggests that enjoyable exercise might have a substantial effect compared to the strict regimens imposed by the needs of a research project.

**Conclusions**

It was seen that lean but not obese individuals adapt to exercise training by increasing food intake. It is also likely that exercise stimulates a preference towards foods high in carbohydrates and low in fats.

RMR does not increase as a result of long term exercise. On the other hand exercise has the potential to reverse partially the dietary induced decrease in RMR and sometimes to preserve it at prediet levels. This benefit may not be manifested when very low calorie diets are used, particularly in severely obese patients.

Long term exercise probably increases the thermic effect of feeding concomitant with improvements in maximal aerobic capacity. The potential of a single bout of exercise to induce a magnification in the thermic effect of a meal should not be utilized in the treatment or prevention of obesity, firstly because such an effect is not observed in obese people and secondly because the discomfort of exercising before or after a meal outweighs the small benefits in caloric expenditure.

Exercise training alone reduces percentage body fat of adult men and women by a moderate 2 per cent on average. Results are much better when dietary restriction is added to an exercise programme. Inversely, addition of exercise to a dietary regimen in most cases accelerates the rate of fat loss and generally preserves fat free weight. Weight loss may not be substantially enhanced because exercise prevents the loss of water as well.

In children conclusions are more difficult to draw because of the limited number of publications and the inaccurate methods that have been used for the assessment of body composition. Judging from the available data, exercise alone is not of benefit in reducing body fat content and body weight in children and adolescents. Also, it does

not seem to have an additional effect when added to dietary regimens of obese children. The reasons for the inability of exercise to manipulate body composition are not clear. Knowledge about the effects of exercise on the body composition of children and adolescents would best be gained from a longitudinal trial of over 20 weeks duration.

Inversely, exercise programmes offer an ideal setting for educating children about healthy eating behaviours. The combination of exercise and nutrition education seems to be of benefit to obese prepubertal children and in particular boys, by reducing body weight and skin fold thickness.

The applicability of the above findings to ascertain whether exercise, if introduced at a very early age, may contribute to the prevention of obesity is limited. No studies appear to exist which have systematically assessed the effects of an exercise regimen on the food intake of young children. RMR in children has been found not to increase with exercise after 4 (Blaak et al., 1992) or 20 weeks of training (Katch et al., 1988). Moreover, although the issue is under researched with this age group, it could be speculated that the exercise induced increase in the thermic effect of a meal seen in lean adults, may not be applied to children because it is closely associated with maximal aerobic capacity. Children have little potential to improving their maximal aerobic capacity and even when this is the case, training must be quite strenuous and probably not enjoyable for them (Rowland, 1990).

It may be concluded that the effects of exercise on other components of the energy balance equation may not fruitfully be applied to manipulate childhood obesity. Instead, children would have to rely on energy expenditure caused by exercise itself to regulate energy balance.

Because children tend only to participate in pursuits that they like, exercise programmes introduced at an early age should attempt to increase and maintain activity levels through enjoyable activities. This then has a greater chance of encouraging adequate levels of physical activity in adulthood when the effects of exercise on body composition are more noticeable. At the same time such programmes, if combined with nutrition education, have great potential to prevent obesity by promoting healthy lifestyles and to correct impaired body composition, at least in prepubertal boys.

# Chapter 5

# Designing Optimal Physical Activity Programmes for Children

## Introduction

In chapter 2 it was shown that adults are generally inactive but for children the data are inconclusive. Subsequently, chapters 3 and 4 presented evidence that increasing physical activity by means of exercise is of benefit for adults but of little immediate benefit for children in respect of obesity and risk factors for coronary atherosclerotic heart disease.

It is thus imperative that physical activity programmes delivered to children should primarily aim at maximizing adulthood participation in physical activity instead of targeting existing physiological or physical fitness status. An important issue concerns the kind of programmes that could best serve this purpose. Probably, the best guidelines could be inferred from research that has examined childhood determinants of adult physical activity.

The scope of this chapter is to review the available literature and to discuss its implications in terms of designing optimal physical activity programmes for young children, with the aim of maximizing adult participation in physical activity. It is the first attempt to go beyond superficial associations between childhood sport experience and adult physical activity levels with the aim of looking into childhood behavioural determinants of adult physical activity. Although data on this topic are scarce and not of the highest quality, they are starting to accumulate and therefore a review was thought to be timely.

## Childhood Determinants of Adult Physical Activity

It is unfortunate that very little high quality work has been done in this area. The most well known article is that of Powell and Dysinger (1987) which was a review of 6 studies that have appeared in the literature. The aim of Powell and Dysinger (1987) was to investigate the relationship between childhood and adult physical activity levels. However, they did not manage to reach any firm conclusions because the studies they reviewed presented several methodological limitations which could have distorted the

results. As a consequence of their critique, these authors proposed several points that future research should consider carefully. Some of the recommendations included clear definitions of the terms physical activity, exercise and sports for both children and adults, adjustment for possible confounding variables such as age, gender and educational level and use of neutral sources in addition to self reports for obtaining information about childhood activity patterns. Powell and Dysinger (1987) also drew attention to possible selection bias. They stated

> "It is likely that constitutional and genetic factors are important determinants of physical activity participation at all ages. Athletically gifted persons may be even more likely to participate in sports in early life and to continue their participation in later life. Hence any observed association is not a simple reflection of childhood opportunities. The fundamental question is not whether gifted athletes remain active, but whether active persons remain active regardless of athletic prowess." (Powell and Dysinger, 1987, p. 280).

More recent research has taken into account the recommendations of Powell and Dysinger (1987) and controlled for most methodological flaws present in previous efforts. Dishman (1988) selected a sample of 265 predominantly middle class men, with the aim of examining the relation between previous athleticism and current general and supervised physical activity tendencies. Mean subject age was approximately 50 years while physical fitness was assessed with a graded exercise tolerance test on a treadmill. Current participation in physical activity was assessed with a standardized questionnaire and the score was converted into energy units. Participation in childhood sports was determined with a single question and on this basis 143 subjects were classified as former athletes while 122 as former non athletes. Dishman (1988) offered the subjects an exercise programme based on participation in aerobic activities three times per week at intensities ranging from 60 to 90 per cent of maximum heart rate. A record was kept concerning the number of days each subject participated in the programme. An analysis of variance was performed to examine possible differences between former athletes and non athletes in respect of current general physical activity and participation in the supervised exercise regimen. No differences were found even when adjusting for age, skin folds, body mass index, fitness status, subjective well being and coronary health status. Similar results were obtained in a study by Brill and associates (1989) who examined 450 white males aged 25 to 60 years using a very similar research design. These authors concluded that previous sport experience was not a determinant of current physical activity, nor did it influence adoption and adherence in exercise programmes in middle aged men. The research by Brill and associates (1989) and Dishman (1988) shared some limitations. For example, determining childhood sport participation using a questionnaire was probably a rather

imprecise method. However, these studies had better designs than the studies reviewed by Powell and Dysinger (1987). Thus, judging from the data available to date, it seems that the childhood sport experience itself is not an important stimulus for developing life long active lifestyles. In the light of these findings Dishman (1988) stated

> "The quality of the school sports experience has not yet been measured. This is an important consideration for future studies. The number of years of involvement and the number of sports participated in may influence adult activity by influencing activity skills and interest. Likewise, both objective and subjective measures of athletic success at all age levels may prove important." (Dishman, 1988, p. 159).

Dishman (1988) indicated the existence of a single abstracted report "of a direct predictive relationship between jogging mileage and a perceived positive elementary school physical education experience" (Dishman, 1988, p. 159)[1] . However, a computerized search of the literature combined with extensive hand searches of journals and edited books done for the purposes of this thesis revealed three more related reports.

Taylor and associates (1993, abstract) interviewed 105 men aged 32 to 60 years about their current physical activity habits and their activity experiences during their teen and pre teen years. It was found that current weekly energy expenditure during exercise was positively and significantly associated with teenage skills but negatively with perception of being forced to exercise during pre teen years. Number of years of involvement in regular exercise was positively and significantly associated with pre teen skill, teen skill and attitude toward physical activity during pre teen years, while it was negatively associated with being forced to exercise during pre teen and teen years. No further details were presented in this report. It was not clear whether older subjects in particular were able to recall their pre-teen experiences accurately, but the authors suggested that probably, skill level and positive attitudes toward physical activity are important determinants of adult physical activity.

Greendorfer (1992) obtained data from 110 female college women involved in intercollegiate sport and a stratified sample of 224 non participants from the same college. Her intention was to explore possible differences in childhood sport socialization experiences of the two groups. A questionnaire was administered which dealt with active sport involvement during childhood, agents of socialization such as parents, peers and significant others and finally with values toward the sport construct. Among other important findings, it was concluded that more college athletes than non

---

[1] Ho P., Graham L., Blair S., et al. Adherence prediction and psychological / behavioral changes following one-year randomized exercise programs, Abstr. Pan. An. Congr. Int. Course Sports Med. Exerc. Sci., 1981; 9. Cited in Dishman (1988). It was not possible to locate this abstracted report.

athletes rated their childhood ability in sports as very good (88 per cent versus 59 per cent). Furthermore 90 per cent of the athletes indicated that sport was perceived as a very important field of endeavour during their childhood as compared to 70 per cent of the non athletes. Finally, 90 per cent of the athletes perceived their childhood ability in learning physical skills easily as high, compared to 67 per cent of the non athletes.

The effect of childhood ability in sports on adult activity levels was documented in a more objective manner in the well designed representative study of Kuh and Cooper (1992), within the context of the Medical Research Council national survey of health and development. A stratified sample of the single legitimate births that occurred in the week 3 to 9 March 1946 in England, Wales and Scotland was obtained. In 1959, when subjects were 13 years old their teachers were asked to rate each individual's ability in sports as above average, below average or average, compared with age peers. Two years later, teachers assessed children according to their energy levels as extremely energetic and never tired, normally energetic, or always tired and washed out[1] . Individuals were followed until the age of 36 years when a large proportion (89 per cent) of the initial sample was interviewed. Current physical activity levels were determined by a standardized questionnaire and subjects were classified as active, less active and inactive. From the men classified as above average in sports ability during childhood, 54 per cent were active during adulthood as compared to 41 per cent of those with average ability and 35 per cent of those with below average ability. Similar proportions were found for women. Multiple logistic regression analysis was performed to control for childhood variables such as educational qualifications, energy level, gender, extroversion and childhood health status. Again, ability in sports at 13 years was a significant discriminator between active and inactive adults. People whose ability in sports was above average during childhood, were twice as likely as the people whose ability was below average to be in the active category during adulthood.

The results of Kuh and Cooper (1992) are supported by Dennison and associates (1988) who used a prospective design to document a significant positive relationship between childhood physical fitness and adult physical activity levels in 453 young men 23 to 25 years of age. In this report, physical fitness tests had been administered at the age of 10 to 11 years and at the age of 15 to 18 years. The best predictors of adult activity levels were the 600 yard run and a sit-up test.

In conclusion, although evidence is only now starting to accumulate, it seems that in the past, most childhood physical activity experiences have been based on skill and thus, children who were good were successful and continued to participate in physical

---

[1] Energy levels were assessed in this manner in order to reflect a dimension of children's temperament. Thus, the term "energy levels" was not used as a substitute for the term physical activity. In fact childhood physical activity levels were not measured in the study by Kuh and Cooper (1992).

activity because of positive experiences. Furthermore, it seems that people who had more positive attitudes toward physical activity during childhood continued to participate in physical activities as adults. The following sections of this chapter discuss childhood attitudes toward physical activity and the concept of ability and aim at deriving implications for physical activity interventions delivered to children.

## Childhood Attitudes Toward Physical Activity

Several instruments have been developed to assess childhood attitudes toward physical activity or physical education (Edgington, 1968; Adams, 1963; Wear, 1951), but the most well known work is that of Schutz and associates (1985; 1981). Schutz and associates (1985; 1981) incorporated the findings of Kenyon (1968) in their inventory. Kenyon (1968) had shown that the domain of physical activity could be reduced to several subdomains, including physical activity as a social experience, as the pursuit of vertigo, as a means for achieving health and fitness, as an aesthetic experience, as an ascetic experience and finally, physical activity as catharsis.

Schutz and associates (1981) generally supported the results of Kenyon (1968) but concluded that for children, the social subdomain should be divided into two subdomains. These were labelled physical activity to continue social relations and physical activity for social growth. In their more recent work, Schutz and associates (1985) presented a modified instrument that utilized happy or sad faces to assess the attitudes of very young children toward physical activity. For older children, each subdomain was assessed with 5 adjective pairs; two of them were selected to embrace the cognitive subcomponent of attitude and the remaining three the affective subcomponent. As a result, the authors further categorized the health and fitness subdomain into health and fitness: value, and health and fitness: enjoyment. An important innovation in the work of Schutz and associates (1985) was that children responded to questions that emphasized feelings about participation in physical activity. Thus, this instrument encompassed affect, cognition and behaviour, being in the same vein as the three component model of attitude proposed by general social psychology. For example, Stahlberg and Frey (1988, p. 143) defined attitudes[1] as

> "...predispositions to respond to some class of stimuli with certain classes of response. These classes of responses are specified as affective (concerning

[1] Although other researchers such as Fishbein and Ajzen (1975) stressed the evaluative character of attitudes, their discussion is not relevant here since it dealt with performance of very specific behaviours. Instead, the instrument developed by Schutz and associates (1985) measures attitude toward participation in the general construct of physical activity and more closely corresponds to the work of Taylor and associates (1993) and Greendorfer (1992), reviewed in the previous section of this chapter.

> evaluative feelings of liking and disliking), cognitive (concerning beliefs, opinions and ideas about the attitude object), and conative / behavioral (concerning behavioral intentions or action tendencies)".

The work of Greendorfer (1992) reviewed in the previous section of this chapter was concerned with cognitive classes of response toward childhood sports. In the reports by Taylor and associates (1993, abstract) and Ho and associates (1981, cited in Dishman, 1988) the attitudinal measures embraced both cognitive as well as affective classes of responses toward childhood physical activity.

Thus, judging from the available data, it can be inferred that childhood physical activity programmes promoting positive beliefs, ideas and opinions toward participation in physical activity as well as targeting the elicitation of positive feelings about physical activity have a good chance of maximizing adulthood physical activity. In fact it is a common assumption in the scientific literature that if children participate in enjoyable physical activities they have a greater likelihood of developing positive attitudes toward participation in them.

Enjoyment is a new construct in the area of sport psychology. It is defined as "a positive affective response to the sport experience that reflects generalized feelings such as pleasure, liking and fun" (Scanlan and Simons, 1992, p. 201). Presumably, the definition can be extended to the more general domain of physical activity, although most of the studies reported to date were concerned with the domain of sport.

Research from the area of sport motivation has shown that fun, that is enjoyment, is one of the major motives for participation in youth sport. This was a common finding in North America (Reed and Chevrette, 1993; Petlichkoff, 1992; Brodkin and Weiss, 1990; Gould and Horn, 1984) as well as in Europe (Wold and Kannas, 1993). Inversely, lack of fun was identified as a major motive for discontinuing participation in sports (Petlichkoff, 1992; Burton, 1988; Gould and Petlichkoff, 1988; Gould and Horn, 1984). However, as Gould and Petlichkoff (1988) suggested, fun and enjoyment or lack of fun or enjoyment are surface level explanations cited for sport participation or withdrawal by children. It is therefore essential to search more deeply and to investigate the constituents of enjoyment if implications for physical activity interventions are to be derived.

Wankel and Kreisel (1985) examined 822 youth sport participants whose age ranged from 7 to 14 years. The sample included soccer, baseball and hockey participants. Data were collected by means of a questionnaire which encompassed both extrinsic and intrinsic enjoyment factors. The results were consistent across sport and age groups. The most important enjoyment items were, improving the skills of the game, testing abilities against others and excitement of the game. Winning the game and pleasing others were ranked at the bottom of the list. Social items such as being

with friends and being on a team were ranked as moderately important to enjoyment. The authors concluded that factors intrinsic to the sport activity were consistently rated as more important compared to factors extrinsic to the activity. These findings agree well with the reports of Goudas and Biddle (1993) and Figley (1985) who found that major reasons for satisfaction or dissatisfaction with the physical education lesson were related to its content. The research of Goudas and Biddle (1993) examined 254 British boys and girls aged 13 to 14 years, while Figley (1985) interviewed 100 elementary school children from the United States.

In an excellent study, Wankel and Sefton (1989) followed 55 girls and 67 boys aged 7 to 15 years, participating in ringette and hockey teams, for 12 games and obtained pre and post competition measures on various psychological constructs. Fun was the dependent variable in this research. Multiple regression analysis was employed to indicate the best predictors of fun after each game. The results were consistent across games in that post game mood states, the perception of how well one played and the challenge of the game came out as the best predictors. Because post game mood states were found to be very highly correlated with the measure of fun, the researchers inferred that they could be considered as alternate indicators of fun. In a subsequent step post game mood states were deleted from the analysis and it was revealed that perception of how well one played and challenge of the game continued to be the best predictors of fun. It was concluded that "enjoyment in youth sport is very achievement oriented" (Wankel and Sefton, 1989, p. 363), being in close agreement with Scanlan and Lewthwaite (1988) who examined 76 young wrestlers aged 9 to 14 years. In this study, perceived wrestling ability, adult involvement and interactions and adult satisfaction with season's performance were the best predictors of enjoyment. In a larger scale investigation Scanlan and associates (1993) explored the constituents and predictors of sport enjoyment in 1,342 male and female young athletes, participating in soccer, American football and volleyball. Their age ranged from 10 to 19 years. A series of Likert scales was constructed and a factor analysis identified several sources of enjoyment. In the next step a multiple regression analysis revealed that the best predictors of enjoyment were mastery of skills and effort put in games, positive team interactions and support and positive coach support and satisfaction with players' seasonal performance.

In summary, a common finding deriving from the studies reviewed was that ability, either as perceived by the young athletes themselves or as evaluated and fed back to them by important adults such as the parents and the coach was of primary importance for the experience of fun and enjoyment from participation in sports. It could be concluded that for children whose perception of ability is low, or evaluation of performance from significant adults is unfavourable, enjoyment is less likely to be

derived from participation in sports. Based on the rationale presented in this section, the development of positive or negative attitudes toward sport seems to depend to a large extent on the development of positive or negative perceptions of ability. This conclusion agrees well with the argument of Roberts (1986) about the reasons children give for dropping out of sport. This author stated that

> "The reasons they give for dropping out are that they do not enjoy the sport experience, but the reason they do not enjoy the sport experience is because they perceive that they have low ability and feel unable to cope." (Roberts, 1986, p. 138, 139).

Because the concept of ability was in addition identified as an important independent childhood predictor of adult physical activity levels it has to be examined in more detail.

**The Concept of Ability**

"The competitive process consists of an individual, or team attempting to achieve a goal or some standard of excellence" (Roberts, 1992, p. 180). Winning or losing in sports naturally creates a situation where individuals and of course children as well, evaluate their performance and attribute the outcomes to certain causes. Roberts (1992) placed the possible causal attributions of success or failure in a bidimensional model presented in figure 5.1.

Locus of Control

| Stability | Internal | External |
|---|---|---|
| Stable | Ability | Task Difficulty |
| Unstable | Effort | Luck |

**Figure 5.1: Dimensions of Causal Attributions** (From Roberts, 1992)

Locus of control refers to whether the elements are internal or external to a person. Stability refers to the stability of the elements over time. Roberts (1992, p. 182, 183) underlined that "attributing winning or losing to an internal element maximizes the degree of pride or shame felt, while attributing the win or loss to an external cause minimizes the degree of pride or shame.". On the other hand

"Attributing winning or losing to a stable element means that the same outcome is expected in the future. Attributing winning or losing to an unstable element means that the outcome may change in the future." (Roberts, 1992, p. 183). Since ability is a stable internal cause, the attribution of success and failure to ability should have major consequences in respect of self esteem as well as expectations of future success or failure.

Roberts (Roberts, 1992; Duda, 1987; Roberts, $1984_a$; Roberts, $1984_b$) utilized Nicholls' developmental theory of achievement motivation (Nicholls, 1984; Nicholls and Miller, 1984; Nicholls, 1978) and derived useful implications for the domain of sport. Nicholls (1978) had proved that children's level of reasoning in attributing success or failure to ability or effort changes as a function of age. At the age of 5 to 6 years children do not distinguish between effort, ability and outcomes. Instead, they believe that people who try harder are smarter even if they get a lower score. At the age of 7 to 9 years, effort and outcome are distinguished as cause and effect. At this age, children believe that equal efforts lead to equal outcomes, but ability is ignored. At the age of 9 to 11 years effort is perceived as necessary for success but ability attributions are made to some extent. In the final developmental stage, when children reach the age of 12 or 13 years,

> "The concept of ability, in the sense of capacity which, if low may limit or, if high, may increase the effectiveness of effort, is used systematically in explanations of observed behavior and outcomes and in predictions of outcomes..." (Nicholls, 1978, p. 812).

Accordingly, Roberts (1992) remarked that it is of no surprise that children under the age of about 10 years may participate enthusiastically in an activity despite obvious indications that they may not be good at it.

Roberts ($1984_a$) presented convincing empirical data that being successful in sports is very important for children and also, that children make judgements about their competence or ability by comparing themselves with their peers, or by utilizing feedback information from important adults. This process happens to take place in a perceptually very important area of endeavour where outcomes are readily available. However, according to the findings of Nicholls (1978) the realization of the perception of ability emerges around the age of 12 years. If this hypothesis is correct, many children low in perceived ability could drop out from sports at about the age of 12 years. Indeed, the recent longitudinal study from Finland by Telama and associates (1994) confirmed that the sharpest decrease in sport participation as well as in physical activity occurred during the transition period from 12 to 15 years of age. Furthermore, Burton and Martens (1986) examined a small sample of 83 young wrestlers aged 7 to 17 years and 26 wrestling drop outs of a comparable age range. They found that

participants demonstrated significantly higher perceived ability, better won-loss records, more positive expectancies and valued wrestling success more than drop outs did. In a more recent study, Petlichkoff (1993) showed that sport participants may differ in perceived ability according to their player status. The author recruited 417 athletes from various sports ranging in age from 14 to 18 years and divided them into subcategories. She found that first team players scored significantly higher in perceived ability than primary and secondary substitutes. This effect was apparent for both boys and girls.

Harter (1978) argued that when a child receives positive reinforcement for its mastery attempts, two critical systems are internalized. The self reward system which gives the child self-reinforcement for continued mastery attempts and a system of standards or mastery goals which are useful in evaluating whether performance was successful or not. Under these circumstances the child becomes intrinsically motivated and there is no need for substantial approval or feedback. If a child's mastery attempts are ignored or disapproved, modelling of the disapproval occurs and the child becomes extrinsically oriented. Such children "have internalized a disapproving voice, which in turn should lead to an internalized view of themselves as relatively incompetent" (Harter, 1978, p. 54). Harter (1978) distinguished three areas of competence, namely, social, cognitive and physical competence. It is important to mention that in Harter's (1978) theory of perceived competence, the reinforcement obtained from adult socializing agents as well as from peer groups by means of direct feedback or comparison processes is of central concern in the development of competence or incompetence. Roberts and associates (1981) obtained empirical support for Harter's theory in the area of sport. They interviewed 143 fourth and fifth grade children and collected data about involvement in sport activities and ratings of perceived competence. They found that sport participants were significantly higher in perceived physical competence than non participants. Further support was obtained by Feltz and Petlichkoff (1983) who examined 239 participants and 43 dropouts aged 12 to 18 years in a number of school-sponsored sports. It was found that participants in school-sponsored sports were significantly higher in perceived physical competence than were dropouts. Finally, Gould and Petlichkoff (1988) reviewed related empirical evidence and proposed that Harter's theory may be used to explain motivation and drop out from youth sports.

Considering the above discussion, the implications for sports are that children who are consistently unsuccessful in a competitively normative environment are likely to internalize a disapproving system of negative evaluative rewards that will derive from comparisons with peers and adult negative feedback or ignorance. About the age of 12

years this background will probably create perceptions of incompetence or perceptions of low ability.

**Conclusions and Recommendations**

Figure 5.2 depicts the major variables examined in this section and presents possible causal associations as identified in the literature reviewed.

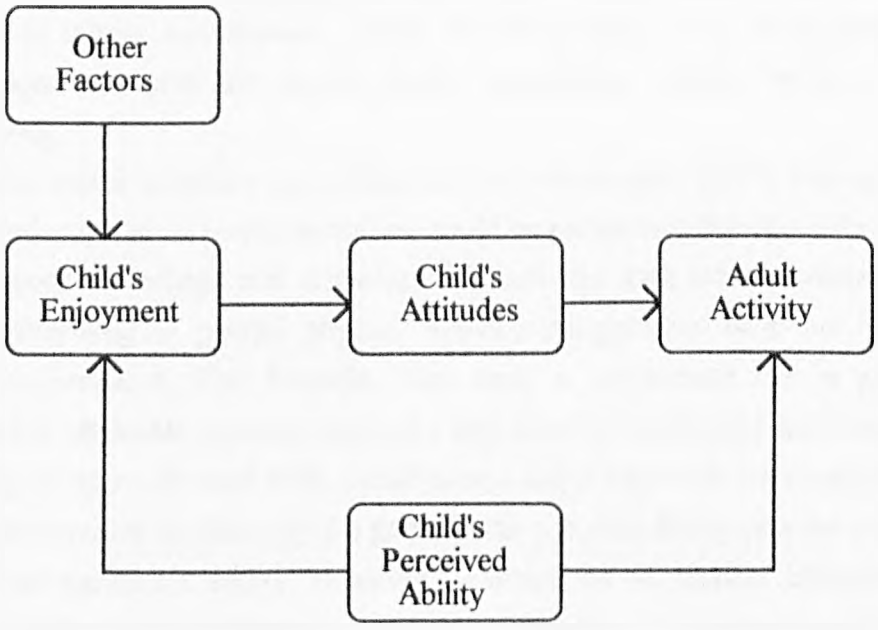


**Figure 5.2: Childhood Determinants of Adult Physical Activity Levels**

Certainly, much more research is needed in the important domain of childhood determinants of adult physical activity. Most of the studies reviewed have looked at involvement in childhood sport whereas adult participation has often been considered in terms of physical activity. Thus, future research may very well reject this model and a reconsideration will be essential. However, in the light of the present findings, this model seems to reflect the more important relationships. Based on the discussion presented in this chapter, it could be proposed that for many children participating in sports, the normative social evaluation occurring during competition in this environment, may produce low levels of perceived ability or perceived incompetence. This will influence adult physical activity levels negatively, either directly, or by affecting enjoyment and the subsequent development of negative attitudes.

Being concerned with the problem of attrition in youth sports Roberts (1992, p. 187) concluded that "The ideal solution is to abolish organized competitive sports for children under approximately age 13..." but he continued that such a solution would be

unrealistic. Rather, he stated that "...we must rethink the procedures by which we handle children in competitive environments. The practical solution is to attempt to make the organized competitive experience more sensitive to the needs of the child." (Roberts, 1992, p. 187).

This thesis is based on the belief that the competitive sport experience may be beneficial for some children, but that for a substantial proportion it may operate negatively at least in relation to adulthood physical activity patterns. Recent research has indicated that outcomes are very important for children within the context of sports (Roberts, 1992), but they are not important during playful activities with peers in the neighbourhood (Greer and Stewart, 1989). In these cases, even when competition occurs, it does not have the intense social comparison element found in sports (Roberts, 1992).

It appears that a voluntary community activity programme that is less concerned with sport and emphasizes playful activities, could be particularly beneficial for children in creating positive feelings and attitudes, although the long term consequences of children participating in playful physical activity programmes have not yet been empirically investigated. The flexibility that such a programme has in providing challenging but attainable physical skills and activities for each child individually and not involving complex physical skills, could have a major impact in the development of favourable perceptions of ability by the participants and stimulating positive evaluative feedback from significant adults. However, it would be of upmost importance for children to be able to choose between this kind of regimen and the sport experience. In such a case they would hopefully choose that which best suits their perceived needs. For this reason, it is recommended that similar programmes should operate alongside the existing sport and physical education system. This position is consistent with that of Biddle (1992) who asked for health related exercise programmes to be delivered to children in addition to sports.

It is the purpose of this thesis to examine the extent to which children would register in a community physical activity programme that offers playful activities rather than sports. For very young children, an assumption was made in this thesis that their registration in an out of school community physical activity programme would be a product of decisions made by their parents. In the same vein, their registration in a programme which emphasizes playful physical activities rather than sports, would also be a product of parental decisions. The theory of planned behaviour was selected as the appropriate theoretical framework to predict and explain this kind of behaviour. Chapter 6 presents the theory of planned behaviour in detail.

# Chapter 6

## The Theory of Planned Behaviour

The theory of planned behaviour (Ajzen, 1991; Ajzen, 1988; Ajzen and Madden, 1986; Ajzen, 1985; Schifter and Ajzen, 1985) is an integrated theory in the area of social psychology aimed at predicting and explaining behaviour.

This section presents the theory of planned behaviour and reviews related applications.

### Definitions

The following operational definitions are used in the theory of planned behaviour:

*Attitude toward the behaviour* is "the individual's positive or negative evaluation of performing the behavior" (Ajzen and Fishbein, 1980, p. 6).

*Subjective norms* are "the person's perception of the social pressures put on him to perform or not to perform the behavior in question" (Ajzen and Fishbein, 1980, p. 6).

*Perceived behavioural control* is the person's belief or perception as to how easy or difficult performance of the behavior is likely to be (Ajzen, 1991; Ajzen and Madden, 1986).

*Intentions* are "indications of how hard are people willing to try, of how much of an effort they are planning to exert, in order to perform the behavior" (Ajzen, 1991, p. 181; Ajzen, 1988, p. 113).

### The Theory of Planned Behaviour

The theory of planned behaviour is an extension of the theory of reasoned action as described by Ajzen and Fishbein (1980) and Fishbein and Ajzen (1975). The theory of reasoned action postulated that *intention* is the immediate antecedent of volitional social behaviour, implying that predictions could be easily made about future behaviour if the person's *intention* toward performing this particular behaviour were known. In addition, it attempted to explain behaviour, suggesting that *intention* is determined and influenced by the person's *attitude toward performing the behaviour* and by his or her *subjective norms*. Thus, within the theory of reasoned action, *attitudes* and *subjective*

*norms* were assumed to influence behaviour only indirectly, via their effect on *intentions*.

The theory of reasoned action is represented schematically in figure 6.1.

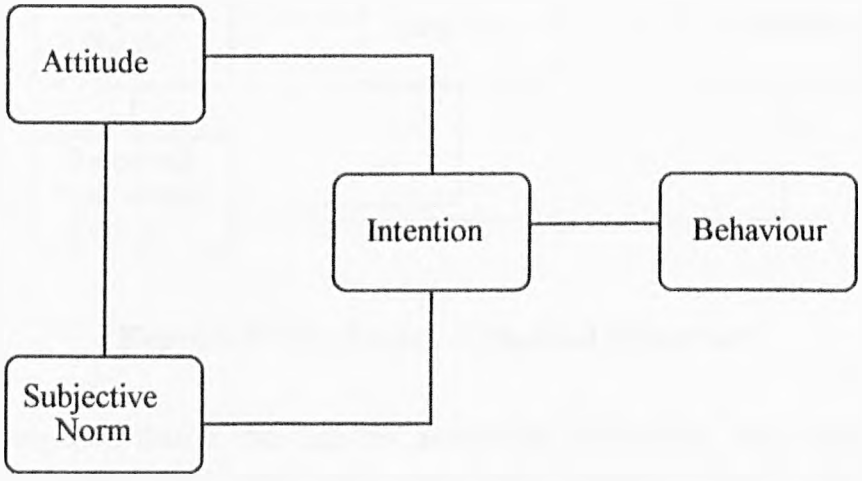


**Figure 6.1: The Theory of Reasoned Action**

The theory of reasoned action received considerable attention and underwent testing in various situations where its utility and validity for predicting volitional behaviour was established (Sheppard et al., 1988).

However, criticism has been made on the ground that most behaviours are neither completely volitional nor completely involitional in nature but rather, they range on a continuum between these extremes. Therefore, it was proposed that the theory of reasoned action erroneously dichotomized behaviours as volitional or involitional and that factors such as resources and opportunities available for performing the behaviour under consideration should be included in the model (Liska, 1984).

Acknowledging the limitation of the reasoned action model, Ajzen (Ajzen, 1988; Ajzen, 1985) proposed the addition of a new variable, that is, *perceived behavioural control*, to allow for behaviours which had involitional features.

The remainder of this chapter will elaborate on the rationale for adding *perceived behavioural control* and on the link between specific beliefs to the variables of the theory of planned behaviour. Finally, it will present a comparison of the theory of planned behaviour with the theory of reasoned action and comment on problems of previous research with the theory of planned behaviour.

Figure 6.2 represents schematically the theory of planned behaviour and the theoretical relationships between its constructs.

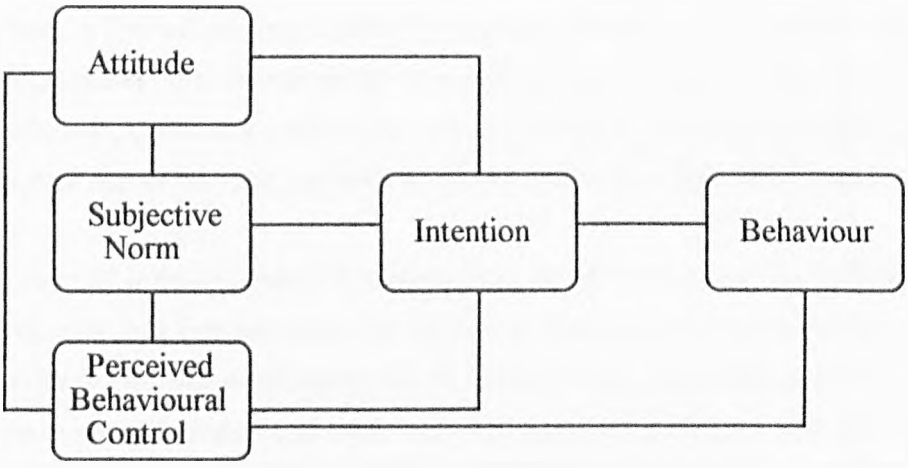


**Figure 6.2: The Theory of Planned Behaviour**

It was proposed that in the case of involitional behaviours "intentions remain behavioral dispositions until at the appropriate time and opportunity, an attempt is made to translate the intention into action" (Ajzen, 1988, p. 113). The author added that "strictly speaking, most intended behaviors are best considered *goals* whose attainment is subject to some degree of uncertainty. We can thus speak of behavior-goal units and of intentions as plans of actions in pursuit of behavioral goals" (Ajzen, 1988, p. 128), implying that "...a behavioral intention can be best interpreted as an intention to *try* performing a certain behavior" (Ajzen, 1988, p. 132).

In the light of the above arguments Ajzen (1991) underlined that "the importance of actual behavioral control is self evident: The resources and opportunities available to a person must to some extent dictate the likelihood of behavioral achievement" (Ajzen, 1991, p. 183). Factors that may interfere with the performance of the behaviour were thought to be internal, such as skills, abilities, power of will, emotions, compulsions (Ajzen, 1985) and / or external such as time, opportunity and dependence on others (Ajzen, 1988; Ajzen, 1985).

Thus, the concept of *perceived behavioural control* arose as a variable of central importance in the theory of planned behaviour because it was introduced mainly in order to represent actual control over performance of the behaviour. However, *attitudes toward performing the behaviour* and *subjective norms* were not neglected. The theory of planned behaviour remained an attitude based theory. As Ajzen (1988) underlined, the traditional tripartite model of attitude that is, cognition-affect-behaviour was transformed and operationally defined as belief-attitude-intention respectively, to serve the needs of the theory.

Beliefs were viewed as "the prevailing determinants of a person's intentions and actions" (Ajzen, 1991, p. 189). Ajzen (Ajzen, 1991; Ajzen, 1988) mentioned that people may hold a number of beliefs pertaining to the behaviour under consideration

but utilize only a limited number of them in making decisions. The theory of planned behaviour postulated the existence of 3 kinds of salient beliefs and named them behavioural beliefs, normative beliefs and control beliefs to correspond to the variables *attitude toward the behaviour*, *subjective norms* and *perceived behavioural control* respectively.

In the case of *attitudes toward performance of the behaviour*, each behavioural belief was viewed as a link between the behaviour and a certain outcome or attribute and thus, *attitudes toward performing the behaviour* were supposed to be determined by these behavioural beliefs combined with the person's perceived strength of each belief that is, the perceived likelihood that performing the behaviour will result in the desired outcome (Ajzen, 1991; Ajzen and Fishbein, 1980).

Normative beliefs were viewed as *subjective norms* connected to specific important others, be they individuals or groups (Ajzen and Fishbein, 1980). As a result, *subjective norms* were stated to be a function of normative beliefs and the motivation of the person to comply with respective important others.

In the same vein, control beliefs represented the presence or absence of specific requisites and opportunities with reference to the particular behaviour and *perceived behavioural control* was viewed as the combination of these control beliefs with the perceived power of each control factor to influence performance of the behaviour.

Inclusion of the three types of beliefs in the theory of planned behaviour resulted in the so called elaborative model which is graphically represented in figure 6.3.

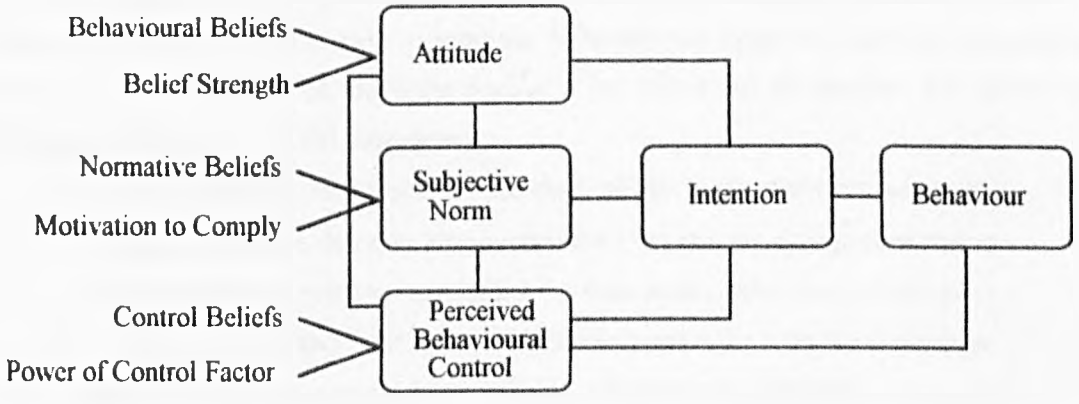


**Figure 6.3: The Elaborative Model of the Theory of Planned Behaviour**

The elaborative model of the theory of planned behaviour became subject to severe contradiction among researchers. The point of concern was the particular mathematical algorithm according to which beliefs should be combined with the accompanying factors that is, belief strength, motivation to comply and perceived power of control beliefs, to produce the respective behavioural measure of interest. Ajzen (Ajzen, 1991;

Ajzen, 1988) advocated the multiplication of these quantities and the subsequent summation of the products for each set of beliefs. Field research (Ajzen and Driver, 1991) has shown that, using this method, *intentions* could be predicted equally as well as when the basic model was tested, that is, the model depicted in figure 6.2 (Ajzen and Driver, 1992). Evans (1991) criticized the multiplicative approach proposed by Ajzen, and suggested that researchers having used this procedure, actually examined the effect of the interaction of each belief with the respective factor on the measure of *intention* and not any main effects. Evans (1991) strongly criticized researchers for having failed to recognize this point and expressed his fear that a whole body of literature was suspect and subject to serious methodological flaws.

The point that Evans (1991) underlined was sound but reference to various types of salient beliefs, independent of the method used for their combination with the respective factors, was fruitful in provoking formulation of research hypotheses under the general framework of the theory of planned behaviour. For instance, Ajzen and Driver (1991) suggested that "control beliefs may be based in part on past experience with the behaviour, but they will usually also be influenced by secondhand information about the behaviour, the experiences of acquaintances and friends, and other factors that increase or reduce the perceived difficulty of performing the behavior in question" (Ajzen and Driver, 1991, p. 188). An important implication of this argument could well be that, in the case of novel or unfamiliar behaviour, *perceived behavioural control* would inaccurately represent actual control. As a result, a statistical analysis of the data would probably reveal the inability of *perceived behavioural control* to predict behaviour directly. In this case *perceived behavioural control* could be assumed to exert an indirect influence on behaviour via its effect on *intentions*. As Ajzen and Madden (1986, p. 457-458) suggested,

> "...perceived behavioural control has motivational implications for intentions. People who believe that they have neither the resources nor the opportunities to perform a certain behavior are unlikely to form strong behavioral intentions to engage in even if they hold favorable attitudes toward the behavior and believe that important others would approve of their performing the behavior".

In brief, the theory of planned behaviour requires the following conditions to be met if a behaviour is to be determined jointly by *intentions* and *perceived behavioural control* (Ajzen, 1991; Ajzen, 1988; Ajzen and Madden, 1986):

1. *Intentions* and *perceived behavioural control* must be compatible with the behaviour under consideration in respect of target, action, context and time.
2. *Intentions* and *perceived behavioural control* must remain stable in the interval between their assessment and observation of the behaviour.

3. *Perceived behavioural control* must reflect actual control over performance of the behaviour accurately.

The first condition represents the principle of compatibility as outlined by Ajzen (1988) and governs not only the particular relationship between *intention*, *perceived behavioural control* and behaviour but all the possible relationships between the various constructs of the theory as they were diagrammatically shown in figure 6.2. Ajzen (1988) proposed that every behaviour could be defined in terms of target, action, context and time and thus, in empirical tests of the theory, researchers should utilize measures corresponding exactly to these features of the behaviour. Furthermore, the author suggested that under the principle of aggregability it would be possible to move from lower to higher levels of generality by aggregating across elements of the behaviour, provided that all measures correspond to the selected behaviour in terms of target, action, context and time. In other words he advocated the use of the theory to predict behaviour at any level as far as appropriate criteria and assumptions were met. In such cases, *attitudes toward the behaviour*, *subjective norms* and *perceived behavioural control* could exert an influence on each other, besides their overall effect on *intention* and behaviour.

**Comparison of Theory of Reasoned Action with Theory of Planned Behaviour**

As mentioned earlier, the theory of planned behaviour was developed to embrace behaviours that carry involitional characteristics. The model has been tested in various situations and has been found to be superior to the theory of reasoned action. Tables 6.1 and 6.2 summarize research that has compared the reasoned action theory with the theory of planned behaviour.

Table 6.1 contains the reference, the behaviour examined, the multiple correlation coefficient when *intention* was regressed on *attitude* and *subjective norms* and the multiple correlation coefficient when *intention* was regressed on *attitude*, *subjective norms* and *perceived behavioural control*.

Table 6.2 contains the reference, a brief description of the behaviour under consideration, the correlation coefficient when behaviour was regressed on *intention* and the multiple correlation coefficient when behaviour was regressed on *intention* and *perceived behavioural control*.

**Table 6.1: Research Comparing Theory of Reasoned Action with Theory of Planned Behaviour: Prediction of Intention**

| Reference | Description of Behaviour | R when intention was regressed on attitudes and subjective norms | R when intention was regressed on attitudes subjective norms and perceived behavioural control |
|---|---|---|---|
| Ajzen and Driver, 1992 | spending time at the beach | 0.45 | 0.50 |
| | jogging | 0.70 | 0.81 |
| | mountain climbing | 0.61 | 0.72 |
| | boating | 0.53 | 0.61 |
| | biking | 0.67 | 0.71 |
| Ajzen and Madden, 1986 | class attendance | 0.55 | 0.68 |
| | getting A in a course | 0.48 | 0.65 (wave 1) |
| | | 0.49 | 0.64 (wave 2) |
| Bagozzi and Kimmel, 1992 | exercising | 0.56 | 0.58 |
| | dieting | 0.75 | 0.74 |
| Beale and Manstead, 1991 | mothers' intentions to limit frequency of infants' sugar intake | 0.33 | 0.39 (wave 1) |
| | | 0.46 | 0.52 (wave 2) |
| Chan and Fishbein, 1993 | women's intentions to tell their partners to use condoms | 0.55 | 0.52 |
| Gatch and Kendzierski, 1990 | attendance in aerobic classes | 0.50 | 0.55 |
| Hounsa et al., 1993 | mothers' intention to use oral rehydration for their children | 0.37 | 0.47 |
| Kimiecik, 1992 | physical activity of corporate employees | 0.77 | 0.81 |
| Madden et al., 1992 | have a good sleep | 0.28 | 0.41 |
| | go shopping with a friend | 0.42 | 0.61 |
| | exercise regularly | 0.68 | 0.71 |
| | wash the car | 0.54 | 0.61 |
| | doing laundry | 0.50 | 0.66 |
| | avoiding caffeine | 0.77 | 0.81 |
| | talk to a close friend | 0.37 | 0.58 |
| | rent a videocassette | 0.46 | 0.59 |
| | listen to an album | 0.69 | 0.76 |

| | | | |
|---|---|---|---|
| | taking vitamin supplements | 0.66 | 0.66 |
| Theodorakis, 1992 | training participation of young swimmers | 0.25 | 0.50 |
| Yordy and Lent, 1993 | aerobic training participation | 0.76 | 0.76 |

**Table 6.2: Research Comparing Theory of Reasoned Action with Theory of Planned Behaviour: Prediction of Behaviour**

| Reference | Description of Behaviour | R when behaviour was regressed on intention | R when behaviour was regressed on intention and perceived behavioural control |
|---|---|---|---|
| Ajzen and Driver, 1992 | spending time at the beach | 0.33 | 0.52 |
| | jogging | 0.72 | 0.73 |
| | mountain climbing | 0.65 | 0.69 |
| | boating | 0.38 | 0.54 |
| | biking | 0.48 | 0.48 |
| Ajzen and Madden, 1986 | class attendance | 0.36 | 0.37 |
| | getting A in a course | 0.26 | 0.26 (wave 1) |
| | | 0.39 | 0.45 (wave 2) |
| Bagozzi and Kimmel, 1992 | exercising | 0.17 | 0.30 |
| | dieting | 0.49 | 0.49 |
| Kimiecik, 1992 | physical activity of corporate employees | 0.68 | 0.70 |
| Madden et al., 1992 | have a good sleep | 0.36 | 0.64 |
| | go shopping with a friend | 0.35 | 0.39 |
| | exercise regularly | 0.56 | 0.66 |
| | wash the car | 0.43 | 0.47 |
| | doing laundry | 0.32 | 0.33 |
| | avoiding caffeine | 0.68 | 0.70 |
| | talk to a close friend | 0.47 | 0.55 |
| | rent a videocassette | 0.26 | 0.28 |
| | listen to an album | 0.48 | 0.48 |
| | taking vitamin supplements | 0.76 | 0.77 |
| Theodorakis, 1992 | training participation of young swimmers | 0.44 | 0.46 |

From table 6.1 it was apparent that the addition of *perceived behavioural control* improved the prediction of *intention* in most of the cases, confirming the superiority of the theory of planned behaviour over that of reasoned action. The contribution of *perceived behavioural control* to the prediction of behaviour was however, more moderate. Inspection of table 6.2, revealed that only in about half of the published articles, was *perceived behavioural control* found to explain a significant amount of the variance in behaviour, over that explained from *intention* alone. The inability of *perceived behavioural control* to predict behaviour could be attributed either to the volitional character of the behaviour in some cases, or to the novelty of the situation in others. However, the general picture emerging from tables 6.1 and 6.2 is that the addition of *perceived behavioural control* to the model, significantly improves its predictive validity. A paired t-test was performed comparing the coefficients in columns 3 and 4 of table 6.1. It was revealed that they differed significantly and that the coefficients derived when *perceived behavioural control* was included in the analysis were higher than when *perceived behavioural control* was not included ($p=0.000$). A similar situation emerged when a paired t-test was calculated comparing columns 3 and 4 of table 6.2 ($p=0.002$).

**Problems of Research with the Theory of Planned Behaviour**

The sufficiency of the theory of planned behaviour has been tested in various situations, by including additional variables in the model and examining their contribution in explaining variance of the dependent variable over and above that explained by the basic variables alone. An issue of concern for many researchers was that of past behaviour. For example, Theodorakis (1992) aimed at predicting frequency of training of 98 young swimmers aged 10 to 13 years using the theory of planned behaviour. Multiple regression analysis showed that past behaviour contributed significantly to the prediction of behaviour as well as to the prediction of *intention*, explaining a significant amount of variance in these variables over and above that explained by the original variables of the model. Results from other studies, generally supported the utility of including past behaviour in the models of planned behaviour and reasoned action (Godin et al., 1993; Theodorakis et al., 1993; Theodorakis et al., 1991).

In these cases, past behaviour was assumed to reflect the existence of a habit but Ajzen (1991) questioned the validity of this assumption. He argued that "only when habit is defined independently of (past) behavior can it legitimately be added as an explanatory variable to the theory of planned behavior" (Ajzen, 1991, p. 203). Godin

and associates (1993) tried to address this question when examining the exercise behaviour of 347 subjects from the general population and 152 pregnant women. They found that "habit of exercising was the best predictor of behavior" (Godin et al., 1993, p. 97). However closer inspection of the operational definition that these researchers used for habit revealed that it actually constituted a measure of past behaviour[1], thus leaving the argument of Ajzen (1991) unanswered.

Ajzen (1991) proposed that when the basic assumptions of the theory of planned behaviour are satisfied, past behaviour should not improve the prediction of later behaviour, implicitly implying that the effect of past behaviour should be mediated through the theory's basic variables that is, *attitudes toward the behaviour*, *subjective norms* and *perceived behavioural control*. The author added that "measures of past and later behavior may have common error variance not shared by measures of other variables in the model" (Ajzen, 1991, p. 202) and thus, researchers should "often expect a small, but possibly significant residual effect of past behavior even when the theoretical model is in fact sufficient to predict future behavior" (Ajzen, 1991, p. 202).

The position advocated by Ajzen (1991) is sound but it is equally possible that in the cases where past behaviour was found to contribute to the predictive validity of the theory of planned behaviour, methodological flaws influenced this effect. Methodological flaws were present in other studies testing the theory of planned behaviour as well. Specifically, in some of the research, partial violations of the principle of compatibility were observed. Measures of *intention* did not always correspond to the behaviour in terms of target, action, context and time. For example, Ajzen and Madden (1986) tested the predictive validity of the theory of planned behaviour when the behavioural goal was getting an A in a course. Clearly, the behavioural goal could either be accomplished or not be accomplished. The authors measured correctly the *intentions* of 90 undergraduate students with the items "I am aiming at an A in the course", "I will try my best to get an A in the course" and "I intend to get an A in the course" on 7 point rating scales, but erroneously selected the grades actually obtained at the end of the course to represent the attainment or not of the behavioural goal. Stated simply, Ajzen and Madden (1986) measured an *intention* to perform a behaviour that differed in terms of target from the behaviour actually considered in the analysis. If the principle of compatibility had been correctly applied, the behaviour in question would have been scored as a dichotomous variable representing the categories: the student obtained an A in the course / the student did

---

[1] The measure of habit for pregnant women was obtained by asking them the questions: How often have you participated in one or more physical activities during your free time before the onset of current pregnancy ? How often have you participated in one or more physical activities during your free time in the last 3 months of current pregnancy ? Similar questions were applied in the case of subjects from the general population.

not obtain an A in the course. Even in this case some problems of scale correspondence could be encountered. As Courneya and McAuley (1993) pointed out, perfect scale correspondence would be obtained if both measures of *intention* and behaviour were scored either on dichotomous or on 7 point rating scales. However, as Ajzen and Fishbein (1980) proposed and Courneya and McAuley (1993) admitted, the combination of *intentions* measured on 7 point rating scales with behaviour scored dichotomously presented here as alternative, "least violates scale correspondence because it treats *intention* and behavior as dichotomous, thus, only violating the response format distinction" (Courneya and McAuley, 1993, p. 57).

Other researchers have fallen into the trap imposed by the principle of compatibility, measuring *intention* toward performance of a behaviour that differed in terms of target, or action, or context, or time from the behaviour actually measured and entered in the statistical analysis (Godin et al., 1993; Kimiecik, 1992; Madden et al., 1992; Theodorakis, 1992; Schifter and Ajzen, 1985). Because the theory of planned behaviour postulates that *perceived behavioural control* may predict behaviour directly, these researchers entered *perceived behavioural control* as a second independent variable in their analysis for the prediction of behaviour. Since their measures of *intention* and *perceived behavioural control* corresponded to each other, but *intention* did not correspond to the behaviour, it is the case that their measure of *perceived behavioural control* did not correspond to the behaviour[1], further violating the principle of compatibility. As a result, these researchers may have obtained lower multiple correlation or may have erroneously rejected the hypothesis that *perceived behavioural control* could contribute to the prediction of behaviour. At worst, their analysis may be valid only in respect to the prediction of *intention* from *attitudes*, *subjective norms* and *perceived behavioural control*. Although the latter position is quite pessimistic, it seems to make more sense, suggesting a reanalysis of the data is needed in respect of prediction of behaviour.

Another point of concern is the measurement of *subjective norms*. Ajzen and Fishbein (1980) proposed a standard measurement format for the assessment of this variable[2]. In the work of Ajzen and Madden (1986) an additional item, the *motivation to comply with important others* helped in the assessment of *subjective norms*. The researchers multiplied the two items to obtain a measure of *subjective norms*. This approach was utilized in other studies with the product of the multiplication entering the regression analysis as a measure of *subjective norms* (Madden et al., 1992; Kimiecik, 1992; Theodorakis, 1992; Gatch and Kendzierski, 1990). The multiplication

---

1 In one case (Theodorakis, 1992), perceived behavioural control was compatible with behaviour but not with intention, since intention was not compatible with behaviour.

2 These authors proposed scales in the form: "Most people who are important to me think I should / I should not perform the behaviour, scored on 7 points.

problem was mentioned in the discussion about the elaborative measures of the constructs included in the theory of planned behaviour. The multiplicative measure of *subjective norms* advocated by Ajzen and Madden (1986) imposed similar problems. Based on the writings of Evans (1991), Cohen (1978), Allison (1977) and Cohen and Cohen (1975), it is argued hereby that by using this method and entering the product in the regression analysis, researchers examined the interaction between the two items. It would be correct to enter the measure of *subjective norms* and the measure of *motivation to comply with important others* as independent variables in the regression analysis and test their interaction hierarchically in a second step as Evans (1991) and Cohen and Cohen (1975) recommended. As a result of this argument and because in the most recent work of Ajzen (Ajzen and Driver, 1992) the variable *motivation to comply with important others* was abandoned, it was decided not to use it in this thesis.

A further problem is that it is very likely that in previous research, *subjective norms* were not measured adequately. According to the definition of Ajzen and Fishbein (1980)[1], *subjective norms* should be assessed on two dimensions, that is, as a perceived social pressure to perform the behaviour and as a perceived social pressure not to perform the behaviour. All previous research assessed *subjective norms* only in respect to the positive dimension that is, the perceived social pressure to perform the behaviour in question. In this thesis, an effort was made to embrace both dimensions in the measure of *subjective norms*.

Another under researched issue is the pattern of influence of an additional variable, named here as *attitude toward not performing the behaviour*, on *intentions*. This variable was operationally defined for the purpose of this thesis as the individual's positive or negative evaluation of not performing the behaviour. This definition resembles the definition of *attitude toward the behaviour* (Ajzen and Fishbein, 1980) differing only in respect to the direction of action that is, evaluation of *not* performing the behaviour instead of evaluation of performing the behaviour. This new variable was assumed to be conceptually different from the *attitude toward performing the behaviour*. For instance, an individual's evaluation of going shopping on a particular day at a particular supermarket may be quite positive, while at the same time his / her evaluation of not going shopping on this day at this particular supermarket may be neutral. From a statistical point of view it would be reasonable to expect a significant correlation between *attitude toward performing the behaviour* and *attitude toward not performing the behaviour* while at the same time this correlation would be expected not to be close to 1.

---

[1] The definition offered by these authors was: subjective norm is the person's perception of the social pressures put on him to perform or not to perform the behaviour in question.

Fishbein and associates (1980) were the first to have implicitly indicated the possibility of examining the effects of this variable within the theory of reasoned action. Specifically, they tried to influence the *intention* of 160 male alcoholics to attend an alcoholic treatment unit in a hospital by influencing their *attitudes toward performing this behaviour*. Three messages were formed and delivered to three equivalent groups of alcoholics. The first message was a traditional persuasive appeal. The second message was based on the theory of reasoned action and contained positive statements such as "Thus, signing up for the ATU will lead to improved physical and mental health..." (Fishbein et al., 1980, p. 231). The third message was also based on the theory of reasoned action but was framed with negative statements such as "Thus, not signing up for the ATU will lead to ruined physical and mental health..." (Fishbein et al., 1980, p. 231). The effect of the latter message containing negative statements was more prominent than the effects of the others in changing the patients' *attitudes* and *intentions* as well as behaviour. Relatedly, Godin and Shephard (1990) noticed that within the theory of planned behaviour, *attitude toward performing the behaviour* is viewed "as a joint reappraisal of the attitude toward (successful) performance of the behaviour and the attitude toward a failed attempt" (Godin and Shephard, 1990, p. 115). In this thesis, it is considered that the results obtained by Fishbein and associates (1980) and the point made by Godin and Shephard (1990) justify the introduction of the new variable, *attitude toward not performing the behaviour*.

Overall, the theory of planned behaviour has been found in many cases to be a useful tool for the prediction of behaviour. Its simplicity, the short length of the questionnaire required for its application and the clearly and mathematically defined relationships between its constructs were thought to be considerable advantages. Finally, the problems identified in previous research were the outcome of inadequate methodology and did not interfere with the validity of the theory itself. As a result, it was thought that the theory of planned behaviour could provide a useful theoretical framework to accomplish the targets of this thesis. In addition, it was hypothesized that the modification proposed for the measurement of *subjective norms* and the introduction of the variable *attitude toward not performing the behaviour* could significantly contribute to the predictive value of the model.

# Chapter 7

## Operational Definitions, Research Hypotheses and Assumptions

### Operational Definitions

The following operational definitions were used in this thesis:

***Behaviour:*** Parental behaviour was registration of their children in an out of school, community physical activity programme supervised by the researcher, starting on the 3rd of May 1993 and ending on the 29th of May 1993, in which, participation would be 3 times per week for 1 hour each time at the Heraklion Tennis Club and registration would take place at the Heraklion Tennis Club from 12 to 14 April, 1993 and from 26 to 30 April, 1993 at 10.30 to 13.30 in the morning and 16.30 to 19.30 in the afternoon of each of those days.

***Attitude Toward Success:*** The term *attitude toward success* was used to represent operationally the concept "*attitude toward performing the behaviour*" as described in chapter 6 of this thesis. Thus, *attitude toward success* was defined as the parents' positive or negative evaluation of registering their children in the physical activity programme.

***Subjective Norms:*** *Subjective norms* were defined as the parents' perception of social pressures put on them to register or not register their children in the physical activity programme.

***Perceived Behavioural Control:*** *Perceived behavioural control* was defined as the parents' perception as to how easy or difficult it would be to register their children in the physical activity programme.

***Attitude Toward Failure:*** The term *attitude toward failure* was used to represent operationally the concept "*attitude toward not performing the behaviour*" as described in chapter 6 of this thesis. Thus, *attitude toward failure* was defined as the parents' positive or negative evaluation of *not* registering their children in the physical activity programme.

***Intention:*** Intention was defined in terms of how hard parents would be willing to try, or how much effort they were planning to exert, in order to register their children in the physical activity programme.

***Past Behaviour:*** Past behaviour was defined as the participation of children in any existing out of school exercise or physical activity programme under the supervision of an instructor.

***Treatment:*** The parents' knowledge that the physical activity programme would not contain competitive sports and that instruction would be based on playful activities was defined as treatment.

**Research Hypotheses**

Based on the review of literature and with reference to the operational definitions stated, the following research hypotheses were formed:

***Hypothesis 1:*** The treatment would not affect the variables *attitude toward success*, *subjective norms*, *perceived behavioural control*, *attitude toward failure* and *intention*.

***Hypothesis 2:*** An equal number of children would register in the programme independent of their gender and the treatment their parents received.

***Hypothesis 3:*** The variables *attitude toward success*, *subjective norms*, *perceived behavioural control*, *attitude toward failure* and *intention* would significantly correlate with each other.

***Hypothesis 4:*** *Intention* would be significantly predicted from *attitude toward success*, *subjective norms* and *perceived behavioural control*. A modification in the measure of *subjective norms* would contribute significantly to the predictive validity of the model. The addition of the variable *attitude toward failure* would contribute to the predictive validity of the model.

***Hypothesis 5:*** Behaviour could be predicted from *intention*. *Perceived behavioural control* would not contribute to the prediction of behaviour.

***Hypothesis 6:*** Past behaviour would not contribute to the prediction of *intention* and behaviour.

***Hypothesis 7:*** The treatment received by the parents, children's gender and the interaction between these variables would not affect the pattern of relationships observed when testing hypothesis 4.

**Assumptions**

In line with the methodology outlined by Thomas and Nelson (1990), the following assumptions were made before proceeding with the collection of the data and / or analysis of the results:

1. The parents would understand the content of the letters and the instructions for completion of the questionnaires.
2. The variables incorporated in the theory of planned behaviour and operationally defined in this thesis could be demonstrated and reliably measured.
3. A considerable proportion of the questionnaires would be completed and returned to allow measurement of the independent variables of the study.
4. Mothers would respond truthfully to the questionnaires.
5. *Intentions* would not change from the time of their assessment until the registration period.
6. Statistical methods including parametric techniques could safely be used with data generated by the research.

# Chapter 8

## Method

### Subjects

The aim of this study was to predict registration of children in an out of school exercise programme from behavioural measures of their parents, within the context of the theory of planned behaviour.

From a population of 1,854 first grade elementary school children resident in the municipality of Heraklion / Crete, a simple random sample of 400 was selected. Subsequently they were randomly assigned to an experimental and a control group each comprising of 200 children. From each group 2 children were excluded because during the time period from subject selection to study implementation their families had moved out of the municipality of Heraklion. Thus, the total number of selected children was reduced to 396. In the next step their mothers were approached with a letter and were asked to complete a questionnaire containing the measures of interest. Mothers were selected to represent the opinions of both parents because, in terms of the geographical area and children's age they were known to be much more involved in the out of school activities of their children than fathers (Pirgiotakis, 1993, interview).

### Instruments

Maternal *attitudes toward success* were assessed with an 8 item scale. Items were selected from Osgood and associates (1957) semantic differential. Their suitability was based on previous research with the theory of planned behaviour (Ajzen and Driver, 1992; Ajzen and Madden, 1986), and on research done in the area of exercise with Greek women using the same theory (Theodorakis, 1992). The question was "Registering my child in the programme is" and responses were obtained on the following adjective pairs: good-bad, laborious-effortless, interesting-boring, intelligent-unintelligent, pleasant-unpleasant, valuable-worthless, comfortable-uncomfortable, important-unimportant. All items were scored on 7-point scales, for example, "Registering my child in the programme is: very good / quite good / relatively good / neutral / relatively bad / quite bad / very bad".

*Subjective norms* were assessed with a 2 item instrument scored on 7-point rating scales. The item "Most people who are important to me would disapprove if I registered my child in the programme" was scored as surely yes / probably yes / maybe yes / neutral / maybe not / probably not / surely not. The item "Most people who are important to me believe I should register my child in the programme" was scored as very likely / quite likely / relatively likely / neutral / relatively unlikely / quite unlikely / very unlikely. The former item was the addition proposed for the measure of *subjective norms* as explained in chapter 6.

*Perceived behavioural control* was assessed with two questions; "Registering my child in the programme is: very easy / quite easy / relatively easy / neutral / relatively difficult / quite difficult / very difficult" and "I think I have the resources to register my child in the programme: surely yes / probably yes / maybe yes / neutral / maybe not / probably not / surely not".

*Attitudes toward failure* were assessed with the question "Not registering my child in the programme is" and answers were given on 6 adjective pairs selected from Osgood and associates (1957). These adjective pairs were good-bad, comfortable-uncomfortable, important-unimportant, pleasant-unpleasant, positive-negative and active-passive. Responses were obtained on 7-point rating scales in the same fashion as for the *attitude toward success scale* already presented.

In previous research with the theory of planned behaviour items pertaining to the independent variables were typically summed or averaged to obtain the respective measure of interest. In this thesis it was decided to proceed with such a manipulation after the appropriate construct validation of the instruments. Analysis showed that *subjective norms*, *attitudes toward failure* and *perceived behavioural control* could indeed be summed, but that *attitude toward success* had to be separated into two constructs. The items laborious-effortless and comfortable-uncomfortable of the *attitude toward success* scale formed one construct and the remaining items another one. Details about these procedures and the respective results are presented in chapter 9 in the section "Validity and Reliability of Instruments".

*Intention* was measured with two 7-point scales; "I intend to register my child in the programme: very likely / quite likely / relatively likely / neutral / relatively unlikely / quite unlikely / very unlikely" was the first item and the second "I shall try to register my child in the programme: surely yes / probably yes / maybe yes / neutral / maybe not / probably not / surely not". Responses on these two items were summed to obtain a measure of intention.

Past behaviour was assessed by asking whether each child already participated in another out of school, organized physical activity or exercise programme and, if so in what kind of activity.

The questionnaire also included questions about demographic data such as children's name, address, phone number, father's profession, father's education, father's age, mother's profession, mother's education, mother's age, total number of children in the family and car ownership. Parental education was scored from 1 to 3 ranging from 1 for elementary, 2 for middle and 3 for higher (university degree) education[1]. Parental profession was scored from 1 to 5. Category 1 stood for housewives, 2 for farming, 3 for manual working, 4 for servants and employees of any type and 5 for engagement in self operated business (Chatzicharistos et al., 1989).

Behaviour was assessed by registration of children in the programme at a specific place during a specified time period and was scored dichotomously, with 1 standing for registration and 0 denoting that registration had not occurred. Information about time and place of registration was included in a covering letter that accompanied the questionnaire.

Letters were addressed to both parents, although the questionnaire contained instructions for it to be completed by the mothers only. Therefore the behavioural measures were considered to be a product of collective decisions that may have been slightly biased by the selection of the mothers as representatives of both parents. On the other hand, behaviour was viewed as the result of collective decisions. Discussions with a number of mothers revealed that this hypothesis was correct. Specifically, they indicated that they had completed the questionnaire alone after having discussed the programme with their spouses and, in addition, had decided about registration in cooperation with them. Copies of the letter, of the questionnaire and of their translations into English appear in appendix 1.

In the same appendix a copy of the letter sent to the families of the experimental group is also included. The two letters were almost identical, with the experimental one containing the treatment in the form of an additional piece of information: "The programme will not contain football, tennis, basketball, volleyball or other sports. Instruction will be based on playful activities.".

The design of the present research was based on literature pertaining to the theory of planned behaviour. A formal pilot study was not carried out. As Moser and Kalton (1971) suggested, a pilot study should constitute a small scale replica of the main survey. Such a requirement could not be fulfilled in the case of this thesis. It required the implementation of an additional pilot exercise programme with a limited number of children and thus, investment of substantial time. Schools closed for summer holidays in early June and there would have been no time for the main survey to be completed.

---

1 Elementary educated Greeks have attended school for a maximum of 6 years while middle educated for a minimum of 7 years and a maximum of 12 years.

On the other hand, because it was crucial to examine whether the instructions for completion of the questionnaire were clear, 5 friends and relatives were asked to give their opinion. Since all of them indicated that instructions were clear and the questionnaire easy to complete no additional pilot work was carried out.

**Procedures**

Approaching the mothers directly at home was perceived to be a difficult task requiring a considerable amount of time and substantial manpower. It was decided that the best solution would be to give an envelope including the letter and the questionnaire to the children during school time. The children would give it to their mothers and after completion would return it to school for collection. This method had been tested in previous research done in the same geographical area with children aged 7-9 years old and achieved a 90 per cent response rate (Atsalakis, 1991). On this basis it was estimated that about 400 envelopes should be sent to the mothers in order to obtain the number of responses that would permit application of multivariate statistical procedures with stable parameter estimates for each experimental group and for the sample as whole (Evans, 1991; West, 1991). Although many more than 400 questionnaires could be administered by this method, it was thought that in this case the number of registered children could be large, making implementation of the programme problematic.

To conduct research through or within Greek schools requires the agreement of the school directors, agreement of the teachers and production of a special licence from the Institute of Education / Ministry of Education. The usual procedure to obtain the licence involves submission of an application accompanied with reference letters from a major professor, curriculum vitae of the researcher, a description of the proposed research identifying its targets and the methods to be used and finally an estimation of the disturbance that will be caused to the normal function of the schools as a result of the research procedure.

The application procedure concerning the present research was initiated during January 1993 and a positive answer along with the licence was received two months later[1]. The next step was to present the licence to the local directorate for elementary education, in order to obtain a letter that explicitly allowed the researcher to implement the research in the schools of the municipality of Heraklion. A copy of this letter was retained by the researcher for production upon request by the school directors. A copy

---

1 I thank Prof. Dr. I. Pirgiotakis, deputy rector of the University of Crete for his help with the application process.

of this letter was also separately sent to each school director, by the director of elementary education[1]. A copy of the licence and its translation into English is included in appendix 2.

The local directorate of elementary education had lists of all schoolchildren in the municipality of Heraklion. In total, 1,854 first grade children were studying at this time in the 55 schools of the area. The selection of the desired sample was done as follows. Each school was assigned a number from 1 to 55. From the lists of schoolchildren held in the directorate of elementary education the number of first grade children of each school was known. Thus, theoretically, the first school had n1 children, the second school n2 children.....and the fifty fifth school n55 children at the first grade. Since the teachers of each school held alphabetic lists of their pupils, each child in a given school could be assigned a unique number that corresponded to his / her rank in the alphabetic list of the teacher. Macroscopically, each child of the population could be uniquely identified using only two numbers that is, the number of the school and the rank in the teacher's alphabetic list. Thus, cumulatively, children could be assigned numbers from 1 to 1,854 while at the same time being identifiable from the two numbers mentioned. Importantly, this manipulation could be done without coming in face to face contact with the children or the teachers. Subsequently, a simple random sample of 400 numbers ranging in magnitude from 1 to 1,854 was obtained using the table of random digits provided by Reid (1987). As explained, each child drawn, could be identified from its school number and its cumulative population rank. For example let us assume that school 1 had 30 children, school 2 had 25 children and school 3 had 30 children at the first grade. If the number 10 were drawn from the table of random digits, this would be the 10th child in the alphabetic list of school 1. If the number 35 were drawn, this would be the 5th child in the alphabetic list of school 2 and if the number 80 were drawn this would correspond to the 25th child in the alphabetic list of school 3. Finally, the 400 children selected were randomly assigned to an experimental and a control condition using the tables of Reid (1987).

It happened that at least one child was selected from each school and therefore, all 55 schools had to be visited for administration of the questionnaires. This process lasted two days. The researcher would introduce himself to the school director during a break, show him / her the licence and the letters from the educational authorities and explain the target and the requirements of the research. In all circumstances the directors were positive. Then, a meeting with the teacher of the first grade class would be

---

1 The implementation of the study showed that production of the licence persuaded the directorate of elementary education to send the appropriate messages to the schools but was of little value in persuading school directors. Instead, the message sent from the local directorate was what actually persuaded the school directors to cooperate. Thus, future research should consider the steps followed here as absolutely essential.

arranged to explain the method of letter administration to the selected children. Each selected child was to be given an envelope containing the questionnaire and the appropriate letter. Envelopes were marked with a number corresponding to the alphabetic list of the teacher as already outlined. Teachers had no particular problems in understanding the administration method. The whole procedure normally lasted between 5 to 10 minutes except where schools were large and had more than one first grade class. In these cases meetings with all first grade teachers were essential. Normally, the total duration of these meetings did not exceed 20 minutes. Directions were given to the teachers so that children were instructed to give the envelopes to their mothers and bring them back to school after 7 days (including a weekend) at the latest.

Accordingly, collection of completed questionnaires took place after 7 days. Schools were visited in the same order as the first time. This phase of the research also lasted 2 days. A few children said their mothers had forgotten to complete the questionnaires and they were allowed 2 to 3 more days to bring them back. After this second deadline no other notification was made to the mothers or the children. Collection of these few delayed responses lasted one more day. All in all, administration and collection of questionnaires lasted 11 days, starting on Monday, 29 March 1993 and ending on Thursday, 8 April 1993.

Some questionnaires had missing answers, so an effort was made to complete the data by phone. About 15 mothers were initially called and it was found that they could not easily answer the questions by phone. Therefore, this attempt was not continued and answers obtained by phone were not retained for the final analysis. Nevertheless, this procedure was of substantial benefit because it offered the opportunity to ask the mothers whether they understood the items in the questionnaire. It seemed that items 2 and 3 from the *attitude toward failure* scale were not clear enough. This notion was confirmed later, when mothers that registered their children in the programme were asked whether they understood the items contained in the questionnaire they had completed. The same items were considered to be misleading and thus they were excluded from further analysis.

Registration of children in the programme started on Monday, 12 April 1993. The dates of registration were 12 to 14 April and from 26 to 30 April. The place of registration was the Heraklion Tennis Club which was well known in the locality. The researcher was present each registration day from 10.30-13.30 and from 16.30-19.30 at the Heraklion Tennis Club, to offer ample time to the parents to register their children. It was thought that less time for registration would interfere with the validity of assumptions underpinning the theory of planned behaviour that is, that the relationship between intention and behaviour or outcome is genuine if no factors related to the research process influence this behaviour or outcome. It was felt that the

time limits offered for registration adequately covered this issue. For example, parents working in the morning had the possibility of coming during the afternoon and vice versa.

After registration, parents were asked to bring their child to a pediatrician for a medical examination, explaining that participation in exercise programmes required preliminary medical screening. A form was given to them in order to be completed by the pediatrician. A copy of this form is included in appendix 3. All parents promptly agreed to comply with this requirement. They were instructed to bring back the completed form on the first day of the programme.

Individual schedules were arranged at the time of registration. Parents were free to select the schedule that suited their needs best. Schedules were not predetermined. Thus, a child could attend the programme any day or time his / her parents wanted. On the other hand, parents were not normally allowed to change the schedule from week to week. Children participated 3 times per week for about 1 hour each time.

The programme started on Monday, 3 May 1993. Its content involved 10 minutes warming up, 35 minutes for the main part and 5 minutes cool down. The warming up period included light jogging, running to various directions and stretching exercises. The main part contained exercises for the legs, the abdomen and the arms, various movements resembling animals (kangaroo, cat, cockroach, birds) and finally playful activities adapted from Hill (1993) and Kyriklidou (1987).

All exercise sessions took place at the facilities of the Heraklion Tennis Club. A tennis court was provided by the club and was used exclusively for the programme presented here. Its net was removed and it was felt that there was ample space for movement since all groups formed had fewer than 15 children.

The court was checked every day and cleared of sharp objects that could injure the children. Parents were allowed to watch the exercise sessions from the tiers of the court.

At the end of the programmes (Friday, 28 May 1993), a letter was given to the parents acknowledging their commitment. As a result of some requests, this letter also contained a list of the activities usually performed in the exercise sessions. Apparently, children insisted that their parents instruct them at home in order to continue the regimen and thus, a rough guide was necessary. A copy of this letter is in appendix 4.

**Statistical Methods**

After appropriate recoding of the behavioural and demographic measures, all data were entered in a computer and analyzed with the statistical programme SPSSPC+, version 4.0. Details about the procedures followed in testing each research hypothesis will be presented in the respective section of chapter 9.

Generally speaking, group means and standard deviations were used for descriptive purposes. Factor analysis, cluster analysis and computation of Cronbach's alpha coefficient were used to assess validity and reliability of the behavioural measures (Norusis, 1990). Chi-square statistics were used to test the degree of independence between and within nominal and ordinal variables. Group differences were detected by independent samples t-tests, analyses of variance, multivariate analysis of variance, binomial tests, Mann-Whitney tests and Kruskal-Wallis analyses of variance, depending on the distributions of the variables and the sample size each time (Norusis, 1990). Bivariate relationships were explored by means of Pearson correlations and finally, multivariate relationships were explored by regression methods (Norusis, 1990). Prediction of behaviour was attempted by means of logistic regression analysis.

Parametric procedures are more powerful than non-parametric ones (Norusis, 1990). Therefore, an alpha level of 0.01 was employed for non-parametric and a 0.05 level for parametric procedures in hypothesis testing .

Use of parametric statistical methods assumes that independent variables are measured at the interval level. Strictly speaking the behavioural measures used in this thesis constitute ordinal variables. However use of similar instruments has taken place in all research related to the theory of planned behaviour. In these cases it was implicitly assumed that the scales used were interval in nature. Relatedly, Cohen and Cohen (1975) discussed the use of such scales with regression methods and stated:

> "Formally, fixed model regression analysis demands that the quantitative independent variables be scaled at truly equal intervals and measured without error. Meeting this demand would rule out the use of all psychological tests, sociological indices, rating scales and interview responses; excepting some experimentally manipulated 'treatments' this eliminates virtually all the kinds of quantitative variables on which the behavioral sciences depend" (Cohen and Cohen, 1975, p. 228).

On another point, the same authors concluded: "In practice, ordinal scales, as well as those which seek (not necessarily successfully) to yield interval or ratio level measurement, may be profitably employed" (Cohen and Cohen, 1975, p. 230).

In the light of these comments, it was considered that parametric methods could safely be used for the purposes of this thesis.

**Delimitations and Limitations**

Considering the methodology outlined by Thomas and Nelson (1990) and the remarks of Moser and Kalton (1971) about the implementation of population surveys, the delimitations of the present research and the assumptions accompanying them were as follows:

1. The sample selected would be adequately representative of the population.
2. The items selected to measure any behavioural construct would be representative of the population of the items that could be used to measure the construct.
3. The mothers would adequately represent both parents for the completion of the questionnaires.
4. The place selected for registration would be either well known or easy to find and thus no parents would be prevented from registering their children in the programme if they wanted to.
5. The time limits offered for registration would be adequate and would not prevent any parents from registering their children in the programme if they wanted to.
6. The sports selected to be included in the treatment statement delivered to the experimental group were adequately representative of the population of existing competitive sports.
7. Comparison on the ground of demographic data would be an adequate indication of initial equality or inequality between the experimental groups.

As a result, the research was limited to the extent that, the delimitations stated represented adequately what they were supposed to represent. Finally it was limited to the extent that the mothers who actually completed and returned the questionnaires were representative of the population from which they were sampled.

# Chapter 9

## Results

### Description of the Sample

In total, 349 questionnaires were returned achieving a response rate of 88.1 per cent (initial number of questionnaires = 396).

From them, 8 questionnaires had no answers to any of the questions and were excluded from further analysis. From the remaining questionnaires, 52.8 per cent came from girls' mothers (n=178) and 47.2 per cent from boys' mothers (n=159). A binomial non parametric test showed that these proportions did not differ significantly (p=0.3268). In addition 46.9 per cent came from mothers of the experimental group (n=161) and 53.1 per cent from mothers of the control group (n=180). Again, a binomial test showed that the number of responses were not statistically different (p=0.2788). A chi-square test was performed to test the hypothesis of independence between experimental condition and children's gender. Since the Pearson statistic was large (p=0.12503) the hypothesis was accepted. These tests established that neither experimental condition nor children's gender were confounding factors in the response rate achieved in the research.

Mean mother age was 32.34 years (standard deviation=4.88, minimum=21, maximum=47). Mean father age was 37.44 years (standard deviation=5.91, minimum=24, maximum=69).

Tables 9.1 and 9.2 present data about parental level of education and parental profession.

**Table 9.1: Parental Level of Education**[1]

| Level of Education | Mothers (%) | Fathers (%) |
|---|---|---|
| Elementary Educated | 22.2 | 33.1 |
| Middle Educated | 62.3 | 46.1 |
| Highly Educated | 15.5 | 20.7 |

[1] Elementary educated people have attended school for a maximum of 6 years while middle educated for a minimum of 7 years and a maximum of 12 years. Highly educated people have attended higher education.

**Table 9.2: Parental Profession** (Categorisation according to Chatzicharistos et al., 1989)

| Parental Profession | Mothers (%) | Fathers (%) |
|---|---|---|
| Housewives | 57.1 | - |
| Farmers | - | 2.7 |
| Manual Workers | 0.67 | 9.9 |
| Servants or Employees | 35.2 | 48.2 |
| Self Employed Business | 6.3 | 39.2 |

Of the families examined, 13.4 per cent had one child, 64.1 per cent had two children and 17.2 per cent had 3 children. A small proportion (5.4 per cent) had more than 3 children.

Finally, 87.2 per cent of the families had a car and the remaining 12.8 per cent did not.

## Participation of Children in Existing Exercise Programmes

A large proportion (81.3 per cent) of the children were not engaged in any out of school organized sport or exercise activity. Sixteen point three per cent participated in one activity, 2.1 per cent in two activities and only 1 child (0.3 per cent) in three activities. In respect of individual activities, 9.2 per cent of the children participated in regular dancing activities in the form of folk dance or ballet. Other activities reported included gymnastics (1.2 per cent), swimming (3.0 per cent), tennis (0.9 per cent), martial arts (0.6 per cent), rhythmic gymnastics (1.8 per cent) and general activity programmes (2.1 per cent). For children participating in two activities, dance was the exclusive second activity. One child participated in three activities, ballet, folk dance and swimming.

## Registration and Participation of Children in the Programme

In total, 66 children registered for the programme, representing 16.7 per cent of the number of children whose mothers were approached and 19.4 per cent of the children whose mothers returned the questionnaire.

Of those registering, 6 children did not attend any exercise session. Table 9.3 presents the number of children that attended the respective number of sessions (maximum possible number of attended sessions = 12).

**Table 9.3: Attendance at the Programme**

| Number of Sessions | Number of Children | Percentage (%) | Cumulative Percentage (%) |
|---|---|---|---|
| 0 | 6 | 9.1 | 9.1 |
| 1 | 4 | 6.1 | 15.2 |
| 3 | 2 | 3.0 | 18.2 |
| 4 | 4 | 6.1 | 24.2 |
| 5 | 2 | 3.0 | 27.3 |
| 6 | 2 | 3.0 | 30.3 |
| 7 | 4 | 6.1 | 36.4 |
| 8 | 6 | 9.1 | 45.5 |
| 9 | 11 | 16.7 | 62.1 |
| 10 | 12 | 18.2 | 80.3 |
| 11 | 10 | 15.2 | 95.5 |
| 12 | 3 | 4.5 | 100 |

## Validity and Reliability of Instruments

### Descriptive Statistics

Table 9.4 contains the means and standard deviations of the behavioural measures for the control group, the experimental group and the total of the cases.

**Table 9.4: Descriptive Statistics for the Whole Sample, the Control Group and the Experimental Group**

| Variables | Mean for the whole Sample (n=341) | Standard Deviation for the whole Sample | Mean for the Control Group (n=181) | Standard Deviation for the Control Group | Mean for the Experime-ntal Group (n=160) | Standard Deviation for the Experime-ntal Group |
|---|---|---|---|---|---|---|
| Attitude Toward Success | | | | | | |
| Item 1 | 6.47 | 0.73 | 6.45 | 0.74 | 6.49 | 0.71 |
| Item 2 | 4.26 | 1.33 | 4.23 | 1.32 | 4.29 | 1.34 |
| Item 3 | 6.25 | 0.84 | 6.22 | 0.83 | 6.28 | 0.86 |
| Item 4 | 5.89 | 0.99 | 5.95 | 0.98 | 5.82 | 0.99 |
| Item 5 | 6.08 | 0.94 | 6.08 | 0.91 | 6.09 | 0.97 |
| Item 6 | 6.26 | 0.78 | 6.34 | 0.76 | 6.17 | 0.79 |
| Item 7 | 4.79 | 1.47 | 4.86 | 1.40 | 4.72 | 1.55 |
| Item 8 | 6.00 | 0.97 | 6.03 | 1.02 | 5.96 | 0.91 |
| Subjective Norms | | | | | | |
| Item 1 | 5.82 | 1.57 | 5.87 | 1.57 | 5.77 | 1.58 |
| Item 2 | 6.02 | 1.44 | 6.08 | 1.44 | 5.95 | 1.43 |
| Perceived Behavioural Control | | | | | | |
| Item 1 | 4.67 | 1.46 | 4.66 | 1.60 | 4.68 | 1.41 |
| Item 2 | 5.32 | 1.55 | 5.17 | 1.68 | 5.48 | 1.48 |
| Attitude Toward Failure | | | | | | |
| Item 1 | 2.91 | 1.46 | 2.83 | 1.38 | 3.00 | 1.54 |
| Item 4 | 2.84 | 1.53 | 2.82 | 1.50 | 2.86 | 1.57 |
| Item 5 | 2.81 | 1.58 | 2.85 | 1.65 | 2.76 | 1.50 |
| Item 6 | 3.00 | 1.70 | 3.02 | 1.75 | 2.97 | 1.65 |
| Intention | | | | | | |
| Item 1 | 5.73 | 1.66 | 5.69 | 1.68 | 5.79 | 1.64 |
| Item 2 | 5.74 | 1.52 | 5.68 | 1.57 | 5.80 | 1.47 |

**Validity and Reliability**

Evidence for the face and construct validity of the measures employed in this thesis is based on the fact that all research pertaining to the theory of planned behaviour has used similar instruments of similar content. Furthermore, the attitudinal items were selected from the semantic differential (Osgood et al., 1957), an already validated and widely accepted tool.

However, Aiken (1988) suggested that further evidence for construct validity should be sought by means of factor analysis. Factor analysis was followed for the experimental and the control group separately, as well as for the whole number of the cases. Because the results from all these analyses were identical, only those generated from the latter (n=341) are presented here.

It was hypothesized that items pertaining to the independent variables of this research would form at least 4 constructs as a result of factor analysis, namely, *attitudes toward success*, *subjective norms*, *perceived behavioural control* and *attitudes toward failure*.

In a discussion about the use of factor analysis, West (1991) recommended the maximum likelihood method when meaningful psychological dimensions are sought and principal components analysis when the target is to reduce a set of data to a manageable number of variables.

Furthermore, Bryman and Cramer (1990) stated that orthogonal rotation of the factor solution does not allow the factors to correlate with each other, probably creating an unreal life situation. The same authors commented that oblique rotation is preferable when high correlations between factors are expected.

Because previous research with Greek women has shown that constructs of the theory of planned behaviour correlated significantly with each other (Theodorakis, 1992) and because the aim was to investigate possible meaningful dimensions, a maximum likelihood method of factor extraction with oblique rotation of the factors was selected as the more appropriate in this situation.

The Kaiser-Meyer-Olkin measure of sampling adequacy was high (KMO=0.86766) and the Bartlett test of sphericity significant (significance=0.00000) and thus, it was appropriate to proceed with the factor analysis (Norusis, $1990_a$).

Using the chi-square criterion (Norusis, $1990_a$), 5 factors should be extracted to represent the data adequately. These factors accounted for 56.4 per cent of the variance. Table 9.5 presents the communalities of the variables, corresponding to the 5-factor solution.

**Table 9.5: Communalities for the 5 Factor Solution**

| Variables | Communalities |
|---|---|
| Attitude Toward Success | |
| Item 1 | 0.45 |
| Item 2 | 0.36 |
| Item 3 | 0.48 |
| Item 4 | 0.55 |
| Item 5 | 0.59 |
| Item 6 | 0.70 |
| Item 7 | 0.47 |
| Item 8 | 0.48 |
| Subjective Norms | |
| Item 1 | 0.38 |
| Item 2 | 0.40 |
| Perceived Behavioural Control | |
| Item 1 | 0.61 |
| Item 2 | 0.51 |
| Attitude Toward Failure | |
| Item 1 | 0.67 |
| Item 4 | 0.84 |
| Item 5 | 0.84 |
| Item 6 | 0.71 |

Examination of the so called reproduced correlation matrix revealed that the model fitted very well the data since only 3 residuals (2 per cent) exceeded the 0.05 value (Norusis, $1990_a$). The factor structure matrix is shown in table 9.6.

**Table 9.6: Five Factor Structure Matrix**

| Variables | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|---|---|---|---|---|
| Attitude Toward Success | | | | | |
| Item 1 | | 0.59 | | 0.53 | |
| Item 2 | | | | 0.57 | |
| Item 3 | | 0.64 | | | |
| Item 4 | | 0.74 | | | |
| Item 5 | | 0.59 | | 0.68 | |
| Item 6 | | 0.82 | | | |
| Item 7 | | | | 0.64 | |
| Item 8 | | 0.67 | | | |
| Subjective Norms | | | | | |
| Item 1 | | | | | 0.61 |
| Item 2 | | | | | 0.62 |
| Perceived Behavioural Control | | | | | |
| Item 1 | | | 0.76 | | |
| Item 2 | | | 0.66 | | |
| Attitude Toward Failure | | | | | |
| Item 1 | -0.80 | | | | |
| Item 4 | -0.90 | | | | |
| Item 5 | -0.90 | | | | |
| Item 6 | -0.83 | | | | |

From the structure matrix, 3 factors were clearly identified and corresponded to the *subjective norms*, *perceived behavioural control* and *attitude toward failure* variables. Factors 2 and 4 were difficult to interpret since there were items loading highly on both factors. However, both factors comprised of items belonging exclusively to the *attitude toward success* scale.

Thus, overall, this factor analysis lent support to the hypothesized constructs. A separate factor analysis was performed for the *attitude toward success* items only. From the overall factor analysis presented in table 9.6 it was clear that the measure of *attitude toward success* should be broken into two separate factors. For this purpose a principal components analysis with oblique rotation was utilized to comply with the approach of other researchers. The Kaiser-Meyer-Olkin measure of sampling adequacy was high (KMO=0.85924) and the Bartlett test of sphericity significant (significance=0.00000) allowing the execution of principal component analysis[1] (Norusis, $1990_a$). The number of factors to be extracted was predetermined at 2. In fact, this solution agreed with the widely accepted criterion for factor extraction: eigenvalue greater or equal to 1. Table 9.7 presents the communalities of the items corresponding to the 2 factor solution.

**Table 9.7: Communalities for the Attitude Toward Success Items**

| Variables | Communalities |
|---|---|
| Attitude Toward Success | |
| Item 1 | 0.55 |
| Item 2 | 0.70 |
| Item 3 | 0.58 |
| Item 4 | 0.61 |
| Item 5 | 0.60 |
| Item 6 | 0.70 |
| Item 7 | 0.69 |
| Item 8 | 0.60 |

The reproduced correlation matrix contained 17 residuals (60 per cent) over the 0.05 value, but closer inspection revealed that these values were quite small indicating that the two factor model described the data satisfactorily (Norusis, $1990_a$). The correlation coefficient between the factors was relatively high (r=0.36) confirming that oblique rotation of the axes was indeed appropriate.

The corresponding structure matrix is shown in table 9.8.

---

1 The same results were obtained when a maximum likelihood method of factor extraction was implemented. The results from the principal components are presented here however to allow comparisons with previous research.

**Table 9.8: Two Factor Structure Matrix for The Attitude Toward Success**

| Variables | Factor 1 | Factor 2 |
|---|---|---|
| Attitude Toward Success | | |
| Item 1 | 0.73 | |
| Item 2 | | 0.84 |
| Item 3 | 0.75 | |
| Item 4 | 0.78 | |
| Item 5 | 0.70 | |
| Item 6 | 0.83 | |
| Item 7 | | 0.83 |
| Item 8 | 0.76 | |

Items 2 and 7 loaded highly on one factor and the remaining items on the other, forming two separate but related constructs.

The results of this factor analysis were confirmed by means of cluster analysis of the item intercorrelation matrix as McKennel (1978) recommended for attitude scales. Two clusters were formed. The first cluster contained the correlation coefficients between item 2 and items 1,3,4,5,6,8 and the coefficients between item 7 and items 1,3,4,5,6,8. The second cluster contained all other coefficients including the one between items 2 and 7. Closer inspection of the magnitude of the coefficients revealed that the first cluster comprised of small and the second cluster of large coefficients. Thus the relationship between items 2 and 7 was strong while their relationship with the remaining items was relatively weak. These results confirmed the factor analysis presented in table 9.8 in that items 2 and 7 formed a separate subconstruct.

Overall, the results from the factor and cluster analytic procedures revealed the existence of 4 separate constructs with the *attitude toward success* scale being composed of two subconstructs. The factor formed by items 1,3,4,5,6 and 8 of the *attitude toward success* scale was clearly evaluative in nature and it was retained in the analysis. The loadings of items 2 and 7 on this factor were very low and thus, these items were excluded from further analysis.

A last step in assessing construct validity is, according to Aiken (1988) and Cronbach and Meehl (1978) the computation of Cronbach's alpha, which is at the same time the most widely accepted coefficient of reliability. Table 9.9 presents Cronbach's alpha coefficients for all the constructs derived, including the measure of *intention*.

**Table 9.9: Reliability / Internal Consistency of the Constructs**

| Variable | Cronbach's Alpha | Sample Size (n) |
|---|---|---|
| Attitude Toward Success | 0.85 | 299 |
| Subjective Norms | 0.53 | 335 |
| Perceived Behavioural Control | 0.72 | 338 |
| Attitude Toward Failure | 0.92 | 284 |
| Intention | 0.88 | 334 |

The reliability coefficients for the *subjective norms* were not very high but were satisfactory since similar values have been obtained in other research with the theory of planned behaviour (Ajzen and Driver, 1992).

Some evidence for the convergent and discriminant validity of the constructs was obtained by comparing the correlations between one item of the construct and items of the same construct, with correlations between the particular item and items of the other constructs. Table 9.10 presents these results.

**Table 9.10: Intercorrelations of Items Within and Between Constructs**

| Variables | Correlations Between the Item and Items of the Same Construct (Absolute Values) | Correlations Between the Item and Items of Other Constructs (Absolute Values) |
|---|---|---|
| Attitude Toward Success | | |
| Item 1 | From 0.40 to 0.56 | From 0.19 to 0.35 |
| Item 3 | From 0.45 to 0.56 | From 0.16 to 0.37 |
| Item 4 | From 0.45 to 0.63 | From 0.15 to 0.29 |
| Item 5 | From 0.43 to 0.52 | From 0.20 to 0.44 |
| Item 6 | From 0.43 to 0.63 | From 0.20 to 0.38 |
| Item 8 | From 0.40 to 0.58 | From 0.14 to 0.36 |
| Subjective Norms | | |
| Item 1 | 0.37 | From 0.17 to 0.34 |
| Item 2 | 0.37 | From 0.19 to 0.32 |
| Perceived Behavioural Control | | |
| Item 1 | 0.56 | From 0.12 to 0.43 |
| Item 2 | 0.56 | From 0.17 to 0.62 |
| Attitude Toward Failure | | |
| Item 1 | From 0.69 to 0.75 | From 0.06 to 0.34 |
| Item 4 | From 0.70 to 0.80 | From 0.13 to 0.34 |
| Item 5 | From 0.69 to 0.80 | From 0.20 to 0.41 |
| Item 6 | From 0.67 to 0.79 | From 0.15 to 0.30 |
| Intention | | |
| Item 1 | 0.78 | From 0.17 to 0.62 |
| Item 2 | 0.78 | From 0.18 to 0.58 |

Clearly, the within construct correlations were higher than correlations between a construct's item and items of other constructs.

All in all, it was felt that evidence for the validity and reliability of the constructs had been achieved, thus allowing progress to the summation of items in order to obtain the respective behavioural measures.

After doing so, evidence for the predictive validity of each construct was sought. The criterion was to compare behavioural measures of mothers whose children did not register in the programme with those of mothers whose children were registered, for each construct of interest. One method was to compare group means and the other to examine correlation coefficients.

The selected statistical instrument was a series of non parametric Mann-Whitney tests. Mann-Whitney tests were preferred to t-tests because, in the distributions of the variables, moderate departures from normality were detected and the samples to be compared were not equal (Norusis, $1990_a$). Table 9.11 presents these results along with the significance level achieved each time.

**Table 9.11: Registered and Unregistered Children. Mean Differences of the Constructs**

| Variables | Mothers with Unregistered Children (n=275) | Mothers with Registered Children (n=66) | Two Tailed p Value |
|---|---|---|---|
| Attitude Toward Success | 137.44 | 172.13 | 0.0034 |
| Subjective Norms | 160.49 | 199.20 | 0.0028 |
| Perceived Behavioural Control | 158.30 | 216.53 | 0.0000 |
| Attitude Toward Failure | 146.43 | 106.30 | 0.0005 |
| Intention | 148.28 | 247.05 | 0.0000 |

Table 9.12 presents the Spearman rank correlation coefficients between the constructs of interest and the dichotomous variable registration / non-registration of children in the programme.

**Table 9.12: Spearman Rank Correlations**

| Variable | Spearman Correlation | Significance |
|---|---|---|
| Attitude Toward Success | 0.17 | 0.003 |
| Subjective Norms | 0.16 | 0.002 |
| Perceived Behavioural Control | 0.24 | 0.000 |
| Attitude Toward Failure | -0.21 | 0.000 |
| Intention | 0.41 | 0.000 |

The significance levels achieved in Mann-Whitney tests and in rank correlations supported the predictive validity of the constructs.

After having examined the variables in terms of validity and reliability, a check for the internal validity of the research was undertaken.

## Testing Internal Validity

Having established that an equal number of responses had been received from the mothers independent of experimental condition and gender of the children, an attempt was made to examine whether the experimental groups were initially similar in order to establish the internal validity of the research.

This hypothesis was tested by comparing the sociodemographic characteristics of the two groups. One way analyses of variance was used to compare fathers' and mothers' ages while a series of chi-square tests of independence were performed for parental profession, parental education, car ownership and number of children in the family.

The results are shown in table 9.13.

**Table 9.13: Internal Validity**

| Variable | Procedure | Significance Level Achieved |
|---|---|---|
| Fathers' Age | One Way ANOVA | 0.3884 |
| Mothers' Age | One Way ANOVA | 0.1373 |
| Fathers' Profession | Chi-Square | 0.8690 |
| Mothers' Profession | Chi-Square | 0.0511 |
| Fathers' Education | Chi-Square | 0.5132 |
| Mothers' Education | Chi-Square | 0.9522 |
| Car Ownership | Chi-Square | 0.5755 |
| Number of Children in the Family | Chi-Square | 0.6990 |

Since all tests were insignificant the hypothesis of initial similarity between the control and the experimental group was accepted and the internal validity of the research assured.

It was thus appropriate to proceed with the testing of the hypotheses.

## Hypothesis Testing

### Hypothesis 1

The initial similarity between the control and the experimental group allowed testing of the hypothesis that treatment affected the responses of the mothers of the experimental group. Since it was thought that gender of the children could have affected these responses in relation to treatment, a multivariate analysis of variance (MANOVA) test for experimental condition and children's gender was employed as the appropriate statistical tool. Cohran's and Bartlett's coefficients were all higher than 0.05 indicating equal variance of all variables for the two groups (Norusis, $1990_b$). Furthermore, a Box's M test (significance=0.105) showed that the variance-covariance matrices were homogeneous (Norusis, $1990_b$). These statistics allowed the execution of MANOVA. The results are presented in table 9.14.

**Table 9.14: MANOVA Results**

| Effect | Test Name | Significance of F |
|---|---|---|
| Children's Gender by Experimental Condition | Pillais | 0.576 |
| | Hotelings | 0.576 |
| | Wilks | 0.576 |
| Experimental Condition | Pillais | 0.420 |
| | Hotellings | 0.420 |
| | Wilks | 0.420 |
| Children's Gender | Pillais | 0.793 |
| | Hotellings | 0.793 |
| | Wilks | 0.793 |

The significance levels indicated that the hypothesis of treatment, as well as children's gender effects, had to be rejected. In addition, no interaction was detected between these two factors.

Because moderate departures from normality were detected for the measures of *intention* and *subjective norms*, a series of non parametric tests were performed to examine the same hypothesis that is, the difference between the groups controlling for children's gender. More specifically, Mann-Whitney tests examined main effects for experimental group membership and children's gender, while Kruskal-Wallis analyses of variance examined the group by gender interaction after appropriate recoding of the

variables (Norusis, $1990_a$). The results are presented in table 9.15 and confirm the conclusions from the MANOVA.

**Table 9.15: Results from Non-Parametric Tests**

| Effect | Variable | Procedure | Significance Level Achieved |
|---|---|---|---|
| Children's Gender by Experimental Condition | Attitude Toward Success | Kruskal-Wallis ANOVA | 0.9163 |
| | Subjective Norms | Kruskal-Wallis ANOVA | 0.4240 |
| | Perceived Behavioural Control | Kruskal-Wallis ANOVA | 0.2442 |
| | Attitude Toward Failure | Kruskal-Wallis ANOVA | 0.9019 |
| | Intention | Kruskal-Wallis ANOVA | 0.8841 |
| Experimental Condition | Attitude Toward Success | Mann-Whitney | 0.7570 |
| | Subjective Norms | Mann-Whitney | 0.5242 |
| | Perceived Behavioural Control | Mann-Whitney | 0.3228 |
| | Attitude Toward Failure | Mann-Whitney | 0.9390 |
| | Intention | Mann-Whitney | 0.5999 |
| Children's Gender | Attitude Toward Success | Mann-Whitney | 0.6654 |
| | Subjective Norms | Mann-Whitney | 0.1692 |
| | Perceived Behavioural Control | Mann-Whitney | 0.9772 |
| | Attitude Toward Failure | Mann-Whitney | 0.5698 |
| | Intention | Mann-Whitney | 0.9438 |

It was concluded that treatment did not affect parental behavioural measures.

**Hypothesis 2**

Chi-square tests of independence examined the hypothesis that an equal number of children were registered in the programme independent of experimental condition and gender. Table 9.16 contains these results.

**Table 9.16: Tests of Independence. Registration, Gender and Treatment**

| Effect | Test | Significance Level Achieved |
|---|---|---|
| Children's Gender by Experimental Condition | Chi-Square | 0.7221 |
| Experimental Condition | Chi-Square | 0.2758 |
| Children's Gender | Chi-Square | 0.8129 |

Judging from the significance levels achieved, the hypothesis of independence between registration in the programme and experimental group membership, or children's gender has to be accepted.

Based on these results it was concluded that the treatment did not influence the decisions of the parents to register their children in the programme.

**Hypothesis 3**

The degree of relationship between dependent and independent variables was examined by means of Pearson correlation coefficients. The results are presented in table 9.17.

**Table 9.17: Correlations between Constructs**

| Variables | Attitude Toward Success | Subjective Norms | Perceived Behaviou-ral Control | Attitude Toward Failure | Intention |
|---|---|---|---|---|---|
| Attitude Toward Success | 1.00 | | | | |
| Subjective Norms | 0.37 | 1.00 | | | |
| Perceived Behavioural Control | 0.30 | 0.33 | 1.00 | | |
| Attitude Toward Failure | -0.43 | -0.36 | -0.26 | 1.00 | |
| Intention | 0.42 | 0.41 | 0.59 | -0.33 | 1.00 |

All correlations were significant at the predetermined 0.05 level and, in fact, were significant at the 0.01 level as well. Before the calculation of the Pearson coefficients it had been established by examination of all possible scatter diagrams that these relationships were fairly linear. The variables *attitude toward success*, *subjective norms*, *perceived behavioural control*, *attitude toward failure* and *intention* were thus found to correlate significantly with each other offering support to hypothesis 3.

**Hypothesis 4**

Hierarchical multiple regression analysis was the method of choice for the prediction of intention in previous research with the theory of planned behaviour. However, Norusis ($1990_a$) recommended that before applying regression techniques the equality between cases with missing values and cases having no missing values on any of the variables should be established. A series of Mann-Whitney tests was performed for the behavioural measures since moderate departures from normality were apparent and the group sizes were unequal, t-tests were applied for the parental ages and chi-square tests of independence for the sociodemographic variables. All results are shown in table 9.18.

**Table 9.18: Comparison of Cases with Missing Values (n=80) with Complete Cases (n=261)**

| Variable | Procedure | Significance Level Achieved |
|---|---|---|
| Attitude Toward Success | Mann Whitney | 0.8150 |
| Subjective Norms | Mann Whitney | 0.3252 |
| Perceived Behavioural Control | Mann Whitney | 0.4180 |
| Attitude Toward Failure | Mann Whitney | 0.4242 |
| Intention | Mann Whitney | 0.5029 |
| Fathers' Age | T Test | 0.960 |
| Mothers' Age | T Test | 0.702 |
| Fathers' Profession | Chi-Square | 0.8887 |
| Mothers' Profession | Chi-Square | 0.2077 |
| Fathers' Education | Chi-Square | 0.4215 |
| Mothers' Education | Chi-Square | 0.5923 |
| Number of Children in the Family | Chi-Square | 0.6706 |
| Car Ownership | Chi-Square | 0.6851 |
| Participation of Children in Existing Sport Activities | Chi-Square | 0.6284 |

Based on the observed significance levels it was concluded that cases with missing values did not differ significantly from cases with no missing values.

Thus, it was considered appropriate to proceed with regression analysis. Following the procedures advocated by Ajzen and Driver (1992), Ajzen and Madden (1986) and Schifter and Ajzen (1985), a hierarchical multiple regression model was developed. *Attitude toward success* was entered in the first step, *subjective norms* were entered at the second and *perceived behavioural control* at the third. *Intention* was the dependent variable. Table 9.19 presents the variables entered at each step, the significance level of

F, the significance of F change from step to step, the significance level achieved for each variable, the multiple R and the multiple R squared.

**Table 9.19: Initial Regression Results**

| Variable | Signifi-cance of F | Signifi-cance of F Change | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|
| Step 1 | 0.0000 | - | | 0.4319 | 0.1865 |
| Attitude Toward Success | | | 0.0000 | | |
| Step 2 | 0.0000 | 0.0000 | | 0.5145 | 0.2647 |
| Attitude Toward Success | | | 0.0000 | | |
| Subjective Norms | | | 0.0000 | | |
| Step 3 | 0.0000 | 0.0000 | | 0.6656 | 0.4437 |
| Attitude Toward Success | | | 0.0000 | | |
| Subjective Norms | | | 0.0004 | | |
| Perceived Behavioural Control | | | 0.0000 | | |

Examination of the residuals for the last step of the regression revealed moderate departures from normality (see figure 9.1).

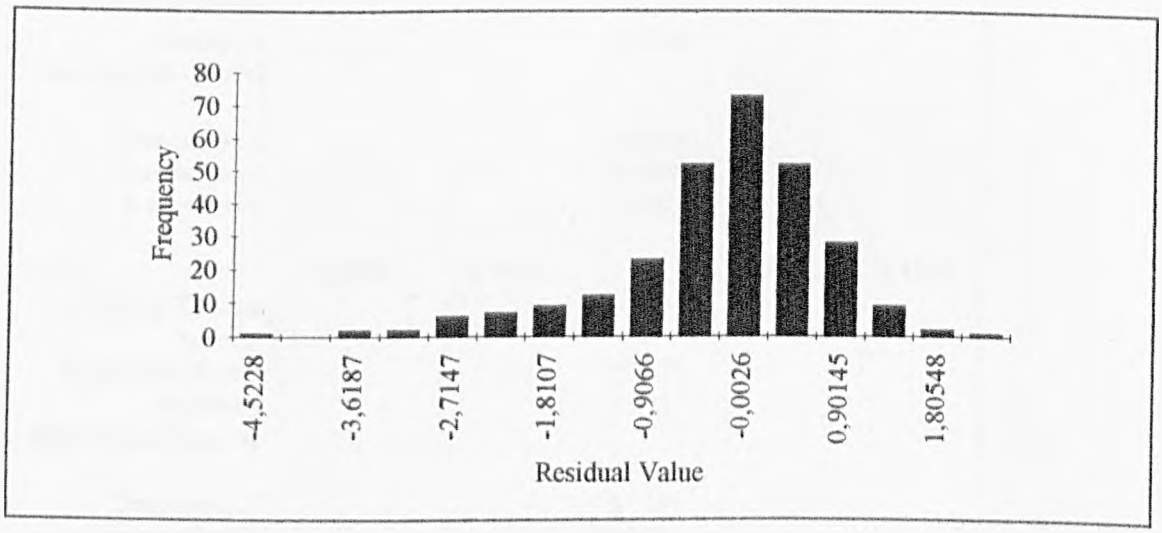


**Figure 9.1: Initial Residual Distribution**

The residual distribution was skewed, and a square transformation of the dependent variable seemed to normalize it. Thus, *intention* was squared and regressed on the independent variables once more. Second order interactions between the independent variables were entered at a fourth step and third order interactions at a

fifth step as Evans (1991) advocated. The addition of interactions did not make any significant contributions to the overall model.

The results of this new analysis are presented in table 9.20.

**Table 9.20: Regression with Intention Squared / Testing for Interactions**

| Variable | Signifi-cance of F | Signifi-cance of F Change | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|
| Step 1 | 0.0000 | - | | 0.4478 | 0.2005 |
| Attitude Toward Success | | | 0.0000 | | |
| Step 2 | 0.0000 | 0.0000 | | 0.5361 | 0.2874 |
| Attitude Toward Success | | | 0.0000 | | |
| Subjective Norms | | | 0.0000 | | |
| Step 3 | 0.0000 | 0.0000 | | 0.6883 | 0.4738 |
| Attitude Toward Success | | | 0.0000 | | |
| Subjective Norms | | | 0.0001 | | |
| Perceived Behavioural Control | | | 0.0000 | | |
| Step 4 | 0.0000 | 0.6788 | | 0.6893 | 0.4751 |
| Attitude Toward Success | | | 0.4867 | | |
| Subjective Norms | | | 0.4560 | | |
| Perceived Behavioural Control | | | 0.1333 | | |
| Interaction 1 | | | 0.8864 | | |
| Interaction 2 | | | 0.2289 | | |
| Interaction 3 | | | 0.9291 | | |
| Step 5 | 0.0000 | 0.4490 | | 0.6901 | 0.4762 |
| Attitude Toward Success | | | 0.3562 | | |
| Subjective Norms | | | 0.3571 | | |
| Perceived Behavioural Control | | | 0.2923 | | |
| Interaction 1 | | | 0.4853 | | |
| Interaction 2 | | | 0.3818 | | |
| Interaction 3 | | | 0.4702 | | |
| Interaction 4 | | | 0.4490 | | |

Note:
Interaction 1: Attitude Toward Success BY Subjective Norms
Interaction 2: Subjective Norms BY Perceived Behavioural Control
Interaction 3: Attitude Toward Success BY Perceived Behavioural Control
Interaction 4: Attitude Toward Success BY Subjective Norms BY Perceived Behavioural Control

Comparing tables 19 and 20, it seemed that the new model was better in that multiple R and R square increased. Furthermore a comparison of figure 9.1 with figure 9.2 showed that the distribution of the residuals had been substantially normalized although some moderate departures from normality were still apparent (skewness before transformation=-1.11, skewness after transformation=-0.60).

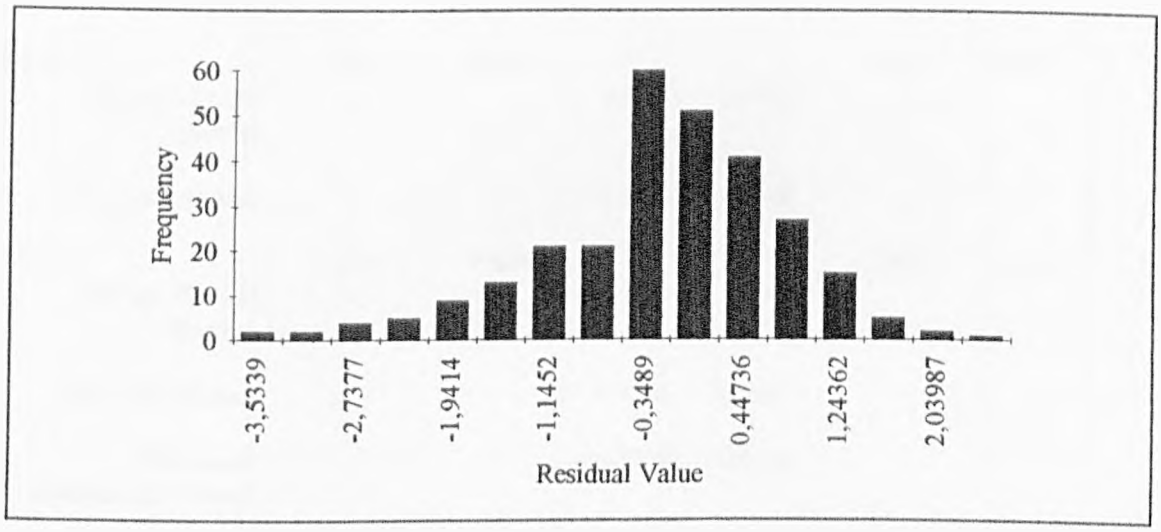


**Figure 9.2: Final Residual Distribution**

*Attitude toward failure* was entered in a further step. Again no contribution to the overall model was made by the addition of this variable.

Results of this additional step are displayed in table 9.21.

**Table 9.21: Regression Including Attitude Toward Failure**

| Variable | Signifi-cance of F | Signifi-cance of F Change | Beta | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|---|
| Step 1 | 0.0000 | - | | | 0.4478 | 0.2005 |
| Attitude Toward Success | | | 0.4478 | 0.0000 | | |
| Step 2 | 0.0000 | 0.0000 | | | 0.5361 | 0.2874 |
| Attitude Toward Success | | | 0.3237 | 0.0000 | | |
| Subjective Norms | | | 0.3198 | 0.0000 | | |
| Step 3 | 0.0000 | 0.0000 | | | 0.6883 | 0.4738 |
| Attitude Toward Success | | | 0.2189 | 0.0000 | | |
| Subjective Norms | | | 0.1946 | 0.0001 | | |
| Perceived Behavioural Control | | | 0.4725 | 0.0000 | | |
| Step 4 | 0.0000 | 0.1195 | | | 0.6906 | 0.4769 |
| Attitude Toward Success | | | 0.1944 | 0.0002 | | |
| Subjective Norms | | | 0.1830 | 0.0004 | | |
| Perceived Behavioural Control | | | 0.4650 | 0.0000 | | |
| Attitude Toward Failure | | | -0.0806 | 0.1195 | | |

Based on the findings from tables 19, 20 and 21, the final model seemed to involve the squared measure of *intention* as the dependent variable and the *attitude toward success*, the *subjective norms* and the *perceived behavioural control* as the independent variables. When this model was developed the results were as shown in table 9.22.

**Table 9.22: Final Regression Results**

| Variables in the Equation | Signifi-cance of F | Beta | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|
| Overall | 0.0000 | | | 0.6883 | 0.4738 |
| Attitude Toward Success | | 0.2189 | 0.0000 | | |
| Subjective Norms | | 0.1946 | 0.0001 | | |
| Perceived Behavioural Control | | 0.4725 | 0.0000 | | |

All the variables made significant contributions to the prediction of *intention*. The value of R square indicated that 47 per cent of the variance in *intention* could be accounted for by these variables. Judging from the beta coefficients, *perceived behavioural control* was the best predictor of *intention* offering full support to the theory of planned behaviour.

The normal probability plot of the residuals was satisfactory, complying with the regression assumption for multivariate normality. Examination of the scatterplots of residuals versus predicted residual values showed no trends satisfying the assumption of linearity. However, moderate violations of the homoscedasticity assumption were apparent (see figure 9.3).

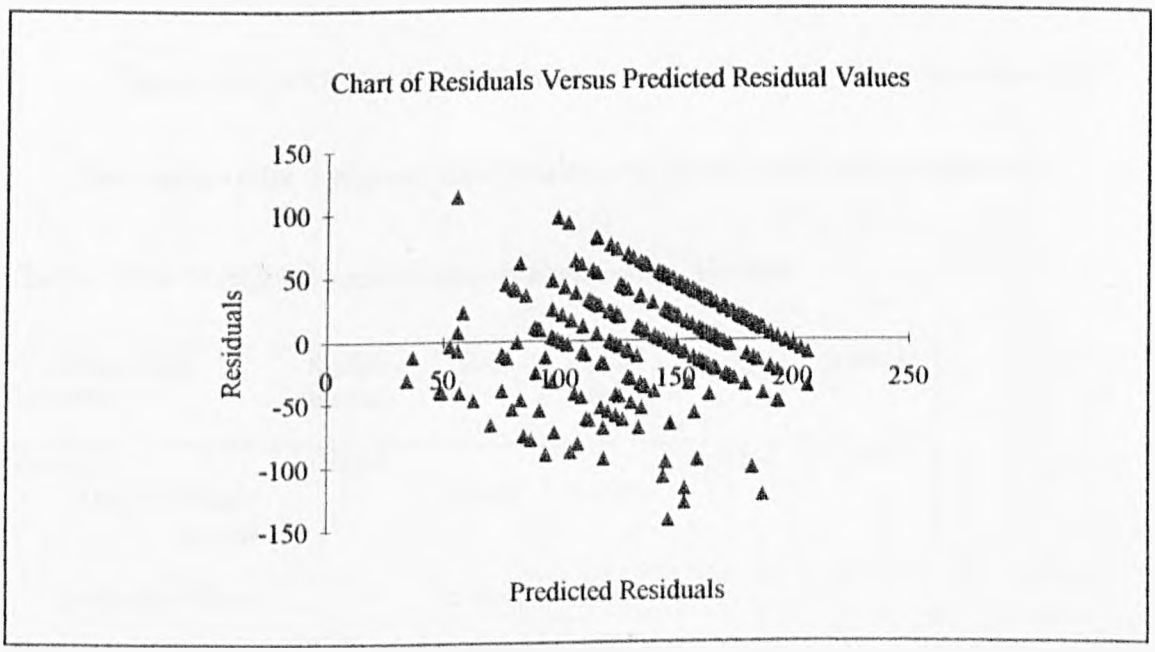


**Figure 9.3: Chart of Residulals versus Predicted Residual Values from Regression**

According to Darlington (1990) heteroscedasticity is not a particular problem when large samples are considered as in this thesis, but for completeness it was decided to perform a weighted, least squares regression analysis, following the suggestions of Hamburg (1987) and Norusis ($1990_a$). Because the squared measure of *intention* seemed to normalize the residual distribution in the ordinary regression, it was retained as the dependent variable for the weighted, least squares analysis. Inspection of the residuals plotted against each independent variable separately, revealed that the *attitude toward success* was the source of heteroscedasticity (see figure 9.4).

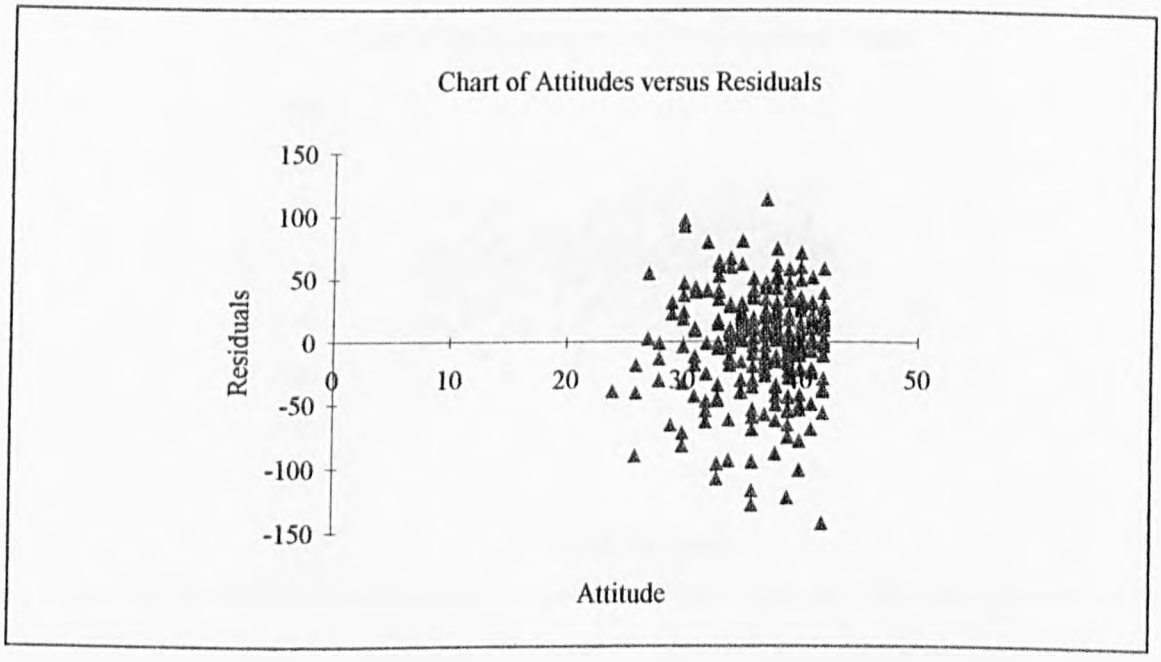


**Figure 9.4: Attitude Toward Success as the Source of Heteroscedasticity**

The results of the weighted least squares analysis are presented in table 9.23.

**Table 9.23: Weighted Least Squares Regression. Results**

| Variables in the Equation | Signifi-cance of F | Beta | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|
| Overall | 0.0000 | | | 0.7714 | 0.5951 |
| Attitude Toward Success | | 0.2446 | 0.0000 | | |
| Subjective Norms | | 0.2496 | 0.0000 | | |
| Perceived Behavioural Control | | 0.4643 | 0.0000 | | |

Table 9.23 shows a dramatic improvement in the values of multiple R compared to the ordinary regression model (table 9.22). Again all the variables significantly contributed to the prediction of *intention*, now explaining a larger amount of the variance (R square= 0.5951).

Further examination of the normal probability and residual scatterplots revealed that linearity and normality were still present while figure 9.5 shows that heteroscedasticity was substantially reduced compared to the situation in figure 9.3.

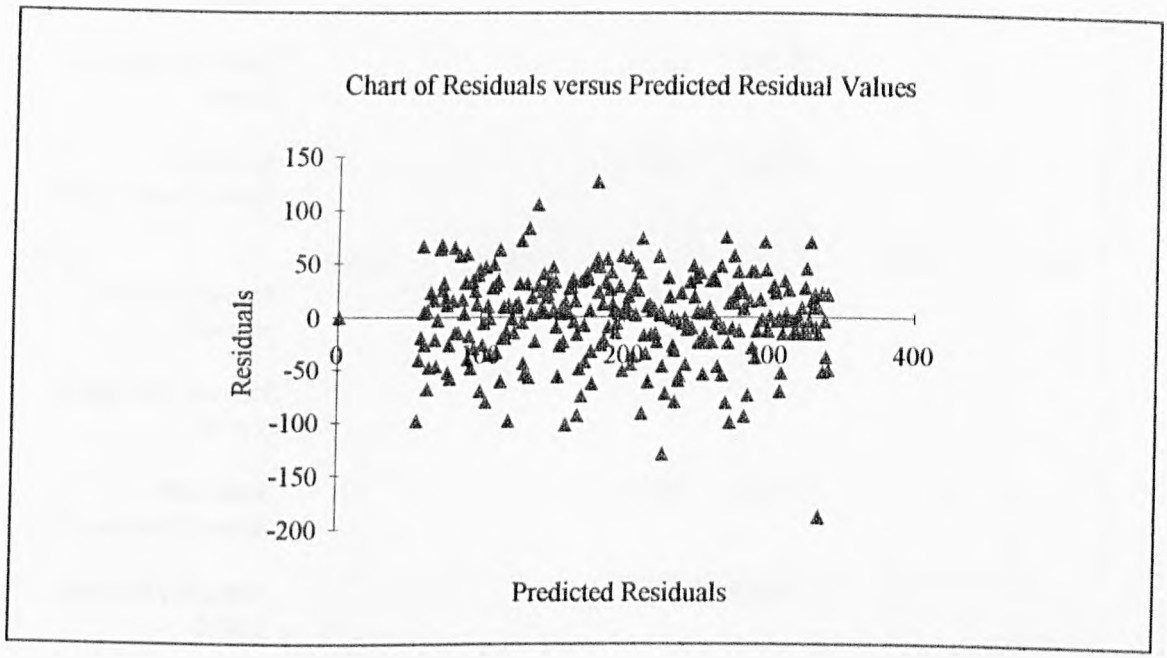


**Figure 9.5: Residuals versus Predicted Residuals from Weighted Least Squares**

A final point of concern was to examine whether the modification proposed in the measure of *subjective norms* was indeed successful. For this purpose, a hierarchical regression model was developed. In the first step *attitude toward success*, item 2 of the *subjective norms* and *perceived behavioural control* were entered, while item 1 from the measure of *subjective norms* was entered in a second step. The results are presented in table 9.24. Judging from the significance of F change at the second step, the complementary item 1 proposed for the measure of subjective norms contributed to the predictive validity of the model over and above the original variables. In fact, after the introduction of item 1, item 2 did not offer any significant contribution to the model, indicating that it could be discarded. However, inspection of the residual plots revealed that the combined measure of *subjective norms* was more efficient in normalizing them and for this reason, item 2 was retained in the analysis.

**Table 9.24: Contribution of the Modified Subjective Norms to the Prediction of Intention**

| Variable | Signifi-cance of F | Signifi-cance of F Change | Beta | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|---|
| Step 1 | 0.0000 | - | | | 0.6746 | 0.4551 |
| Attitude Toward Success | | | 0.2503 | 0.0000 | | |
| Subjective Norms / Item 2 | | | 0.1162 | 0.0172 | | |
| Perceived Behavioural Control | | | 0.4931 | 0.0000 | | |
| Step 2 | 0.0000 | 0.0010 | | | 0.6902 | 0.4764 |
| Attitude Toward Success | | | 0.2182 | 0.0000 | | |
| Subjective Norms / Item 2 | | | 0.0663 | 0.1852 | | |
| Perceived Behavioural Control | | | 0.4760 | 0.0000 | | |
| Subjective Norms / Item 1 | | | 0.1644 | 0.0010 | | |

All in all, the results presented in this section indicated that *intention* could be predicted from the variables contained in the theory of planned behaviour. The modification proposed for the measure of *subjective norms* improved the predictive validity of the model, but the contribution made by the new variable *attitude toward failure* was too low to achieve significance.

**Hypothesis 5**

Behaviour was a dichotomous variable and therefore logistic regression analysis was the appropriate method in this case (Norusis, $1990_b$). *Intention* was the independent variable at the first step while *perceived behavioural control* was entered at the second step of the analysis. Results are displayed in table 9.25.

**Table 9.25: Prediction of Behaviour**

| Variable | Wald | Significance | R |
|---|---|---|---|
| Step 1 | | | |
| Intention | 29.7999 | 0.0000 | 0.2906 |
| Step 2 | | | |
| Intention | 26.9150 | 0.0000 | 0.2755 |
| Perceived Behavioural Control | 0.1430 | 0.7054 | 0.0000 |

Based on the significance level of the corresponding R, *intention* made a significant contribution to the prediction of behaviour. In addition, the positive sign of R indicated that the higher the intention, the more likely it was for the children to be registered in the programme. In contrast, *perceived behavioural control* did not contribute to the prediction of behaviour. Thus, the results of the first step as outlined in table 9.25 were considered as final.

Inspection of the classification table however revealed that, although the logistic regression correctly classified 80.5 per cent of the cases, this high proportion was achieved by classifying all of the cases as not having been registered in the programme. The highly significant classification rule was achieved only because it happened that the majority of the children were not registered in the programme. To resolve this problem, the predicted probability levels derived from the logistic regression were examined for each case and it was revealed that much of the misclassification occurred in the area of predicted probability level equal to 0.40. Thus, the 0.40 predicted probability level was selected as the appropriate classification point. Using this modified cutoff point the logistic regression correctly classified 76.95 per cent of cases corresponding to children who did not register in the programme and 67.60 per cent of the cases corresponding to children who registered in the programme. Overall, 75 per cent of the total number of cases were correctly classified offering a useful predictive tool. The goodness of fit coefficient (=0.2269) as well as the -2 Log Likelihood value (=0.9984) confirmed that the logistic model fitted well to the data (Norusis, $1990_b$).

**Hypothesis 6**

To examine whether past behaviour could contribute to the prediction of *intention* or behaviour, it was entered in the respective analysis and its effect was tested hierarchically. The measure of past behaviour was recoded as a dummy variable having two categories: the children already participated in existing out of school organized exercise programmes / the children did not participate in any out of school organized exercise programmes.

For prediction of *intention*, past behaviour was entered in a second step after the inclusion of the basic variables of the theory of planned behaviour. The results from this analysis are presented in table 9.26.

**Table 9.26: Regression with Past Behaviour**

| Variable | Signifi-cance of F | Signifi-cance of F Change | Beta | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|---|
| Step 1 | 0.0000 | - | | | 0.6883 | 0.4738 |
| Attitude Toward Success | | | 0.2189 | 0.0000 | | |
| Subjective Norms | | | 0.1946 | 0.0001 | | |
| Perceived Behavioural Control | | | 0.4725 | 0.0000 | | |
| Step 2 | 0.0000 | 0.6509 | | | 0.6886 | 0.4742 |
| Attitude Toward Success | | | 0.2198 | 0.0000 | | |
| Subjective Norms | | | 0.1965 | 0.0001 | | |
| Perceived Behavioural Control | | | 0.4707 | 0.0000 | | |
| Past Behaviour | | | -0.0199 | 0.6509 | | |

It was concluded that past behaviour did not contribute to the prediction of *intention* over the original variables of the theory of planned behaviour.

In a similar manner, past behaviour was entered in the logistic regression analysis after the inclusion of *intention* for the prediction of behaviour. These results are presented in table 9.27 and confirm the hypothesis that past behaviour had no effect in this situation as well.

**Table 9.27: Logistic Regression with Past Behaviour**

| Variable | Wald | Significance | R |
|---|---|---|---|
| Step 1 | | | |
| Intention | 29.7999 | 0.0000 | 0.2906 |
| Step 2 | | | |
| Intention | 29.8225 | 0.0000 | 0.2909 |
| Past Behaviour | 0.0292 | 0.8643 | 0.0000 |

**Hypothesis 7**

To examine whether the treatment had any effect on the pattern of relationship between the variables of the model, experimental condition was entered as a dummy variable in the regression and the logistic regression analysis in a similar manner to past behaviour. The results from the regression analysis are presented in table 9.28 and the results from the logistic regression analysis in table 9.29.

**Table 9.28: Regression Controlling for Experimental Condition**

| Variable | Signifi-cance of F | Signifi-cance of F Change | Beta | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|---|
| Step 1 | 0.0000 | - | | | 0.6883 | 0.4738 |
| Attitude Toward Success | | | 0.2189 | 0.0000 | | |
| Subjective Norms | | | 0.1946 | 0.0001 | | |
| Perceived Behavioural Control | | | 0.4725 | 0.0000 | | |
| Step 2 | 0.0000 | 0.6509 | | | 0.6883 | 0.4738 |
| Attitude Toward Success | | | 0.2190 | 0.0000 | | |
| Subjective Norms | | | 0.1949 | 0.0001 | | |
| Perceived Behavioural Control | | | 0.4722 | 0.0000 | | |
| Experimental Condition | | | -0.0041 | 0.9245 | | |

**Table 9.29: Logistic Regression Controlling for Experimental Condition**

| Variable | Wald | Significance | R |
|---|---|---|---|
| Step 1 | | | |
| Intention | 29.7999 | 0.0000 | 0.2906 |
| Step 2 | | | |
| Intention | 29.9356 | 0.0000 | 0.2913 |
| Experimental Condition | 1.9775 | 0.1597 | 0.0000 |

Regression and logistic regression were also used to examine whether the gender of the children influenced the relationship between the original variables of the model. The regression results for this case are presented in table 9.30 and the logistic regression results in table 9.31.

**Table 9.30: Regression Controlling for Children's Gender**

| Variable | Signifi-cance of F | Signifi-cance of F Change | Beta | Signifi-cance of T | R | R square |
|---|---|---|---|---|---|---|
| Step 1 | 0.0000 | - | | | 0.6883 | 0.4738 |
| Attitude Toward Success | | | 0.2189 | 0.0000 | | |
| Subjective Norms | | | 0.1946 | 0.0001 | | |
| Perceived Behavioural Control | | | 0.4725 | 0.0000 | | |
| Step 2 | 0.0000 | 0.8169 | | | 0.6884 | 0.4739 |
| Attitude Toward Success | | | 0.2182 | 0.0000 | | |
| Subjective Norms | | | 0.1958 | 0.0001 | | |
| Perceived Behavioural Control | | | 0.4725 | 0.0000 | | |
| Children's Gender | | | 0.0102 | 0.8169 | | |

**Table 9.31: Logistic Regression Controlling for Children's Gender**

| Variable | Wald | Significance | R |
|---|---|---|---|
| Step 1 | | | |
| Intention | 29.7999 | 0.0000 | 0.2906 |
| Step 2 | | | |
| Intention | 29.8539 | 0.0000 | 0.2911 |
| Children's Gender | 0.2286 | 0.6326 | 0.0000 |

It was concluded that experimental condition and the gender of the children did not influence the relationship between the variables of the model.

Finally, the interaction between children's gender and experimental condition was recoded as a dummy variable having four categories and its effect was examined following the same procedure. For brevity these results are not shown here but they were very similar to those of tables 28, 29, 30 and 31 leading to the conclusion that this variable did not have any effect on the observed relationships.

# Chapter 10

# Discussion

## Introduction and Summary of the Results

Coronary atherosclerotic heart disease and obesity are major health hazards in contemporary society. Evidence indicates that an active lifestyle helps to prevent these problems (see chapters 3 and 4) and yet adult physical activity levels appear to be particularly low (see chapter 2). Because it is generally regarded as a difficult task for adults to change and / or maintain active lifestyles, attention has focused on the physical activity of children. Although it is not yet clear whether children are active enough, it is likely that they do not engage in physical activities which lead to the establishment of lifelong active habits (see chapter 2). Since available data do not support the immediate value of increased physical activity in preventing or correcting obesity and incidence of adult risk factors for coronary atherosclerotic heart disease in children (see chapters 3 and 4), it was concluded that attention should be directed to promote development of lifelong active lifestyles by providing appropriate physical activity for children. Community physical activity programmes are a means through which children may be provided with appropriate physical activity. Available evidence suggests that sports may not be of benefit in establishing lifelong active lifestyles for most children while playful, enjoyable activities may be more successful in doing so (see chapter 5).

A major gap in knowledge is how children first become involved in community physical activity programmes. In this thesis, initial involvement of very young children in community physical activity programmes was assumed to be a product of decisions made by their parents and thus, it was considered legitimate to apply theoretical models with the aim of predicting and explaining this kind of parental behaviour. The purpose of the thesis was to explore the usefulness of the theory of planned behaviour in predicting and explaining registration of children in community physical activity programmes from decisions made by their parents, to examine whether children would become involved in a community physical activity programme which emphasizes playful physical activities rather than sports and finally, to test whether a community physical activity programme could enjoy any success in Greece, a country with high rates of coronary atherosclerotic heart disease and obesity and low levels of physical activity.

The theory of planned behaviour was described in chapter 6 and problems regarding its application were identified. Subsequently, specific research hypotheses were formulated and a methodology was developed in chapters 7 and 8 respectively. The present chapter will summarize the results which were analyzed in detail in chapter 9 and will discuss their applicability in respect of the theory of planned behaviour, in respect of promoting community physical activity programmes which emphasize playful physical activities rather than sports and finally, in respect of launching large scale physical activity programmes in the Greek community. Because a purpose of the thesis was to test the theory of planned behaviour, reference to the statistical methods pertaining to this process will also be made where appropriate.

In connection with the specific research hypotheses stated in chapter 7, the findings of the present research may be summarized as follows:

1. Treatment did not influence parental *attitude toward success*, *subjective norms*, *perceived behavioural control*, *attitude toward failure* or *intention*.
2. Treatment did not influence initial involvement of children in the programme and this effect was independent of children's gender.
3. The variables outlined in the theory of planned behaviour and measured for the purposes of this thesis, correlated significantly with each other.
4. *Intention* was significantly predicted from the variables outlined in the theory of planned behaviour. The modification proposed for the measurement of *subjective norms* contributed significantly to the predictive value of the model. The variable *attitude toward failure* which was introduced did not make any significant contribution to the predictive value of the model.
5. *Intention* was a significant predictor of behaviour. *Perceived behavioural control* did not contribute to the prediction of behaviour.
6. Past behaviour did not contribute to the prediction of *intention* and / or behaviour.
7. Treatment, children's gender and the interaction between these variables did not affect the pattern of relationships between *intention* and behaviour and between *intention* and the remaining variables of the theory of planned behaviour.

In addition, although not stated as a specific research hypothesis, it is worthy of mention that a substantial number of children registered for the programme whose parents were approached in the initial phase of the study.

## The Theory of Planned Behaviour

### Prediction of Intention

In general, the findings of the present research support the validity of the theory of planned behaviour in predicting and explaining the behaviour under consideration. For the prediction of *intention* from *attitude toward success*, *subjective norms* and *perceived behavioural control*, hierarchical regression analysis was selected as an appropriate method. This method has been widely used by other researchers in tests of the theory of planned behaviour (for example, Ajzen and Driver, 1992; Theodorakis, $1992_a$; Theodorakis, $1992_b$) while others used linear structural equations (for example, Godin et al., 1993). As Evans (1991) remarked, hierarchical regression analysis is at present one of the most appropriate techniques for testing interactions between independent variables. In the same vein, Ajzen and Madden (1986) found that while linear structural equations and hierarchical regressions give essentially identical results when testing the theory of planned behaviour, hierarchical regressions are preferable because they permit relatively easy incorporation of interaction terms. Nevertheless, in the present research, interactions made no significant contribution to the prediction of *intention* over and above that of main effects.

When *intention* was regressed on *attitude toward success*, *subjective norms* and *perceived behavioural control*, the multiple regression coefficient was 0.69. This value lies in the middle of the range of regression coefficients found in other tests of the theory of planned behaviour (see table 6.1 in chapter 6). However, it is much higher than the respective values found in research by Beale and Manstead (1991) who aimed at predicting maternal *intention* to limit frequency of infants' sugar intake before and after an educational intervention. Multiple regression coefficients were 0.33 and 0.52 in the first and second waves of this study, respectively. In addition, a low multiple regression coefficient was obtained by Hounsa and associates (1993) who examined the usefulness of the theory of planned behaviour in predicting maternal *intention* to use oral rehydration therapy in children suffering from diarrhoea in a rural area of Benin / Africa. In the former case, Beale and Manstead (1991) argued that at the time of their first interview mothers were probably not making structured decisions about the behaviour which, therefore, hardly merited the description planned behaviour. After an educational intervention about the effects of sugar intake on the development of dental caries, multiple regression coefficient increased and Beale and Manstead (1991) concluded that at the time of the second interview mothers were beginning to think about the behaviour and the issues involved. They explained that "It therefore seems

unlikely that many of the mothers taking part in our study would have given much consideration to this behaviour prior to their participation" (Beale and Manstead, 1991, p. 427). The same argument may hold for the report of Hounsa and associates (1993) while in this case, mothers' illiteracy could have additionally contaminated the relationship between *intention* and independent variables. However, Hounsa and associates (1993) and Beale and Manstead (1991) obtained measurements of the variables of the theory of planned behaviour at the time of interviews. Possibly, because behaviours examined in these cases were novel, the lack of adequate time for thought might have contributed to the relatively low multiple regression coefficients. In contrast, in the present research, mothers were allocated substantial time to share ideas with spouses, decide about their behaviour and complete the questionnaire. It may be reasonable to assume that decisions became structured and were expressed through the framework of the theory of planned behaviour.

Alternatively, it may be proposed that it is the type of behaviour that differs between studies. Limiting infants' sugar intake or applying rehydration therapy in children is an every day form of behaviour that probably requires relatively little effort and planning. Thus, it may be possible that in these cases, attitude had a direct effect on behaviour which was not mediated by *intention*. This position is supported by the findings of Bagozzi and associates (1990) who proved experimentally that the effect of attitude on behaviour was mediated through *intention* when performance of the behaviour required substantial effort, but that attitude directly influenced behaviour when behaviour required little effort. Thus, the low regression coefficients obtained by Hounsa and associates (1993) and Beale and Manstead (1991) for the prediction of *intention* may be explained by this argument. On the other hand, it is not possible to support this position fully since behaviour was not assessed in the research by Beale and Manstead (1991) and Hounsa and associates (1993).

In the present thesis, registration of children in a community physical activity programme may have been considered as a demanding form of behaviour for the parents that necessitated deliberate efforts for scheduling, planning and providing, in terms of transportation, time and finance. Thus, in agreement with the findings of Bagozzi and associates (1990) it could be expected that the effect of attitude on behaviour would be mediated through *intention*. As such, this kind of behaviour may resemble other types of highly structured behaviours such as adherence to exercise programmes. Multiple regression coefficients for the prediction of *intention* typically exceeded the 0.55 level in exercise studies (see table 6.1 in chapter 6) and in some cases reached the 0.80 level (Ajzen and Driver, 1992; Kimiecik, 1992). In this thesis, the achieved regression coefficient for the prediction of *intention* (=0.69) agreed well with these reports. Furthermore, application of weighted, least squares regression

analysis boosted the regression coefficient to the higher levels of the range (= 0.77). Comparative data for the application of weighted, least squares regression analysis are not available, since other researchers did not mention any problems in the residual distribution derived from their regression analysis and thus, probably, application of more sophisticated statistical methods was not necessary. Nevertheless, weighted, least squares regression showed that in the present situation, a substantial amount of the variance in *intention* could be accounted for by the predictor variables, offering full support to the theory of planned behaviour.

Particular attention was paid to measure *intention* according to the guidelines and definitions advocated in the theoretical work by Ajzen (1991), Ajzen (1988) and Ajzen and Fishbein (1980). However, in field research carried out by these authors, assessment of *intention* followed much more the definition adopted by Bagozzi and associates (1990), that is "behavioural commitment to perform the behaviour or deliberate planning to attain a goal" (Bagozzi et al., 1990, p. 47). The second part of this definition complemented the definition of Ajzen (1991), Ajzen (1988) and Ajzen and Fishbein (1980) and agreed well with the measurement of *intention* done in previous tests of the theory of planned behaviour (for example Ajzen and Driver, 1992; Ajzen and Madden, 1986). As a result, *intention* was measured in the present research following the definition of Bagozzi and associates (1990). This means that parents who had more positive attitudes toward registering their children in the programme, who perceived greater social pressure for doing so and perceived performance of this behaviour as relatively easy to perform, were more likely to form conscious plans or exert effort in order to register their children in the programme. Furthermore, particular attention was paid to avoid mixing the definition of *intention* with that of behavioural expectation which "refers to a person's estimate of the likelihood that he actually will perform a certain behavior" (Ajzen 1985, p. 33). This distinction has been made by other researchers as well (for example Courneya and McAuley, 1993) while Ajzen (1985, p. 34) stated that "unlike behavioral intentions, behavioral expectations may have no *causal* effect on actual behavior".

**Prediction of Behaviour**

In most studies which have examined the theory of planned behaviour, the behaviours under consideration were measured as continuous variables and therefore, simple regressions were applied in these cases. However, as explained in chapter 6, the tendency to measure behaviour as a continuous variable led some researchers to violate the principle of compatibility and / or the principle of scale correspondence between

*intention* and behaviour making their results suspect for methodological errors. Analysis of this flawed research (for example Theodorakis, $1992_a$; Ajzen and Madden, 1986; Schifter and Ajzen 1985) revealed that if behaviour was scored dichotomously, the principle of scale correspondence would be minimally violated, in agreement with the recommendations of Courneya and McAuley (1993). In the present research, particular efforts were made to comply with the principle of compatibility as advocated by Ajzen (1988). Furthermore, the response format for the measurement of *intention* was in line with the recommendations of Courneya and McAuley (1993) thus, least violating the principle of scale correspondence between *intention* and behaviour. The same precautions were taken for the measurement of all other independent variables because their direct influence on behaviour has been recently examined (for example, Bagozzi et al., 1990; Ajzen and Madden, 1986).

The dichotomous nature of the behaviour in the present thesis necessitated the use of either discriminant function analysis or logistic regression analysis for prediction from *intention*. One report has been concerned with the prediction of behaviour which was scored dichotomously, under the framework of the theory of planned behaviour. Yordy and Lent (1993) applied discriminant function analysis to predict the exercise behaviour of 284 psychology students. Subjects indicated whether they participated in a defined amount and type of exercise over a one week period. Measurement format for the construct of *intention* complied with the guidelines advocated by Courneya and McAuley (1993), being in agreement with the format adopted in the present thesis. The independent effect of *intention* on behaviour was not however possible to differentiate in the research by Yordy and Lent (1993) because other variables were entered in the discriminant function analysis simultaneously. In the present thesis discriminant function analysis could not be applied because violations of basic assumptions required for application of this method were apparent. Logistic regression analysis is often used in epidemiological surveys where the dependent variable is scored as dead or alive (Norusis, 1990). Furthermore, logistic regression analysis is less demanding than discriminant function in terms of independent variable distribution (Norusis, 1990) and in addition it is flexible, allowing for modification of the predictive probability levels and the construction of classification rules according to the needs of the research. These were considered as significant advantages and thus, logistic regression analysis was selected as the most appropriate instrument for the present research.

As already seen in chapter 9, application of this technique with appropriate modification of predictive probability levels correctly classified a substantial (75 per cent) number of cases. Given the lack of previous research with dichotomous types of behaviours it is not possible to make comparisons. Furthermore, in the studies of Beale and Manstead (1991) and Hounsa and associates (1993) where a similar behaviour to

the present was targeted, measurement of actual behaviour was not carried out. Nevertheless, as far as the present research is concerned, it may be concluded that *intention* is a significant predictor of behaviour. This means that the stronger the *intention* the more likely the performance of the behaviour. Parents who indicated they had formed conscious plans for registering their children in the programme or were willing to exert effort to do so, were more likely to register their children in the programme.

These results offer partial support to the theory of planned behaviour. In contrast, the present findings do not support the role of *perceived behavioural control* as a direct predictor of behaviour. Application of multiple logistic regression analysis (see chapter 9 for details) clearly indicated that *perceived behavioural control* did not contribute to the prediction of behaviour over and above *intention*. The following explanations may be given for this apparent discrepancy with the theoretical basis of the theory of planned behaviour.

1. The theory of planned behaviour supports the role of *perceived behavioural control* as a direct predictor of *intention*, only under the assumption that it is an accurate estimate of actual control (Ajzen and Madden, 1986). In the same vein, Ajzen (1991) and Ajzen (1988) advocated that when behaviours are novel or unfamiliar to the subjects, *perceived behavioural control* is very unlikely to approximate actual control over the behaviour. Since the behaviour examined in the present thesis was novel and unfamiliar to the parents, it may be assumed that *perceived behavioural control* did not accurately reflect actual control over the behaviour. Under these circumstances, the inability of *perceived behavioural control* to predict behaviour directly, came at no surprise. It was not possible to obtain a measurement of actual control over the behaviour for the purposes of the present research, firstly because of lack of man power and resources and secondly because of the difficulty in obtaining an objective estimate of this variable (Ajzen, 1988). In fact *perceived behavioural control* was embraced in the theory of planned behaviour due to the practical difficulties of obtaining an estimate of actual control in real life situations (Ajzen, 1988).

2. If however, *perceived behavioural control* accurately reflected actual control over the behaviour, the present findings contradict the utility of *perceived behavioural control* to the direct prediction of behaviour. Since *perceived behavioural control* embraces factors such as opportunities and resources, it may be assumed that the presence or absence of these factors is not a direct determinant of behaviour. This position is in agreement with the conclusions of Ajzen and Madden (1986) who suggested that *perceived behavioural control* may influence behaviour independent of *intention*, if performance of the behaviour is at least partially beyond a person's control. Recent research which examined exercise behaviour of pregnant women and adults

taken from the general population, indicated that *perceived behavioural control* "does not influence directly exercising behavior, presumably because exercise is a behavior under one's volitional control" (Godin et al., 1993, p. 99). In the same vein, it is possible that the behaviour examined in this thesis resembled that of exercise adherence and thus, in agreement with the findings of Godin and associates (1993) it may have been under volitional control.

3. In the same vein, Fishbein and Stasson (1990) questioned the utility of *perceived behavioural control* in predicting training session attendance of non-academic employees of the University of Illinois. However, they made a clear distinction between behaviours and outcomes, suggesting that *perceived behavioural control* may be valuable in predicting outcomes, as for example in the study of weight loss by Schifter and Ajzen (1985). Examination of table 6.2 in chapter 6 offers support to the opinion of Fishbein and Stasson (1990) in that *perceived behavioural control* is a direct determinant of outcomes but not behaviour. The present research dealt with a behaviour and not with an outcome and in this respect it agrees well with the propositions of Fishbein and Stasson (1990).

Whatever the reasons, the present findings do not support the direct contribution of *perceived behavioural control* to the prediction of *intention*. This means that perceived availability of resources and / or perceived difficulty for registration of children in a community physical activity programme does not directly influence actual registration of children in the programme by their parents.

In conclusion, support was found for the prediction of *intention* from *attitude toward success*, *subjective norms* and *perceived behavioural control*. Furthermore, *intention* was a significant predictor of behaviour but *perceived behavioural control* was not. Overall, the present findings indicate that the theory of planned behaviour may be a valuable tool for predicting and explaining registration of young children in community physical activity programmes from decision making processes of their parents.

**Perceived Behavioural Control as a Predictor of Intention**

The present findings showed a strong influence of *perceived behavioural control* on *intention*, that is, the formation of plans or the exertion of effort for performance of the behaviour. The bulk of research carried out to date is in agreement that the addition of *perceived behavioural control* improves significantly the predictive power of the theory of planned behaviour when *intention* is considered as the dependent variable (see table 6.1 in chapter 6). Ultimately, considerable evidence has been gathered to

support the notion that factors such as perceived availability of resources or perceived difficulty for performance of behaviour may have a strong motivational influence on the formation of plans for action and the exertion of effort for accomplishment of the behaviour. Such evidence justifies the approach of Liska (1984) who criticized the theory of reasoned action as inadequate to embrace behaviours that partially depend on availability of resources. In addition, it justifies the subsequent formation of the theory of planned behaviour (Ajzen, 1991; Ajzen, 1988; Ajzen and Madden, 1986), underpinning its utility and predictive power over and above that of the theory of reasoned action. The findings of the present research offer full support to this position, in that the theory of planned behaviour is clearly superior to the theory of reasoned action for the prediction of *intention*. Judging from the beta weights calculated from multiple regression as well as from weighted, least squares regression analysis, the variable *perceived behavioural control* made the most significant contribution to the prediction of *intention*, almost double that of *attitude toward success* or *subjective norms*.

The alpha reliability coefficient for the *perceived behavioural control* scale was quite high and comparable to other research reports (for example, Ajzen and Driver, 1992; Theodorakis, $1992_a$; Ajzen and Madden, 1986). Furthermore, measurement of *perceived behavioural control* was carried out, placing emphasis on perceived ease or difficulty of performing the behaviour and also on perceived availability of resources, being in close agreement with the original definition of the variable (Ajzen, 1991) and the recent writings of Ajzen and Driver (1992).

Within the context of the present thesis, it may be concluded that perceived availability of resources and perceived ease or difficulty of registering children in the programme had motivational consequences for the formation of parental conscious plans and the exertion of effort in order to register children in the programme. In contrast, where resources were not perceived as available or registration of children in the programme was considered as a demanding commitment, parents were less likely to form plans or exert effort to register children in the programme. In connection with the previous section where it was shown that *perceived behavioural control* had no direct influence on registration of children in the programme, it may be proposed that the single action of making facilities readily available and accessible to all people should not be expected to attract participants unless formation of plans for participation are made by the parents, or unless efforts for registration of children in the programme take place. On the other hand, highly accessible, low cost facilities may be thought to constitute a motivational element in the formation of such plans for action. This effect would be partially independent of the formation of positive attitudes for registration of children in the programme or the existence of social pressure.

The present findings indicated that even if parents held very positive attitudes toward registering their children in the programme or they were subject to severe social pressure to do so, if they perceived performance of this behaviour as very demanding and difficult, they were unlikely to form plans or exert effort to register their children in the programme. An important task of future research with parents, may be the elicitation of specific beliefs that are related to the resources and perceived ease or difficulty of registering children in a community physical activity programme. This task was clearly beyond the scope and the resources available to the present research. While it is reasonable to assume that factors such as time, distance and available means of transportation are decisive and related to the concept of behavioural control, such a position needs experimental verification according to methodological guidelines advocated by Ajzen (1991) adapted to the specific situation.

**Attitude Toward Success as a Predictor Variable in the Theory of Planned Behaviour**

The link between *attitude toward success* and *intention* was not as strong as the link between *perceived behavioural control* and *intention*. However, it was generally the case that parents who held a more positive attitude toward registering their children in the programme were more likely to form plans or exert effort to register their children in the programme.

Results from factor analysis showed that the variable *attitude toward success* had to be divided into two subscales. Similar results were reported by Ajzen and Driver (1992) who applied the theory of planned behaviour to predict and explain recreational behaviour of college students. Ajzen and Driver (1992) distinguished between the instrumental and cognitive dimension of attitude. Such a distinction was not supported in the present thesis and this was in agreement with previous research of the theory of planned behaviour with exercise adherence of Greek women (Theodorakis, $1992_a$). The one dimension formed from factor analysis was clearly evaluative in nature while the remaining two items formed another factor and as was seen in chapter 9 they were eliminated from further analysis. A better action would be to follow the refined approach of Osgood and associates (1957). Osgood and associates (1957) proposed that for the assessment of the evaluative dimension of attitude it is possible to administer to subjects several adjective pairs and after collection of raw data to perform a factor analysis of the items. To derive the desired score, Osgood and associates (1957) suggested that each item should be weighted according to its loading on the evaluative dimension of attitude as derived from factor analysis and

subsequently, be summed with the respective score of the other items. In fact, a similar approach was followed in the present research before deciding to eliminate the two items. However, evidence for multicollinearity with *perceived behavioural control* was obtained during multiple regression analysis and therefore the decision to eliminate these items was final. It was interesting to note that the items eliminated were laborious / effortless and comfortable / uncomfortable. The separate factor that these items formed, correlated highly and significantly with *perceived behavioural control* ($r=0.4474$, $n=301$, $p<0.001$) and thus, the multicollinearity problem documented when using the combined *attitude toward success* measure during regression analysis was not unexpected.

It could be argued however, that the two items which were eliminated from analysis constituted an evaluative subdimension of *attitude toward success*. If this is correct, then it seems likely that these two items formed an affective dimension of attitude while the others that were retained in the analysis represented the instrumental dimension of *attitude toward success*. This position would agree well with the approach of Ajzen and Driver (1992) who, subsequently, treated the subdimensions of attitude as separate variables in their regression analysis for the prediction of *intention*. When a similar approach was adopted for the purposes of this thesis, the dimension of *attitude toward success* which was considered as affective did not make any significant contribution to the prediction of *intention* after the addition of *perceived behavioural control* in the equation. From this perspective, the association between *perceived behavioural control* and the eliminated subdimension of attitude becomes particularly interesting since it means that for parents, the higher the perceived obstacles to registering their children in the programme, the less attractive / likeable was the programme for them. Conversely, possible feelings of dislike for the programme might have created perceived obstacles and lack of resources. In the light of the strong influence of *perceived behavioural control* on *intention*, this may be a possible indirect pathway through which feelings of liking or disliking registration of children in the programme might have influenced the formation of plans and the exertion of effort for registering the children in the programme. On the other hand, instrumental but not affective attitude had a direct effect on the formation of plans and the exertion of effort for registration of children in the programme.

It is interesting that items, which in the research by Ajzen and Driver (1992) loaded on the affective component of attitude, in the present research loaded on the instrumental dimension of the variable. Research with Greek women's exercise behaviour (Theodorakis, 1992a) revealed that instrumental or affective items may mix well in forming a single attitude toward performing the behaviour scale. Other researchers reached similar conclusions (for example Ajzen and Madden, 1986) and

thus, it is reasonable to hypothesize that for each defined behaviour examined under the theoretical framework of the theory of planned behaviour, attitudinal items may carry different evaluative qualities. As far as the present research is concerned, items such as pleasant / unpleasant, that in other research (Ajzen and Driver, 1992) were found to be affective, may have been instrumental in nature in the sense that parents may have liked to register their children in the programme if this was thought to carry instrumentally positive outcomes. It was not possible to verify this idea however since collection of specific behavioural beliefs was not undertaken for reasons already explained. Future research should certainly aim at filling this gap.

Although *attitude toward success* had a significant influence on *intention*, it had no direct effect of behaviour. It stems that its effect on behaviour was fully mediated by *intention* and means that for parents whose *attitude toward success* was positive, performance of the behaviour was unlikely if they did not first form plans or exerted effort to do so. This conclusion is in agreement with the basic assertions of the theory of planned behaviour as outlined by Ajzen (1991) and Ajzen (1988). An alternative explanation may lie within the concept of level of effort required for performance of the behaviour. Bagozzi and associates (1990) first dealt with this issue in an experiment with college students, in which they modified the difficulty of getting access to the attitude object. They concluded that when the behaviour required substantial effort, *intentions* played a strong mediating role and attitudes had no direct effect on behaviour. In contrast, when the behaviour required relatively little effort, attitudes had a significant direct effect on behaviour while the mediating role of *intention* was reduced. A limitation of the generalizability of the findings of Bagozzi and associates (1990) may be that they tested the theory of reasoned action and not the theory of planned behaviour. It could be argued that level of effort required for performance of the behaviour could be substituted by *perceived behavioural control* under the framework of the theory of planned behaviour. However, this may not be a viable explanation because Bagozzi and associates (1990) did not consider level of effort required for behaviour as an independent variable but as a changing background environment within which performance of the behaviour occurred. In addition, while Bagozzi and associates (1990) objectively and experimentally manipulated level of effort required for behaviour, it is likely that *perceived behavioural control* would not be an accurate estimator of actual control over the behaviour (Ajzen 1991; Ajzen, 1988) since the behaviour examined was novel.

In this respect, it may be argued that the findings of Bagozzi and associates (1990) may well apply to the theory of planned behaviour as well. Application of these conclusions to the present research may explain why a direct influential path from *attitude toward success* to behaviour was not documented. Under this condition it

would be reasonable to assume that if registration of children in the programme was an easily accessible behaviour, *intention* would not fully mediate the effects of attitude on behaviour. Thus, promotion of a highly accessible programme should concentrate very much on the formation of positive parental attitudes toward registration of children in the programme. In contrast, promotion of a programme in which registration of children is difficult for parents should take into account all the components of the theory of planned behaviour that contribute to the formation of *intention* for action. The programme offered to the children for the purpose of this thesis was considered as quite demanding for the parents. Promotion of a similar scheme would thus mean that the latter strategy be implemented.

**Subjective Norms as a Predictor Variable in the Theory of Planned Behaviour**

*Subjective norm* was found to be a strong influential factor for the formation of *intention*. Judging from the beta weights obtained from simple and weighted, least squares regression analysis, the strength of the contribution of *subjective norms* to the prediction of *intention* was of similar magnitude to that of *attitude toward success*. In most previous research, the contribution of *subjective norms* to the prediction of *intention* was much lower compared with the effect of attitudes. This observation was repeated for several types of behaviour as for instance in class attendance of college students (Ajzen and Madden, 1986), exercise behaviour of college women (Gatch and Kendzierski, 1990), recreation participation (Ajzen and Driver, 1992), *intention* of mothers to limit frequency of their infants' sugar intake (Beale and Manstead, 1991) and weight loss (Schifter and Ajzen, 1985). In these research papers the contribution of *subjective norms* to prediction of *intention* was about half compared to the influence of attitude toward performing the behaviour. Other researchers found that *subjective norms* made no significant contribution to the prediction of *intention* in behaviours such as physical activity of corporate employees (Kimiecik, 1992), or exercise behaviour of Greek women (Theodorakis, $1992_a$). Certainly, across various types of behaviour it may be reasonable to expect that independent variables do not have equal weight in predicting *intention*, a contribution which may vary according to various factors, external to the theory of planned behaviour, such as subjects' age. For example, while Theodorakis ($1992_a$) showed that *subjective norms* were not a significant predictor of *intention* in respect of exercise behaviour of Greek women, research from the same author which examined swimming training participation of children aged 10 to 13 years (Theodorakis, $1992_b$) revealed that *subjective norms* were a significant predictor of *intention*. The discrepancy between these studies may be

attributed to the young age of the swimmers who probably relied heavily on parental influence to decide about their training participation (Theodorakis, $1992_b$). Another factor that may shape the association between *subjective norms* and *intention* may be the kind of behaviour examined. For example, the role that perceived social pressure plays in the formation of *intention* for using drugs may well be different to the perceived social pressure to lose weight.

The following explanations may be given to account for the influence of *subjective norms* on *intention* which as already mentioned was found to be much stronger in the present thesis than in most previous research which has utilized the theory of planned behaviour. Firstly, the behaviour examined in the present thesis may have had qualities which led to the influence being stronger. As in the case of *perceived behavioural control* and *attitude toward success*, specific normative beliefs were not collected for the purpose of this research, mainly because of manpower and financial constraints. Thus, it is not possible to identify which individuals were important in determining parental perceptions of social pressure to register their children in the programme. Although it needs empirical support, it may be speculated that children themselves act as important referents in determining the formation of parental plans for action in respect of the particular behaviour. Secondly, it may be speculated that the selection of mothers as representatives of both parents may have biased the results. If mothers completed the questionnaires without having discussed them with their husbands, it is very likely that for the formation of their *subjective norms* they considered their husbands as important referents as well. Under these circumstances, it is reasonable to expect that mothers would perceive a strong social pressure to perform or not to perform the behaviour in question, related to their husbands' opinions and ideas.

Thirdly, the difference between previous research and the present thesis may lie within the modification proposed for the measurement of *subjective norms*. Ajzen and Fishbein (1980, p. 6) defined *subjective norms* as "the person's perception of the social pressures put on him to perform or not perform the behaviour in question". As mentioned in chapter 6, previous research with the theory of planned behaviour considered only the positive dimension of *subjective norms* that is, perceived social pressure to perform the behaviour. Thus, researchers adopted only half of the original definition of *subjective norms*. In the present research *subjective norms* were scored on a bidimensional scale which assessed approving and disapproving social pressures for performance of the behaviour. These dimensions were not identical since after appropriate recoding of the questions a significant but moderate magnitude correlation coefficient was obtained ($r=0.37$, $n=335$, $p<0.001$). Probably, the magnitude of association between *subjective norm* items contributed to the relatively low alpha coefficient for internal consistency of the respective scale. Nevertheless, the coefficient

of internal consistency was judged as acceptable based on previous research with the theory of planned behaviour (for example, Ajzen and Driver, 1992; Beale and Manstead, 1991).

As was shown in chapter 9, the new item made a significant contribution to the prediction of *intention* over and above that of the original variables of the theory of planned behaviour. In fact, inclusion of the new item meant that the original *subjective norm* item made an insignificant contribution to the prediction of *intention*. However, the combined scale was retained because it was found that it normalized the residual distribution in regression and weighted, least squares regression analysis. When the original *subjective norm* item was included alone in the prediction equation, its beta weight was comparable to values reported for *subjective norms* in previous research and equalled half the magnitude of the *attitude toward success* beta weight. Inclusion of the new item boosted the beta weight for *subjective norms* to levels similar to that of *attitude toward success*. In the light of these findings it is proposed that a modified *subjective norms* scale may be more viable in explaining differences between the present and previous research in respect of the contribution of *subjective norms* to the prediction of *intention*.

In conclusion, the present research lent empirical support to the variable of *subjective norms* as a predictor of *intention*. The higher the perceived social pressure to register their children in the programme the more likely were the parents to form plans or exert effort to do so. Inversely, the higher the perceived social disapproval to engage in that form of behaviour, the more unlikely were the parents to form plans or exert effort to register their children in the programme. It may be recommended that future research concentrates more on the assessment of *subjective norms* and utilizes the modification proposed in this thesis. Furthermore, promotional efforts in respect of community physical activity programmes may be more successful if they help parents to alleviate perceptually existent social disapproval for registration of children in them and also, to create perceptually existent social pressure for registering children in them. In a similar vein, it may be proposed that promotion should be directed at the social microenvironment that is significant in respect of parental action to register children in programmes. It is an important task of future research to define this microenvironment based on field data collected according to the recommendations of Ajzen and Fishbein (1980).

## Predictor Variables External to the Theory of Planned Behaviour: Attitude Toward Failure and Past Behaviour

### Attitude Toward Failure as a Predictor Variable

*Attitude toward failure* which was a new variable introduced in this thesis did not make any significant contribution to the prediction of *intention* over and above that of the original variables of the theory of planned behaviour. It correlated with the other independent variables as well as with *intention* but the highest correlation was observed with *attitude toward success* ($r=0.43$). Nevertheless, this did not mean that the two constructs were identical, a position which was supported by factor analytic procedures presented in chapter 9. The individuality of the variable *attitude toward failure* was clearly demonstrated and supported in this analysis. Furthermore, its inclusion in the prediction equation for *intention* did not produce any multicollinearity effect with *attitude toward success* despite their significant correlation. It could be argued that these constructs would be more highly correlated if the adjective pairs used for their assessment were identical. However, correlation between the first items from each scale which were the same (good / bad) was significant, but much lower than the correlation between the constructs themselves ($r=-0.23$, $n=301$, $p<0.01$). Thus, this position may not be considered as particularly viable. It may be concluded that *attitude toward failure* may constitute a separate variable related to the original independent variables of the theory of planned behaviour. In the present thesis, its effect on *intention* was probably mediated through the effect of these variables. In conclusion, having a favourable or unfavourable evaluation of not registering their children in the programme did not influence parental formation of plans or the exertion of effort to register their children in the programme.

Possibly, the usefulness of the variable *attitude toward failure* may be more salient in other forms of behaviour where, not performing the behaviour could mean that people miss something perceptually very important for them. In the present case, although registration of children in the programme was viewed by parents as beneficial (*attitude toward success* was in general very positive), not registering their children in it, may not have carried perceptually significant consequences. An additional factor was the short length of the programme which probably was considered as a disadvantage by some of the parents. Discussions with them revealed that this hypothesis was true even for parents who eventually registered their children in the programme. The majority indicated that they would have preferred the programme to be of one or two years duration or for it to be repeated during the next academic

period. Under these circumstances the insignificant effect of *attitude toward failure* on *intention* may be partially explained.

Alternatively, it could be proposed that there were limitations in the assessment of *attitude toward failure*. As mentioned in chapter 8, some mothers indicated that they could not understand the meaning of items 2 and 3 from the respective scale and thus, these items were omitted from further analysis. Certainly, the fact that questionnaires were sent to the mothers might have contributed to this shortcoming. In previous research with Greek women testing the theory of planned behaviour, Theodorakis ($1992_a$) supervised the completion of questionnaires and reported no practical problems with their application. However, in his research, the behaviour examined was adherence to existing exercise programmes and it was necessary for instructors of the fitness classes to help the women complete the questionnaires. Furthermore, Theodorakis ($1992_a$) did not use a representative sample of the population. In the present thesis, a difficult point was to combine the representativeness of the obtained sample with the fact that the programmes were created only for the purposes of the research. Thus, valuable help from fitness instructors was lacking. Furthermore, lack of resources such as financial aid and manpower made administration of questionnaires a problem that could be optimally solved only by following the method described in chapter 8[1]. Consequently, elimination of items 2 and 3 from the *attitude toward success* scale was viewed as a limitation of the present thesis deriving from practical problems.

It is not known to what extent these two items could have additionally contributed to the prediction of *intention*. With adequate resources and supervised administration of questionnaires future research might be able to contradict or verify the inability of *attitude toward failure* as a predictor of *intention*. Nevertheless, as far as the present thesis is concerned, *attitude toward failure* does not contribute to the prediction of *intention*. This position agrees well with the writings of Ajzen (1991) and Ajzen (1988) who claimed that variables external to the theory of planned behaviour exert their influence only via the original variables of the theory. It may be recommended that promotional efforts of community physical activity programmes do not need to emphasize to parents the possible consequences of not registering their children in them. Reference to the positive may be enough information to shape formation of plans for action and exertion of effort.

---

[1] As mentioned in chapter 8 the questionnaires were given to the children during school time. The children gave them to their mothers and after completion they returned them to school for collection.

**Past Behaviour as a Predictor Variable**

Past behaviour was not found to contribute significantly to the prediction of behaviour or *intention* in the present research. This finding is in contrast with previous research that found a significant effect of prior behaviour on behaviour within the context of the theory of reasoned action (Theodorakis et al., 1993; Theodorakis et al., 1991; Fredricks and Dossett, 1983), and the theory of planned behaviour (Godin et al., 1993; Theodorakis, $1992_b$). As mentioned however, in chapter 6, in most of these cases there were methodological errors producing violations of the principle of compatibility (Ajzen, 1988) and / or scale correspondence (Courneya and McAuley, 1993). In the present thesis, assessment of *intention* and behaviour was done in a way that, according to Courneya and McAuley (1993), minimally violated scale correspondence but satisfied the principle of compatibility. It was found that, in agreement with the arguments of Ajzen (1991) and Ajzen (1988), any possible effects of past behaviour were mediated through the theory's basic variables. This finding also agrees with Beale and Manstead (1991) who aimed to predict mothers' *intention* to limit frequency of sugar intake and found that past behaviour did not make any significant contribution to the model over and above the original independent variables of the theory of planned behaviour. Furthermore, Ajzen (1991) reanalyzed data from other studies that tested the theory of planned behaviour and concluded that even though there was a significant residual effect of past behaviour on subsequent behaviour, this could have been in most cases attributed to error variance shared by prior and subsequent behaviour.

In this respect, the present findings may be limited because the behaviour examined was novel for the parents. Therefore, it could be argued that the measure of past behaviour used did not closely correspond to the behaviour under consideration. On the other hand, the measure of past behaviour obtained was closely related to the behaviour of interest. Other measures of past behaviour could have been parental physical activity levels or participation of other children of the family in organized sports. Measurement of these variables would require the use of extensive questionnaires and also, they would probably introduce errors, common in physical activity assessment. Besides these practical limitations, these variables were not judged to be more closely related to the behaviour of interest than the measure of past behaviour eventually obtained.

Given that actual behaviour was objectively measured and that measurement of past behaviour as a dichotomous variable referring to parental reports of children's participation in organized forms of out of school physical activity was quite reliable (Freedson, 1992; Saris, 1985), the error variance shared by past and actual behaviour

may be considered as minimal. Under this condition, any observed effects of past behaviour on actual behaviour would represent a genuine relationship. However, as mentioned, such an effect was not observed, in agreement with the assertions of Ajzen (1991) and Ajzen (1988). It has been suggested that inclusion of past behaviour in the theory of planned behaviour constitutes a statistical test for "the model's sufficiency" (Ajzen, 1991, p. 202). Judging from the present results the theory of planned behaviour was demonstrated to be sufficient for the prediction of registration of children in community physical activity programmes. The inability of past behaviour to predict *intention* or behaviour over and above the original variables of the theory of planned behaviour means that promotional efforts for similar programmes need to target all the referent population and not concentrate on parents whose children are already participants in existing organized sport activities.

## The Effects of Treatment

### Validity of the Experimental Design

Manstead and Semin (1988) stated that experimental research should consider three types of validity, namely, internal, external and construct validity. Subsequently, these authors identified threats to each of these types of validity, accruing from limitations imposed on the experimental design, or from unforeseen factors. The present research complied with the guidelines advocated by Manstead and Semin (1988) as follows:

1. To maximize internal validity and to establish a causal relationship, the post-test only control group design was used. The design may depicted as in figure 10.1.

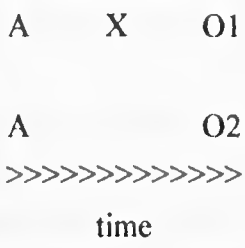


**Figure 10.1: Graphic Representation of the Post-Test Only Control Group Design**

A stands for random assignment of subjects in control and experimental groups, X stands for treatment and O1 and O2 for measurement of the dependent variables. The design is generally considered as sufficient to support a causal association between treatment and observed change in the dependent variable, particularly when the two groups do not differ significantly in their initial characteristics (Manstead and Semin, 1988). In the present research, evidence for internal validity was obtained due to insignificant differences of the two experimental groups in respect of sociodemographic variables (see chapter 9 for details).

2. To maximize external validity and provide generalizability of the findings, a simple random sample of the population of first grade children residing in the municipality of Heraklion was selected and their mothers were approached. Moser and Kalton (1971) suggested that a stratified random sample was more representative of the

population. In the present thesis there were two basic problems in applying this approach. Firstly, the latest detailed census material available for the municipality of Heraklion was dated back to 1981 and thus, it was reasonable to assume that it would not accurately reflect the reality at the time of the research. Secondly, it was not certain as to which variables should be utilized in a stratified selection of the sample. Under these restrictions, the simple random sampling procedure probably offered the best available alternative technique. Response rate achieved (88 per cent) was high for population surveys (Moser and Kalton, 1971), but it is likely that people who did not return the questionnaire shared common personality or sociodemographic features unknown to the researcher (Moser and Kalton, 1971). Therefore, the findings of the research are generalizable to the population of Heraklion to the extent that the response rate achieved may be judged as satisfactory. In addition, the findings may not be readily generalizable to populations of rural areas while they might pertain to populations of other Greek cities to the extent that the city of Heraklion may be considered as adequately representative of them. It is not certain however, whether the present findings could replicate to populations of other countries.

3. In the present research, dependent variables in relation to treatment were actual behaviour as well as the remaining variables of the theory of planned behaviour. Manstead and Semin (1988) identified three types of threat to the construct validity of dependent variables in social psychological experimentation: experimenter expectancy, demand characteristics and social desirability[1]. In respect of experimenter expectancy, Manstead and Semin (1988, p. 74) recommended that "The goal in each case is to reduce the opportunity for the experimenter to communicate his or her expectancies". In the present research, such a possibility did not exist since administration of questionnaires was unsupervised and communication with parents possible only at the time of children's registration in the programme, that is, after dependent variables had been measured. As a result, it may be assumed that the effect of experimenter expectancy and the respective threat on construct validity of dependent variables was minimal.

   To avoid the pitfall of demand characteristics, Manstead and Semin (1988) proposed that a cover story to make the subjects believe that the experiment has a different purpose than the actual, should be used. For this purpose, the covering

---

1 Manstead and Semin (1992) suggested that experimenter expectancy may unintentionally influence the experimenter's behaviour toward subjects in such a way as to enhance the likelihood that they will confirm his or her hypothesis. Demand characteristics are cues in the experimental setting which convey to the subject the nature of the experimenter's hypothesis. Social desirability is a term used to describe the fact that subjects are usually keen to be seen in a positive light and may therefore not provide answers that would be regarded negatively.

letter sent to the parents together with the questionnaire, was used. Parents were informed that the programme offered the opportunity to children to participate in physical activity and that the purpose of the questionnaire was to survey their opinion about the programme. The same response was given to parents who phoned to ask for more details about the programme. In no case did parents seem to believe that the real purpose of the programme was different than that indicated, while subsequent discussions with parents who registered their children did not reveal the opposite. As a result, there was no reason to hypothesize that the threat of demand characteristics influenced the construct validity of the research in respect of dependent variables.

It is not known to what extent social desirability may have contaminated the results. The three precautions recommended by Manstead and Semin (1988) and Moser and Kalton (1971) were taken. It was emphasized to the parents that (1) responses were anonymous and they would be seen only by the researcher, (2) there would be no correct or erroneous answers and (3) the researcher was asking for the true opinion of the parents toward the programme and that they should be motivated to respond truthfully. Nevertheless, a common weakness of questionnaire use in population surveys is the inability to control adequately for social desirability effects. It was hoped however, that this effect was minimal because (1) there was no face to face contact of the parents with the researcher during completion of the questionnaires and (2) it was assumed that people would trust a doctoral student of a British University in keeping their anonymity.

Further validation of the dependent variables contained in the questionnaire was done by means of statistical methods and was presented in chapter 9 of the thesis. Treatment received by the parents was the independent variable for this part of the research. The programmes were defined as physical activity programmes which in Greek may be translated as "φυσικης δραστηριοτητας" (pronounced "fisikis drastiriotitas") or "γυμναστικης" (pronounced "gimnastikis"). The former term was judged as too sophisticated for every day language and thus, the latter was adopted as more appropriate for use in the covering letters (Pirgiotakis, 1993, interview). This term is used to define physical education in Greek schools as well as exercise programmes for adults. All in all, it is a generic term that embraces all kinds of physical activity, including sports, that are done with the purpose of maintaining health or improving physical fitness[1]. As a result, parents of the control group believed that the programme would contain sports. The statement delivered to the parents of the

[1] No field research has examined what Greek people mean when referring to the term but it is so widely used in every day language with the meaning provided in this thesis (Pirgiotakis, 1993) that it was felt it would not be necessary to conduct separate research for this purpose.

experimental group emphasized that the programme would omit sports and thus, the content of the programme would probably have been expected to contain skill related activities, fitness exercises and games in the form of play. Parents who phoned to ask for more details were told that the programme would be similar to the school physical education lesson. For parents of the control group this response supported the letter that was sent to them. Parents of the experimental group normally indicated the presence of treatment themselves, so, in these cases the message was simply verified by the researcher. In this way it was not necessary to ask whether parents belonged to the experimental or control group and therefore, contamination of the effect of treatment on dependent variables was probably avoided.

**The Effects of Treatment**

Treatment was not found to have any effect on registration of children in the programme or on the variables pertaining to the theory of planned behaviour. It may be concluded that to the extent that the present findings may be generalizable, it does not make a significant difference in registration rates or the related decision making process if a community physical activity programme emphasizes playful physical activities rather than sports. This might be a relatively surprising finding given that contemporary society is highly competitive and sport is an industry that currently receives substantial promotional efforts world-wide. On the other hand, it may also be true that recently, emphasis has been placed on the importance of physical activity in maintaining health. For example, recent research with Greek women revealed that major reasons for exercise were related to health objectives (Theodorakis, $1992_a$). Furthermore, community activity programmes targeting youngsters are presently lacking in the Greek community (Dramytinos, 1993, interview). In Heraklion particularly, while childhood physical activity is a concept that enjoys wide acceptance and publicity due to efforts from the department of Social Medicine of the local University (Kafatos, 1993, interview), implementation of ideas and schemes is very poor as far as the public sector is concerned (Dramytinos, 1993, interview). In addition, the private sector has concentrated its efforts on specific childhood activities such as dance or swimming, an assumption which was confirmed in the present research (see chapter 9). Under these circumstances it is reasonable to assume that a substantial latent demand currently exists at least in the area that the present research was implemented, for children's physical activity independent of whether it contains sports or not.

In the same vein, treatment was found to have no effect on registration of children in the programme and this was true independent of children's gender. Registration rates did not differ between experimental groups and / or between boys and girls. The same observation held for the variables pertaining to the theory of planned behaviour. This may come as a surprise since national surveys carried out in the USA showed that boys were much more involved in competitive sports than girls, in all age groups (Ross and Pate, 1987; Ross and Gilbert, 1985). This discrepancy may be explained (1) by the young age of the children in the present research, (2) from the already mentioned publicity and promotion that general forms of physical activity have recently received in Greece and in particular in Heraklion, which probably makes activity programmes for children attractive independent of content, (3) from possible bias in the responses since the mothers were selected as representatives of both parents. It could be argued that if parents responded to the questionnaires they would not favour physical activity programmes that emphasized playful physical activities rather than sports. However, this latter explanation may not be particularly viable because (1) the theory of planned behaviour was shown in the present research to be valid in predicting the behaviour of interest, in combination with (2) the fact that registration rates, a variable whose reliability and objectivity is probably unquestionable, did not differ irrespective of experimental condition and / or children's gender.

Whatever the possible explanations, the present findings support the notion that community physical activity programmes may be launched and promoted independent of whether they are general in nature or emphasize playful physical activities rather than sports. From the review of literature presented in chapters 2 through 5, it was concluded that initial evidence does not support the value of childhood sports in promoting adult physical activity. Instead, it could be hypothesized that it is playful, enjoyable activities that secure establishment of life long active lifestyles. In this light, the present results indicate that such programmes may attract equal numbers of children as sports programmes. Certainly, these recommendations may be stated with relative confidence for Heraklion and possibly for similar Greek urban areas. However, they possess limited generalizability to rural and semi urban Greek populations as well as for other countries. In these cases, experimental verification is needed.

**Registration of Children in the Programme**

As mentioned in chapter 9, registration of children in the programme reached 16.7 per cent of the children whose mothers were approached and 19.4 per cent of the children whose mothers returned the questionnaire. Considering that 18.7 per cent of the children whose mothers returned the questionnaire participated in existing sport programmes and that this behaviour was statistically unrelated to registration of children in the present programme, it follows that enrolment of children in the programme may be judged as satisfactory. Comparative data do not exist since in other community physical activity programmes, quantification of participation relative to the referent population was not done (for example Baranowski et al., 1990; Connor et al., 1986). Furthermore, this is a typical limitation in physical activity programmes that aim to correct childhood obesity (for example Nuutinen, 1992; Epstein et al., 1982) and / or adult coronary atherosclerotic heart disease risk factors in children (for example Korsten-Reck et al., 1993; Nuutinen, 1992). Educational interventions are normally delivered to children through schools and thus, they are more or less compulsory for the target population. For example, an educational programme for prevention of chronic disease was delivered to all students of 22 high schools in Bronx, New York (Walter et al., 1985). A similar programme implemented in Crete / Greece also utilized the system of compulsory education to assure its success (Kafatos et al., 1991). Although these attempts clearly have medical significance, they are of little value in stimulating larger scale governmental efforts. Their limitation lies in that they do not normally incorporate a cost-effect analysis because they do not take into account the preferences of people. The present research aimed at overcoming this limitation and delivered a community physical activity programme that could be safely considered as a pilot study resembling applied marketing research experiments. Under the assumption that the 400 children randomly selected adequately represented the population of 1854 first grade children in Heraklion, it follows that if the same programme was offered to the entire population of the city, just over 300 children could be expected to register. In this case, if no more than 15 children were allowed per group and if each child participated three times per week, 4 full time qualified physical activity instructors would be required to cover the demand.

Certainly, these calculations hold if instruction was to take place in the same location that the present programme was implemented. However, this location, although a well known place in Heraklion, presented some accessibility problems. For example, it had limited parking facilities and also, people were required to transport their children by bus or by car, since, being in the city centre it was some distance from densely populated areas. Its surroundings comprised mainly of shops, museums and

hotels. In addition, as already discussed, the perception of how easy or difficult it was to register children in the programme was the main factor that motivated or demotivated parents to form plans or exert effort for doing so. In the light of these findings it may be reasonable to assume that the number of children who were registered in the programme was close to an expected minimum. If larger scale programmes were launched utilizing areas in closer proximity to children's houses, it is likely that numbers of registered children would be greater, with respective increased requirements for staff and equipment. Whether such schemes could be self financed by asking parents to pay a small sum of money, may not be derived from the present findings. Discussions however with parents showed that in general, they would be willing to pay a small sum to cover the needs of the programme. It was estimated that an optimal amount to cover the needs of the programme considering current Greek payment rates and producing minimal concern to the parents, would be the equivalent in Greek currency of £5 per month per child. This amount was calculated without taking in account expenses for buying equipment or hiring appropriate areas. These financial recommendations may be stated with relative confidence but should be tested in appropriate pilot efforts. Since the theory of planned behaviour was earlier shown to be a valid instrument for predicting and explaining children's participation in a community physical activity programme as a result of decisions made by parents, it may be useful to examine how decisions were affected if parents were required to finance a similar programme.

Parents were free to select weekday mornings, weekday afternoons or any time during weekends for their children's attendance. A consistent observation was that parents did not select morning or weekends even when they indicated they had no other obligations during these times. Certainly, children attended schools primarily in the morning but afternoon times were chosen even when children had school in the afternoon. Furthermore, all parents requested that their children participate after 17.00 hours in the afternoon, while the most popular time was between 18.00 to 19.00, followed by 19.00 to 20.00. The present research does not offer suggestions as to why parents had these preferences. Possibly, other obligations such as their job, other households activities and care of other children in the family may be responsible. Nevertheless, recommendations may be made on the basis of these conclusions in case larger scale programmes are to be introduced. For example, equipment and facilities should be made available after 17.00 hours in the afternoon on week days only.

Generalizability of the present findings to the local population is limited to the extent that the sample selected was representative of the referent population. While findings may pertain to other Greek cities, drawing inferences about semi urban and rural populations of Greece as well as general populations of other countries is unwise.

# Chapter 11

## Conclusions and Recommendations

### Conclusions

This thesis was based on the assumption that initial involvement of young children in organized community physical activity programmes constitutes a form of parental behaviour. Under this assumption the purposes of the thesis were (1) To examine the usefulness of the theory of planned behaviour in predicting and explaining initial involvement of children in a community physical activity programme taking place in Heraklion / Crete / Greece, (2) To examine whether more or less children would become initially involved in an organized community physical activity programme, when parents were informed that it would emphasize playful physical activities rather than sports and (3) To examine the success that an organized community physical activity programme targeting young Greek children could have, in terms of registration of children in it.

Accordingly, it was hypothesized that (1) The theory of planned behaviour would be valid in explaining and predicting the defined behaviour, (2) Parents would register their children in a community physical activity programme in spite of being informed that it would emphasize playful physical activities rather than sports and (3) Registration of Greek children in an organized community physical activity programme would be high enough to justify launching larger scale programmes in Greece.

The following points may summarize the conclusions drawn:

1. The predictive and explanatory value of the theory of planned behaviour is supported. *Intention* is a significant predictor of behaviour. A direct influence of *perceived behavioural control* on behaviour was not found. *Attitude toward performing the behaviour*, *subjective norms* and *perceived behavioural control* are all significant predictors of *intention*. The modification proposed for the measurement of *subjective norms* may be expected to increase the predictive value of the model.
2. Parental knowledge that community physical activity programmes offered to children emphasize playful physical activities rather than sports does not affect initial involvement of children in the programmes nor does it influence psychosocial parental variables related to this decision making process.

3. An adequate number of young Greek children could be expected to register in organized community physical activity programmes, justifying the launch of large scale schemes in the Greek community.

**Recommendations**

A principal contribution of the present research was to establish the value of the theory of planned behaviour in explaining and predicting registration of children in a community physical activity programme as a result of decisions made by parents. Accordingly, promotion of such programmes could be done through the framework of the theory of planned behaviour. Thus, parents should be exposed:

1. To messages emphasizing the positive consequences of registering their children in the programme.
2. To messages reassuring parents that people important to them would not disapprove if they registered their children in the programme. Instead, they should be made aware that people important to them would be happy if they registered their children in the programme.
3. To messages emphasizing that registering their children in the programme would be much easier than they thought and that with little effort they could manage to fit it into their schedules. In addition, making facilities readily available and accessible for all families could facilitate the formation of parental plans and the exertion of effort for registering children in the programme.

More specific recommendations about promotion of similar programmes cannot be made since specific behavioural, normative and control beliefs pertaining to *attitude toward performing the behaviour*, *subjective norms* and *perceived behavioural control* respectively, were not surveyed for the purposes of the thesis, due to financial and man power constraints.

Physical activity programmes that emphasize playful physical activities rather than sports could be organized and advertised as such, without the fear of low registration rates. Since registration of children in such programmes was shown to follow the framework of the theory of planned behaviour, promotion of such efforts could be done as already outlined.

Finally, it is recommended that community physical activity programmes be launched in the Greek community with high expectations for success, at least in urban areas such as Heraklion.

On a theoretical level it is proposed that the theory of planned behaviour should be used more extensively for predicting and explaining social behaviour and particularly

the behaviour examined in the present thesis. Furthermore, it is recommended that the modified version of *subjective norms* as presented in chapter 8, should be utilized more extensively since it probably embraced a neglected dimension of this construct.

**Recommendations for Future Research**

1. An obvious extension of the present research would be to examine fathers instead of mothers as representatives of both parents.
2. Future efforts should survey specific behavioural, normative and control beliefs in respect of the defined behaviour in this thesis .
3. Different childhood age groups should be examined in respect of the defined behaviour.
4. The utility of the variable *attitude toward failure* in predicting *intention* should be examined with other forms of behaviour.
5. The modification proposed for the measurement of *subjective norms* should be examined in other settings and with other forms of behaviour.
6. Semi urban and rural Greek populations as well as populations of other countries should be examined for their responsiveness to general physical activity programmes and programmes emphasizing playful physical activities rather than sports.
7. Finally, the present research may offer indications for the utility of the theory of planned behaviour in explaining and predicting initial involvement of young children in competitive sport activities through decisions of their parents. Since research in this topic is lacking (Brustad, 1992), this might be a promising avenue of research.

# REFERENCES

## References for Chapter 1


Ajzen (1992): Professor, Department of Psychology, University of Massachusetts at Amherst, *Personal Correspondence*.

Ajzen I. (1988): *Attitudes, Personality and Behavior*, Open University Press, Milton Keynes.

Ajzen I. (1991): The Theory of Planned Behavior, *Organizational Behavior and Human Decision Processes*, Volume 59, pp. 179-211.

Ajzen I., Fishbein M. (1980): *Understanding Attitudes and Predicting Social Behavior*, Prentice Hall, Inc., New Jersey, USA.

Ajzen I., Madden T.J. (1986): Prediction of Goal-Directed Behavior: Attitudes, Intentions, and Perceived Behavioral Control, *Journal of Experimental Social Psychology*, Volume 22, pp. 453-474.

American College of Sports Medicine (1988): Opinion Statement on Physical Fitness in Children and Youth, *Medicine and Science in Sports and Exercise*, Volume 20, Number 4, pp. 422-423.

Anderssen N., Wold B. (1992): Parental and Peer Influences on Leisure-Time Physical Activity in Young Adolescents, *Research Quarterly for Exercise and Sport*, Volume 63, Number 4, pp. 341-348.

Baranowski T., Simons-Morton B., Hooks P., Henske J., Tiernan K., Dunn J.K., Burkhalter H., Harper J., Palmer J. (1990): A Center-Based Program for Exercise Change among Black-American Families, *Health Education Quarterly*, Volume 17, Number 2, pp. 172-196.

Beale D.A., Manstead A.S.R. (1991): Predicting Mothers' Intentions to Limit Frequency of Infants' Sugar Intake: Testing the Theory of Planned Behavior, *Journal of Applied Social Psychology*, Volume 21, Number 5, pp. 409-431.

Berlin J.A., Colditz G.A. (1990): A Meta-Analysis of Physical Activity in the Prevention of Coronary Heart Disease, *American Journal of Epidemiology*, Volume 132, Number 4, pp. 612-628.

Biddle S., Mutrie N. (1991): *Psychology of Physical Activity and Exercise*, Springer Verlag, London.

Bijnen F.C.H., Caspersen C.J., Mosterd W.L. (1994): Physical Inactivity as a Risk Factor for Coronary Heart Disease: a WHO and International Society and Federation of Cardiology Position Statement, *Bulletin of the World Health Organization*, Volume 72, Number 1, pp. 1-4.

Blair S.N. (1988): Exercise Within a Healthy Lifestyle, In: R.K. Dishman (Ed.): *Exercise Adherence: Its Impact on Public Health*, Human Kinetic Books, Champaign, Illinois, pp. 75-89.

Bouchard C. (1990): Discussion: Heredity, Fitness and Health, In: C. Bouchard, R.J. Shephard, J.R. Sutton, B.D. McPherson (Eds.): *Exercise, Fitness, and Health, A Consensus of Current Knowledge*, Human Kinetics Books, Champaign, Illinois, pp. 147-153.

Bouchard C., Shephard R.J., Sutton J.R, McPherson B.D. (1990): *Exercise, Fitness, and Health, A Consensus of Current Knowledge*, Human Kinetics Books, Champaign, Illinois.

Bray G.A., York B., DeLany J. (1992): A Survey of Obesity Experts on the Causes and Treatment of Obesity, *American Journal of Clinical Nutrition*, Volume 55, pp. 151S-154S.

Brustad R.J. (1992): Integrating Socialization Influences Into the Study of Children's Motivation in Sport, *Journal of Sport and Exercise Psychology*, Volume 14, pp. 59-77.

Brustad R.J. (1993): Who Will Go Out and Play ? Parental and Psychological Influences on Children's Attraction to Physical Activity, *Pediatric Exercise Science*, Volume 5, pp. 210-223.

Connor M.K., Smith L.G., Fryer A., Erickson S., Fryer S., Drake J. (1986): Future Fit: A Cardiovascular Health Education and Fitness Project in an After-School Setting, *Journal of School Health*, Volume 56, Number 8, pp. 329-333.

Dempsey J.M., Kimiecik J.C., Horn T.S. (1993): Parental Influence on Children's Moderate to Vigorous Physical Activity Participation: An Expectancy-Value Approach, *Pediatric Exercise Science*, Volume 5, pp. 151-167.

Dishman R.K. (1990): Determinants of Participation in Physical Activity, In: C. Bouchard, R.J. Shephard, J.R. Sutton, B.D. McPherson (Eds.): *Exercise, Fitness, and Health, A Consensus of Current Knowledge*, Human Kinetics Books, Champaign, Illinois, pp. 75-101.

Dramytinos E. (1993): Director of the Department of Sport in the Municipality of Heraklion / Crete / Greece, *Interview*.

Eccles J.S., Harold R.D. (1991): Gender Differences in Sport Involvement: Applying the Eccles' Expectancy-Value Model, *Journal of Applied Sport Psychology*, Volume 3, pp. 7-35.

Epstein L.H. (1992): Exercise and Obesity in Children, *Journal of Applied Sport Psychology*, Volume 4, pp. 120-133.

Ferguson K.J. (1992): Associate Research Scientist, College of Medicine, The University of Iowa, *Personal Correspondence*.

Fishbein M., Ajzen I. (1975): *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesley Publishing Company, USA.

Fletcher G.F., Blair S.N., Blumenthal J., Caspersen C., Chaitman B., Epstein S., Falls H., Froelicher S.E.S., Froelicher V.F., Pina I. (1992): Statement on Exercise, Benefits and Recommendations for Physical Activity Programs for All Americans, A Statement for Health Professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association, *Circulation*, Volume 86, Number 1, pp. 340-344.

Gidding S.G. (1993): The Rationale for Lowering Serum Cholesterol Levels in American Children, *American Journal of Diseases of Children*, Volume 147, pp. 386-392.

Godin G., Shephard R.J. (1986): Children's Perception of Parental Exercise: Influence of Sex and Age, *Perceptual and Motor Skills*, Volume 62, pp. 511-516.

Greendorfer S.L., Lewko J.H. (1978): Role of Family Members in Sport Socialization of Children, *Research Quarterly for Exercise and Sport*, Volume 49, pp. 146-152.

Haskell W.L. (1988): Physical Activity and the Diseases of Technologically Advanced Society, In: R.M. Malina, H.M. Eckert (Eds.): *Physical Activity in Early and Modern Populations*, American Academy of Physical Education Papers, Number 21, Human Kinetics Books, Champaign, Illinois, pp. 73-87.

Health Education Authority / Sports Council (1992): *Allied Dunbar National Fitness Survey*, Author, London.

Hounsa A.M., Godin G., Alihonou E., Valois P., Girard J. (1993): An Application of Ajzen's Theory of Planned Behaviour to Predict Mothers' Intention to use oral Rehydration Therapy in a Rural Area of Benin, *Social Science and Medicine*, Volume 37, Number 2, pp. 253-261.

Jambor E., Weekes E.M. (1994, abstract): The Parental Influences on Pre-Adolescent Children's Adult-Organized Sport Participation, *Research Quarterly for Exercise and Sport*, Volume 65, Number 1, Supplement, pp. A-87.

Kafatos A., Kouroumalis I., Vachonikolis I., Thedorou C., Labadarios D. (1991): Coronary-Heart-Disease Risk-Factor Status of the Cretan Urban Population in the 1980s, *American Journal of Clinical Nutrition*, Volume 54, pp. 1-8.

Kafatos A., Mamalakis G. (1993): Policies and Programs in Nutrition and Physical Fitness in Greece, *World Review in Nutrition and Dietetics*, Volume 72, pp. 206-217.

Kafatos A.G., Panagiotakopoulos G., Trakas D., Wynder E., Pantelakis S., Doxiadis S. (1981): The Epidemiology of Cardiovascular Risk Factors in Greek Children Aged 13, in Comparison to Children from 11 other Countries, *Iatriki*, Volume 40, pp. 113-121. Text in Greek.

Knapp D.N. (1988): Behavioral Management Techniques and Exercise Promotion, In: R.K. Dishman (Ed.): *Exercise Adherence: Its Impact on Public Health*, Human Kinetic Books, Champaign, Illinois, pp. 203-235.

Korsten-Reck U., Bauer S., Keul J. (1993): Sport und Ernärung - ein ambulantes Programm für adipöse Kinder, *Pädiatrie und Pädologie*, Volume 28, pp. 145-152. Text in German.

Lewko J.H., Greendorfer S.L. (1988): Family Influences in Sport Socialization of Children and Adolescents, In: F.L. Smoll, R.A. Magill, M.J. Ash (Eds.): *Children in Sport*, Human Kinetics Books, Champaign, Illinois, pp. 287-300.

Lohman T.G. (1992): *Advances in Body Composition Assessment*, Current Issues in Exercise Science Series, Monograph Number 3, Human Kinetics Publishers, Champaign, Illinois.

Malina R.M. (1988): Physical Activity in Modern Populations: An Evolutionary View, In: R.M. Malina, H.M. Eckert (Eds.): *Physical Activity in Early and Modern Populations*, American Academy of Physical Education Papers, Number 21, Human Kinetics Books, Champaign, Illinois, pp. 1-12.

McPherson B.D., Brown B.A. (1988): The Structure, Processes and Consequences of Sport for Children, In: F.L. Smoll, R.A. Magill, M.J. Ash (Eds.): *Children in Sport*, Human Kinetics Books, Champaign, Illinois, pp. 265-286.

Nieman D.C. (1986): *The Sports Medicine Fitness Guide*, Bull Publishing Company, Palo Alto, California.

Patriksson G. (1981): Socialization to Sports Involvement, *Scandinavian Journal of Sports Sciences*, Volume 3, Number 1, pp. 27-32.

Rowland T.W. (1990): *Exercise and Children's Health*, Human Kinetics Books, Champaign, Illinois.

Royal College of Physicians of London (1991): *Medical Aspects of Exercise, Benefits and Risks*, RCP, London.

Sallis J.F., Alcaraz J.E., McKenzie T.L., Hovell M.F., Kolody B., Nader P.R. (1992): Parental Behavior in Relation to Physical Activity and Fitness in 9-Year-Old Children, *American Journal of Diseases of Children*, Volume 146, pp. 1383-1388.

Sallis J.F., Hovell M.F. (1990): Determinants of Exercise Behaviour, *Exercise and Sport Science Reviews*, Volume 18, pp. 307-330.

Schifter D.E., Ajzen I. (1985): Intention, Perceived Control, and Weight loss: An Application of the Theory of Planned Behavior, *Journal of Personality and Social Psychology*, Volume 49, Number 3, pp. 843-851.

Sheppard B.H., Hartwick J., Warshaw P.R. (1988): The Theory of Reasoned Action: A Meta-Analysis of Past Research with Recommendations for Modifications and Future Research, *Journal of Consumer Research*, Volume 15, pp. 325-343.

Simons-Morton B.G., Parcel G.S., O'Hara N.M., Blair S.N., Pate R.R. (1988): Health Related Physical Fitness in Childhood: Status and Recommendations, *Annual Review of Public Health*, Volume 9, pp. 403-425.

Smith A., Jacobson B. (1988): *The Nation's Health, A Strategy for the 1990s*, Oxford University Press, London.

Sonstroem R.J. (1988): Psychological Models, In: R.K. Dishman (Ed.): *Exercise Adherence: Its Impact on Public Health*, Human Kinetic Books, Champaign, Illinois, pp. 125-153.

Statistisches Bundesamt (1993): *Statistisches Jahrbuch 1993 für das Ausland*, Metzler Poeschel, Wiesbaden. Text in German.

Theodorakis I. (1992): *Social Psychological Factors in Predicting Adults Female Participation in Physical Fitness Programs*, PhD Thesis, Department of Physical Education and Sport, Aristotle University of Thessaloniki, Greece. Text in Greek.

Thomas J.R., Nelson J.K. (1990): *Research Methods in Physical Activity*, Human Kinetic Books, Champaign, Illinois, Second Edition.

Torkildsen G. (1992): Leisure and Recreation Management, E & FN Spon, London, Third Edition.

Walker H.J. (1993): Youth Sports: Parental Concerns, *The Physical Educator*, Volume 50, Number 2, pp. 104-112.

Wold B., Anderssen N. (1992): Health Promotion Aspects of Family and Peer Influences on Sport Participation, *International Journal of Sport Psychology*, Volume 23, pp. 343-359.

## References for Chapter 2

Andersen I.B., Henckel P., Saltin B. (1989): Risk Factors for Cardiovascular Disease in 16-19-Year-Old Teenagers, *Journal of Internal Medicine*, Volume 225, pp. 157-163.

Andersen K.L., Illmarinen J., Rutenfranz J., Ottman W., Berndt I., Kylian H., Ruppe M. (1984): Leisure Time Sport Activities and Maximal Aerobic Power During Late Adolescence, *European Journal of Applied Physiology*, Volume 52, pp. 431-436.

Aravanis C., Dontas A.S., Lekos D., Keys A. (1966): Rural Populations in Crete and Corfu, Greece, *Acta Medica Scandinavica*, Supplement 460, pp. 209-230.

Armstrong N., Balding J., Gentle P., Kirby B. (1990): Patterns of Physical Activity among 11 to 16 Year Old British Children, *British Medical Journal*, Volume 301, pp. 203-205.

Armstrong N., Bray S. (1991): Physical Activity Patterns Defined by Continuous Heart Rate Monitoring, *Archives of Disease in Childhood*, Volume 66, pp. 245-247.

Atsalakis M., Kafatos A. (in press): Physical Activity and Obesity in a Sample of 12 Years Old Greek School Children. Article in Greek.

Baranowski T., Bouchard C., Bar-Or O., Bricker T., Heath G., Kimm S.Y.S., Malina R., Obarzanek E., Pate R., Strong W.B., Truman B., Washington R. (1991): Assessment, Prevalence, and Cardiovascular Benefits of Physical Activity and Fitness in Youth, *Medicine and Science in Sports and Exercise*, Volume 24, Number 6, pp. S237-S247.

Baranowski T., Hooks P., Tsong Y., Cieslik C., Nader P.R. (1987): Aerobic Physical Activity Among Third- to Sixth-Grade Children, *Developmental and Behavioral Pediatrics*, Volume 8, Number 4, pp. 203-206.

Baranowski T., Simons-Morton B.G. (1991): Dietary and Physical Activity Assessment in School-Aged Children: Measurement Issues, *Journal of School Health*, Volume 61, Number 5, pp. 195-197.

Baranowski, T. (1988): Validity and Reliability of Self Report Measures of Physical Activity: An Information-Processing Perspective, *Research Quarterly for Exercise and Sport*, Volume 59, Number 4, pp. 314-327.

Biddle S. (1992): Sport and Exercise Motivation: A Brief Review of Antecedent Factors and Psychological Outcomes of Participation, *Physical Education Review*, Volume 15, Number 2, pp. 98-110.

Biddle S., Armstrong N. (1992): Children's Physical Activity: An Exploratory Study of Psychological Correlates, *Social Science and Medicine*, Volume 34, Number 3, pp. 325-331.

Blaak E.E., Westerterp, K.R., Bar-Or O., Wouters L.J.M., Saris W.H.M. (1992): Total Energy Expenditure and Spontaneous Activity in Relation to Training in Young Boys, *American Journal of Clinical Nutrition*, Volume 55, pp. 777-782.

Blair S.N., Kohl H.W., Powell K.E. (1987): Physical Activity, Physical Fitness and the Public's Health, In: *The Cutting Edge in Physical Education and Exercise Science Research*, American

Academy in Physical Education Papers, No 20, Human Kinetics Books, Champaign, Illinois, pp. 53-69.

Bouchard C., Shephard R.J., Stephens T. (1993): *Physical Activity, Fitness and Health, Consensus Statement*, Human Kinetics Publishers, Champaign, Illinois.

Brooks C.M. (1987): Leisure Time Physical Activity Assessment of American Adults through an Analysis of Time Diaries Collected in 1981, *American Journal of Public Health*, Volume 77, Number 4, pp. 455-460.

Cale L., Almond L. ($1992_a$): Physical Activity Levels of Young Children: a Review of the Evidence, *Health Education Journal*, Volume 51, Number 2, pp. 94-99.

Cale L., Almond L. ($1992_b$): Physical Activity Levels of Secondary-Aged Children: a Review, *Health Education Journal*, Volume 51, Number 4, pp. 192-197.

Chatzicharistos D. (1990): *Pedagogical Foundations of Physical Education*, Symmetria Publishers, Athens. Text in Greek.

Chatzicharistos D., Zounhia K., Kotzamanidis X. (1989): Factors that Influence the Interest of Students in Studying in Physical Education Departments, *Physical Education and Sport*, Volume 26, pp. 32-48. Article in Greek.

Deutscher Sportbund (1986): *Sport Gesundheit Lebensstil, Ergebnisse einer Befragung*, Deutsher Sportbund, Frankfurt am Main. Text in German.

Durant R.H., Baranowski T., Davis H., Thompson W.O., Puhl J., Greaves K.A., Rhodes T. (1992): Reliability and Variability of Heart Rate Monitoring in 3-, 4-, or 5-Yr-Old Children, *Medicine and Science in Sports and Exercise*, Volume 24, Number 2, pp. 265-271.

Durnin J.V.G.A. (1990): Assessment of Physical Activity During Leisure and Work, In: C. Bouchard, R.J. Shephard, T. Stephens, J.R. Sutton, B.D. McPherson (Eds.): *Exercise, Fitness, and Health, A Consensus of Current Knowledge*, Human Kinetics Books, Champaign, Illinois, pp. 63-70.

Eaton W.O., Enns L.R. (1986): Sex Differences in Human Motor Activity Level, *Psychological Bulletin*, Volume 100, Number 1, pp. 19-28.

Freedson P. (1992): Physical Activity Among Children and Youth, *Canadian Journal of Sport Sciences*, Volume 17, Number 4, pp. 280-283.

Goran M.I. (1993): Application of the Doubly Labeled Water Technique for Studying Total Energy Expenditure in Young Children: A Review, *Pediatric Exercise Science*, Volume 6, Number 1, pp. 11-30.

Health Education Authority / Sports Council (1992): *Allied Dunbar National Fitness Survey*, Author, London.

Hübner H., Kirschbaum B. (1993): *Sportreiben in Münster*, Münsteraner Schriften zur Körperkultur, Band 13, Lit Verlag, Münster. Text in German.

Jenner D.A., Vandongen R., Beilin L. (1992): Relationships Between Blood Pressure and Measures of Dietary Energy Intake, Physical Fitness, and Physical Activity in Australian Children Aged 11-12 Years, *Journal of Epidemiology and Community Health*, Volume 46, pp. 108-113.

Kafatos A. (1992): Professor of Epidemiology and Community Health, Medical Faculty, University of Crete, *Personal Correspondence*.

Kafatos A., Kouroumalis I., Vachonikolis I., Thedorou C., Labadarion D. (1991): Coronary-Heart-Disease Risk-Factor Status of the Cretan Urban Population in the 1980s, *American Journal of Clinical Nutrition*, Volume 54, pp. 1-8.

Klesges R.C., Eck L.H., Mellon M.W., Fulliton W., Somes G.W., Hanson C.L. (1990): The accuracy of Self-Reports of Physical Activity, *Medicine and Science in Sports and Exercise*, Volume 22, Number 5, pp. 690-697.

Kuh D.J.L., Cooper C. (1992): Physical Activity at 36 Years: Patterns and Childhood Predictors in a Longitudinal Study, *Journal of Epidemiology and Community Health*, Volume 46, pp. 114-119.

Lamb K.L., Brodie D.A. (1990): The Assessment of Physical Activity by Leisure-Time Physical Activity Questionnaires, *Sports Medicine*, Volume 10, Number 3, pp. 159-180.

LaPorte R.E., Kuller L.H., Kupfer D.J., McPartland R.J., Matthews G., Caspersen C. (1979): An Objective Measure of Physical Activity for Epidemiologic Research, *American Journal of Epidemiology*, Volume 109, Number 2, pp. 158-168.

Lee I.M., Paffenbarger R.S., Hsieh C. (1991): Physical Activity and Risk of Developing Colorectal Cancer Among College Alumni, *Journal of the National Cancer Institute*, Volume 83, Number 18, pp. 1324-1329.

Livingstone B.M.E., Coward A.W., Prentice A.M., Davies P.S.W., Strain J.J., McKenna G.P., Mahoney C A., White J.A., Stewart C M., Kerr M.J.J. (1992): Daily Energy Expenditure in Free-Living Children: Comparison of Heart-Rate Monitoring with the Doubly Labeled Water ($^2H_2{}^{18}O$) Method, *American Journal of Clinical Nutrition*, Volume 56, pp. 343-352.

Marti B., Vartiainen E. (1989): Relation Between Leisure Time Exercise and Cardiovascular Risk Factors among 15-Years-Olds in Eastern Finland, *Journal of Epidemiology and Community Health*, Volume 43, pp. 228-233.

McKenzie T.L. (1991): Observational Measures of Children's Physical Activity, *Journal of School Health*, Volume 61, Number 5, pp. 224-227.

Montoye H.J. (1990): Discussion: Assessment of Physical Activity During Leisure and Work, In: C. Bouchard, R.J. Shephard, T. Stephens, J.R. Sutton, B.D. McPherson (Eds.): *Exercise, Fitness, and Health, A Consensus of Current Knowledge*, Human Kinetics Books, Champaign, Illinois, pp. 71-74.

Montoye H.J., Taylor H.L.(1984): Measurement of Physical Activity in Population Studies: A Review, *Human Biology*, Volume 56, Number 2, pp. 196-216.

National Statistical Service (1981): *Census Material for the Municipality of Heraklion, Crete*, Unpublished Manuscript, Heraklion, Crete, Greece. Manuscript in Greek.

Powell K.E (1988): Habitual Exercise and Public Health: An Epidemiological View, In: R.K. Dishman (Ed.): *Exercise Adherence, Its Impact on Public Health*, Human Kinetics Books, Champaign, Illinois, pp. 15-39.

Riddoch C., Savage J.M., Murphy N., Cran G.W., Boreham C. (1991): Long Term Health Implications of Fitness and Physical Activity Patterns, *Archives of Disease in Childhood*, Volume 66, pp. 1426-1433.

Roberts K., Brodie D.A., Cambell R., Lamb K.L., Minten J., York C. (1989): Indoor Sports Centres: Trends in Provision and Usage, In: *Fit for Life, Proceedings of a Symposium on Fitness and Leisure*, The Health Promotion Research Trust, Labute Ltd., Cambridge, pp. 103-114.

Ross J.G., Gilbert G.G. (1985): The National Children and Youth Fitness Study I, A Summary of Findings, *Journal of Physical Education Recreation and Dance*, Volume 56, pp. 45-50.

Ross J.G., Pate R.R. (1987): The National Children and Youth Fitness Study II, A Summary of Findings, *Journal of Physical Education Recreation and Dance*, Volume 58, pp. 51-56.

Sallis J.F., Buono M.J., Freedson P.S. (1991): Bias in Estimating Caloric Expenditure from Physical Activity in Children, *Sports Medicine*, Volume 11, Number 4, pp. 203-209.

Saris W.H.M. (1985): The Assessment and Evaluation of Daily Physical Activity in Children, *Acta Paediatrica Scandinavica*, Supplement 318, pp. 37-48.

Saris W.H.M. (1986): Habitual Physical Activity in Children: Methodology and Findings in Health and Disease, *Medicine and Science in Sports and Exercise*, Volume 18, Number 3, pp. 253-263.

Saris W.H.M. (1992): Professor of Nutrition, Department of Human Biology, University of Limburg, *Personal Correspondence*.

Schoeller D.A., van Santen E. (1982): Measurement of Energy Expenditure in Humans by Doubly Labeled Water Method, *Journal of Applied Physiology*, Volume 53, Number 4, pp. 955-959.

Shaper A.G., Wannamethee G. (1991): Physical Activity and Ischaemic Heart Disease in Middle-Aged British Men, *British Heart Journal*, Volume 66, pp. 384-394.

Shephard R.J. (1993): Is Population Involvement in Exercise Programs Increasing?, *Yearbook of Sportsmedicine*, pp. xv-xxix.

Silagy C., Muir J., Coulter A., Thorogood M., Roe L. (1993): Cardiovascular Risk and Attitudes to Lifestyle: What Do Patients Think?, *British Medical Journal*, Volume 306, pp. 1657-1660.

Simons-Morton B.G. (1992): Associate Professor, School of Public Health, The University of Texas, *Personal Correspondence*.

Simons-Morton B.G., O'Hara N.M., Parcel G.S., Huang I.W., Baranowski T., Wilson B. (1990): Children's Frequency of Participation in Moderate to Vigorous Physical Activities, *Research Quarterly for Exercise and Sport*, Volume 61, Number 4, pp. 307-314.

Simons-Morton B.G., Parcel G.S., O'Hara N.M., Blair S.N., Pate R.R. (1988): Health Related Physical Fitness in Childhood: Status and Recommendations, *Annual Review of Public Health*, Volume 9, pp. 403-425.

Sleap M., Warburton P. (1992): Physical Activity Levels of 5-11-Year-Old Children in England as Determined by Continuous Observation, *Research Quarterly for Exercise and Sport*, Volume 63, Number 3, pp. 238-245.

Sleap M., Warburton P. (1994): Physical Activity Levels of Preadolescent Children in England, *British Journal of Physical Education*, Research Supplement, Number 14, Summer, pp. 2-6.

Sunnegardh J., Bratteby L.E., Sjölin S. (1985): Physical Activity and Sports Involvement in 8- and 13-Year-Old Children in Sweden, *Acta Paediatrica Scandinavica*, Volume 74, pp. 904-912.

Tancred W., Gleeson N. (1989): Exercise for a Lifetime: An Educational Effort, In: *Fit for Life, Proceedings of a Symposium on Fitness and Leisure*, The Health Promotion Research Trust, Labute Ltd., Cambridge, pp. 29-68.

Telama R., Laakso L., Yang X. (1994): Physical Activity and Participation in Sports of Young People in Finland, *Scandinavian Journal of Medicine and Science in Sports*, Volume 4, pp. 65-74.

Telama R., Viikari J., Välimaki I., Siren-Tiusanen H., Akerblom H.K., Uhari M., Dahl M., Pesonen E., Lähde P.L., Pitkäinen M., Suoninen P. (1985): Atherosclerosis Precursors in Finnish Children and Adolescents. X. Lesisure Time Physical Activity, *Acta Paediatrica Scandinavica*, Supplement 318, pp. 169-180.

Tell G., Vellar O.D. (1988): Physical Fitness, Physical Activity, and Cardiovascular Disease Risk Factors in Adolescents: The Oslo Youth Study, *Preventive Medicine*, Volume 17, pp. 12-24.

Tuomilehto J., Marti B., Salonen J.T., Virtala E., Lahti T., Puska P. (1987): Leisure-Time Physical Activity is Inversely Related to Risk Factors for Coronary Heart Disease in Middle-Aged Finnish Men, *European Heart Journal*, Volume 8, pp. 1047-1055.

Vassilakis D., Kafatos A., Kounali D., Labadarios D.: Physical Activity, Health and Nutritional Status of the Medical Students at the University of Crete, *Unpublished Manuscript*, University of Crete.

Washburn R.A., Montoye H.J. (1986): The Assessment of Physical Activity by Questionnaire, *American Journal of Epidemiology*, Volume 123, Number 4, pp. 563-576.

## References for Chapter 3

ACSM (1993): Physical Activity, Physical Fitness and Hypertension, Position Stand, *Medicine and Science in Sports and Exercise*, Volume 25, Number 10, pp. i-x.

Aellen R., Hollmann W., Boutellier U. (1993): Effects of Aerobic and Anaerobic Training on Plasma Lipoproteins, *International Journal of Sports Medicine*, Volume 14, pp. 396-400.

Andersen L.B., Henckel P., Saltin B. (1989): Risk Factors for Cardiovascular Disease in 16-19-Year-Old Teenagers, *Journal of Internal Medicine*, Volume 225, pp. 157-163.

Andrew M., Carter C., O'Brodovich, Heigenhauser G. (1986): Increases in Factor VIII Complex and Fibrinolytic Activity Are Dependent on exercise Intensity, *Journal of Applied Physiology*, Volume 60, Number 6, pp. 1917-1922.

Atomi Y., Kuroda Y., Asami t., Kawahara T. (1986): HDL2-Cholesterol of Children (10 to 12 Years of Age) Related to VO2max, Body Fat, and Sex, In: J. Rutenfranz, R. Mocellin, F. Klint (Eds.): *Children and Exercise XII*, Volume 17, Human Kinetics Publishers, Champaign, Illinois, pp. 167-172.

Austin M.A., Breslow J.L., Hennekens C.H., Buring J.E., Willett W.C., Krauss R.M. (1988): Low-Density Lipoprotein Subclass Patterns and Risk of Myocardial Infarction, *Journal of the American Medical Association*, Volume 260, Number 13, pp. 1917-1921.

Bagby G.J., Johnson J.L., Benett B.W., Shepherd R.E. (1986): Muscle Lipoprotein Lipase Activity in Voluntarily Exercising Rats, *Journal of Applied Physiology*, Volume 60, Number 5, pp. 1623-1627.

Baranowski T., Bouchard C., Bar-Or O., Bricker T., Heath G., Kimm S.Y.S., Malina R., Obarzanek E., Pate R., Strong W.B., Truman B., Washington R. (1991): Assessment, Prevalence and Cardiovascular Benefits of Physical Activity and Fitness in Youth, *Medicine and Science in Sports and Exercise*, Volume 24, Number 6, pp. S237-S247.

Baranowski T., Tsong Y., Henske J., Dunn J.K., Hooks P. (1988): Ethnic Variation in Blood Pressure among Preadolescent Children, *Pediatric Research*, Volume 23, pp. 270-274.

Baumstark M.W., Frey I., Berg A. (1993): Acute and Delayed Effects of Prolonged Exercise on Serum Lipoproteins, *European Journal of Applied Physiology*, Volume 66, pp.526-530.

Becque M.D., Katch V.L., Rocchini A.P., Marks C.R., Moorehead C. (1988): Coronary Risk Incidence of Obese Adolescents: Reduction by Exercise Plus Diet Intervention, *Pediatrics*, Volume 81, Number 5, pp. 605-612.

Bell R.D., Macek M., Rutenfranz J., Saris W.H.M (1986): Health Indicators and Risk Factors of Cardiovascular Diseases During Childhood and Adolescence, In: J. Rutenfranz, R. Mocellin, F. Klint (Eds.): *Children and Exercise XII*, Volume 17, Human Kinetics Publishers, Champaign, Illinois, pp. 19-27.

Berlin J.A., Golditz G.A. (1990): A Meta-Analysis of Physical Activity in the Prevention of Coronary Heart Disease, *American Journal of Epidemiology*, Volume 132, Number 4, pp. 612-628.

Blair S.N., Haskell W.L., Ho P., Paffenbarger R.S., Vranizan K.M., Farquhar J.f., Wood P.D. (1985): Assessment of Habitual Physical Activity by a Seven-Day Recall in a Community Survey and Controlled Experiments, *American Journal of Epidemiology*, Volume 122, Number 5, pp. 794-804.

Blair S.N., Kohl H.W., Paffenbarger R.S., Clark D.G., Cooper K.H., Gibbons L.W. (1989): Physical Fitness and All-Cause mortality, A Prospective Study of Healthy Men and Women, *Journal of the American Medical Association*, Volume 262, Number 17, pp. 2395-2401.

Blumenthal J.A., Siegel W.c., Appelbaum M. (1991): Failure of Exercise to Reduce Blood Pressure in Patients With mild Hypertension, Results of a Randomized Controlled Trial, *Journal of the American Medical Association*, Volume 226, Number 15, pp. 2098-2104.

Boldt F., Meyer-Beer M., Meller W., Drygas W., Franz I.W. (1987): Effect of Endurance Training and Endurance Training Plus Strength Training on Coronary Risk Factors, *International Journal of Sports Medicine*, Volume 8, p. 159, Abstract.

Bonanno J.A., Lies J.E. (1974): Effects of Physical Training on Coronary Risk factors, *American Journal of Cardiology*, Volume 33, pp. 760-763.

Bourey R.E., Santoro S.A. (1988): Interactions of Exercise, Coagulation, Platelets, and Fibrinolysis-A Brief Review, *Medicine and Science in Sports and Exercise*, Volume 20, Number 5, pp. 439-446.

Boyden T.W., Pamenter R.W., Going S.B., Lohman T.G., Hall M.C., Houtkooper L.B. (1993): Resistance Exercise Training is Associated with Decreases in Serum Low Density Lipoprotein Cholesterol Levels in Premenopausal Women, *Archives of Internal Medicine*, Volume 153, Number 1, pp. 97-100.

Brommer E.J.P., Potter van Loon, B.J., Rijken D.C., van Bockel J.H. (1992): Composition and Susceptibility to Thrombolysis of Pathological Human Arterial Thrombi, *Annals of the New York Academy of Sciences*, Volume 667, pp. 283-285.

Brown M.S., Goldstein J.L. (1985): The Receptor Model for Transport of Cholesterol in Plasma, *Annals of the New York Academy of Sciences*, Volume 454, pp. 178-182.

Bryant J.G., Garrett H.L., Dean Mostafa M.S. (1984): The Effects of an Exercise Program on Selected Risk Factors to Coronary Heart Disease in Children, *Social Science and Medicine*, Volume 19, Number 7, pp. 765-766.

Budohoski L. (1985): Exercise-Induced Changes in Lipoprotein Lipase Activity (LPLA) in Skeletal Muscles of the Dog, *Pflügers Arch*, Volume 405, pp. 188-192.

Cohen C.H., McMillan C., Samuelson D.R. (1991): Long-Term Effects of a Lifestyle Modification Exercise Program on the Fitness of Sedentary Obese Children, *Journal of Sports Medicine and Physical Fitness*, Volume 31, Number 2, pp. 183-188.

Collen D., Lijnen H.R. (1991): Thrombolytic Therapy, *Annals of the New York Academy of Sciences*, Volume 614, pp. 259-269.

Cook T.C., Laporte R.E., Washburn A., Traven N., Slemenda C.W., Metz K.F. (1986): Chronic Low Level Physical Activity as a Determinant of High Density Lipoprotein Cholesterol and

Subfractions, *Medicine and Science in Sports and Exercise*, Volume 198, Number 6, pp. 653-657.

Cotton P. (1991): Exercise, Health Links Need Hard Proof, Say Researchers Studying Mechanisms, *Journal of the American Medical Association*, Volume 265, Number 22, pp. 2928-2929.

Danforth J.S., Allen K.D., Fitterling J.M., Danforth J.A., Farrar D., Brown M., Drabman R.S. (1990): Exercise as a Treatment for Hypertension in Low-Socioeconomic-Status Black Children, *Journal of Consulting and Clinical Psychology*, Volume 58, Number 2, pp. 237-239.

Daoud A.S., Fritz K.E., Jarmolych J., Frank A.F. (1985): Role of Macrophages in Regression of Atherosclerosis, *Annals of the New York Academy of Sciences*, Volume 454, pp. 101-114.

De Paz J.A., Lasierra J., Villa J.G., Viladés E., Martin-Nuno M.A., González-Gallego J. (1992): Changes in the Fibrinolytic System Associated with Physical Conditioning, *European Journal of Applied Physiology*, Volume 65, pp. 388-393.

De Plaen J.F., Detry J.M. (1980): Hemodynamic effects of Physical Training in established Arterial Hypertension, *Acta Cardiologica*, Volume XXXV, pp. 179-188.

de-Geus E.J., Kluft C., de-Bart A.C., van-Doornen L.J. (1992): Effects of Exercise Training on Plasminogen Activator Inhibitor Activity, *Medicine and Science in Sports and Exercise*, Volume 24, Number 11, pp. 1210-1219.

Després J.P., Pouliot M.C., Moorjani S., Nadeau A., Tremblay A., Lupien P.J., Thériault G., Bouchard C. (1991): Loss of Abdominal Fat and Metabolic Response to Exercise Training in Obese Women, *American Journal of Physiology*, Volume 261, pp. E159-E167.

Després J.P., Tremblay A., Moorjani S., Lupien P.J., Thériault G., Nadeau A., Bouchard C. (1990): Long-Term Exercise Training with Constant Energy Intake. 3: Effects on Plasma Lipoprotein Levels, *International Journal of Obesity*, Volume 14, pp. 85-94.

Deveaux K.F., Bell R.D., Laxdal V.A. (1986): The Effects of a Season of Competitive Soccer on the Serum Lipid and Lipoprotein Cholesterol Profile of Adolescent Boys, In: J. Rutenfranz, R. Mocellin, F. Klint (Eds.): *Children and Exercise XII*, Volume 17, Human Kinetics Publishers, Champaign, Illinois, pp. 173-183.

DiGirolamo M., Schlant R.C. (1978): Etiology of Coronary Atherosclerosis, In: J.W. Hurst (Ed.): *The Heart, Arteries and Veins*, McGraw-Hill Book Company, Fourth Edition, USA, pp. 1103-1121.

Dinarello C.A., Wolff S.M. (1993). The role of Interleukin-1 in Disease, *New England Journal of Medicine*, Volume 328, Number 2, pp. 106-113.

Drygas W., Jegler A., Kunski H. (1988): Study on the Threshold Dose of Physical Activity in Coronary Heart Disease Prevention. Part I. Relationship Between Leisure Time Physical Activity and Coronary Risk Factors, *International Journal of Sports Medicine*, Volume 9, pp. 275-278.

Drygas W.K. (1988): Changes in Blood Platelet Function, Coagulation, and Fibrinolytic Activity in Response to Moderate, Exhaustive and Prolonged Exercise, *International Journal of Sports Medicine*, Volume 9, pp. 67-72.

Dufaux B., Order U., Liesen H. (1991): Effect of Short Maximal Physical Exercise on Coagulation, Fibrinolysis, and Complement System, *International Journal of Sports Medicine*, Volume 12, pp. S38-S42.

Duncan J.J., Farr J.E., Upton J., Hagan R.D., Oglesby M.E., Blair S.N. (1985): The Effects of Aerobic Exercise on Plasma Catecholamines and Blood Pressure in Patients With Mild Hypertension, *Journal of the American Medical Association*, Volume 254, Number 18, pp. 2609-2613.

El-Sayed M. (1990): Exercise Intensity-Related Responses of Fibrinolytic Activity and Vasopressin in Man, *Medicine and Science in Sports and Exercise*, Volume 22, Number 4, pp. 494-500.

Elliot R.S., Edwards J.E. (1978): Pathology of Coronary Atherosclerosis and its Complications, In: J.W. Hurst (Ed.): *The Heart, Arteries and Veins*, McGraw-Hill Book Company, Fourth Edition, USA, pp. 1121-1134.

Endo H., Takagi Y., Nozue T., Kuwahata K., Uemasu F., Kobayashi A. (1992): Beneficial Effects of Dietary Intervention on Serum Lipid and Apolipoprotein Levels in Obese Children, *American Journal of Diseases of Children*, Volume 146, pp. 303-305.

Epstein L.H., Kuller L.H., Wing R.R., Valoski A., McCurley J. (1989): The Effect of weight Control on Lipid Changes in Obese Children, *American Journal of Diseases of Children*, Volume 143, pp. 454-457.

Faber M., Spinnler Benade A.J., celliers C., Marais M. (1992): Changes in Plasma Lipoprotein Levels During a Hiking Expedition in South America, *International Journal of Sports Medicine*, Volume 13, pp. 279-284.

Falk E. (1992): Dynamics in Thrombus Formation, *Annals of the New York Academy of Sciences*, Volume 667, pp. 204-223.

Ferguson E.W., Bernier L.L., Banta G.R., Yu-Yahiro J., Schoomaker E.B. (1987): Effects of Exercise and Conditioning on Clotting and Fibrinolytic Activity in Men, *Journal of Applied Physiology*, Volume 62, Number 4, pp. 1416-1421.

Frey I., Berg A., Baumstark W., Collatz K., Keul J. (1990): Effects of Age and Physical Performance Capacity on Distribution and Composition of High-Density Lipoprotein Subfractions in Men, *European Journal of Applied Physiology*, Volume 60, pp. 440-444.

Fripp R.R., Hodgson J.L. (1987): Effect of Resistive Training on Plasma Lipid and Lipoprotein Levels in Male Adolescents, *Journal of Pediatrics*, Volume 111, Number 6, pp. 926-931.

Fripp R.R., Hodgson J.L., Kwiterovich P.O., Werner J.C., Schuler G., Whitman V. (1985): Aerobic Capacity, Obesity and Atherosclerotic Risk Factors in Male Adolescents, *Pediatrics*, Volume 75, Number 5, pp. 813-818.

Giada F., Balocchi M.R., Zuliani G., Vitale E., Fellin R. (1991): Specialized Physical Training Programs: Effects on Serum Lipoprotein Cholesterol, Apoproteins A-I and B and Lipolytic Enzyme Activities, *Journal of Sports Medicine and Physical Fitness*, Volume 31, Number 2, pp. 196-203.

Giada F., Bando-Enzi G., Balocchi M.R., Zuliani G., Baroni L., Fellin R. (1988): Heparin-Released Plasma Lipase Activities, Lipoprotein and Apoprotein Levels in Young Adult Cyclists and Sedentary Men, *International Journal of Sports Medicine*, Volume 9, pp. 270-274.

Gilliam T.B., Burke M.B. (1978): Effects of Exercise on Serum Lipids and Lipoproteins in Girls, Ages 8 to 10 Years, *Artery*, Volume 4, pp. 203-213.

Gilliam T.B., Freedson P.S. (1980): Effects of a 12-week School Physical Fitness Program on Peak $VO_2$, Body Composition and Blood Lipids in 7 to 9 Year Old Children, *International Journal of Sports Medicine*, Volume 1, pp. 73-78.

Gilliam T.B., Freedson P.S., MacConnie S.E., Geenen D., Pels A.E. (1981): Comparison of Blood Lipids, Lipoproteins, Anthropometric Measures and Resting and Exercise Cardiovascular Responses in Children 6-7 Years Old, *Preventive Medicine*, Volume 10, pp. 754-764.

Ginsberg H.N. (1990): Lipoprotein Physiology and Its Relationship to Atherogenesis, *Endocrinology and Metabolism Clinics of North America*, Volume 19, Number 2, pp. 211-228.

Glueck C.J. (1986): Pediatric and Adult Primary and Secondary Prevention of Atherosclerosis, In: N.H. Fidge, P.J. Nestel (Eds.): *Atherosclerosis VII*, Proceedings of the Seventh International Symposium on Atherosclerosis and the 7th Scientific Committee of the National Heart Foundation of Australia, Melbourne, 6-10 October 1985, Elsevier Science Publishers, Amsterdam, International Congress Series No. 696, pp. 521-524.

Goldberg A.P. (1989): Aerobic and Resistive Exercise Modify Risk Factors for Coronary Heart Disease, *Medicine and Science in Sports and Exercise*, Volume 21, Number 6, pp. 669-674.

Gupta A.K., Ross E.A., Myers J.N., Kashyap M.L. (1993): Increased Reverse Cholesterol, Transport in Athletes, *Metabolism*, Volume 42, Number 6, pp. 684-690.

Gutin B., Basch C., Shea S., Contento I., DeLozier M., Rips J., Irigoyen M., Zybert P. (1990): Blood Pressure, Fitness and Fatness in 5- and 6-Year-Old Children, *Journal of tthe American Medical Association*, Volume 264, Number 9, pp. 1123-1127.

Haahr P.M., Pedersen B.K., Fomsgaard A., Tvede N., Diamant M., Klarlund K., Hlakjaer-Kristensen J., Bendtzen K. (1991): Effect of Physical Exercise on in Vitro Production of Interleukin-1, Interleukin-6, Tumour Necrosis Factor-$\alpha$, Interleukin-2 and Interferon-$\gamma$, *International Journal of Sports Medicine*, Volume 12, pp. 223-227.

Hagberg J.M., Goldring D., Ehsani A.A., Heath G.W., Hernandez A., Schechtman K., Holloszy J.O. (1983): Effect of Exercise Training on the Blood Pressure and Hemodynamic Features of Hypertensive Adolescents, *American Journal of Cardiology*, Volume 52, pp. 763-768.

Hagberg J.M., Montain S.J., Martin W.H., Ehsani A.A. (1989): Effect of Exercise Training in 60- to 69- Year- old Persons with Essential Hypertension, *American Journal of Cardiology*, Volume 64, pp. 348-353.

Haskell W.L. (1986): The Influence of Exercise Training on Plasma Lipids and Lipoproteins in Health and Disease, *Acta Medica Scandinavica*, Supplement 711, pp. 25-37.

Hawkey C.M., Britton B.J., Wood W.G., Peele M., Irving M.H. (1975): Changes in Blood Catecholamine Levels and Fibrinolytic Activity in Response to Graded Exercise in Man, *British Journal of Haematology*, Volume 29, pp 377-383.

Herbert P.N., Bernier D.N., Cullinane E.M., Edelstein L., Kantor M.A., Thompson P.D. (1984): High-Density Lipoprotein Metabolism in Runners and Sedentary Men, *Journal of the American Medical Association*, Volume 252, Number 8, pp. 1034-1037.

Herren T., Bärtsch P., Haeberli A., Straub P.W. (1992): Increased Thrombin-Antithrombin III Complexes After 1 h of Physical Exercise, *Journal of Applied Physiology*, Volume 73, Number 6, pp. 2499-2504.

Hessel L.W., Kluft C. (1986): Fibrinolysis: Defence Against Thrombosis. Survey of Recent Developments, In: N.H. Fidge, P.J. Nestel (Eds.): *Atherosclerosis VII*, Proceedings of the Seventh International Symposium on Atherosclerosis and the 7th Scientific Committee of the National Heart Foundation of Australia, Melbourne, 6-10 October 1985, Elsevier Science Publishers, Amsterdam, International Congress Series No. 696, pp. 473-476.

Hinkleman L.L., Nieman D.C. (1993): The Effects of a Walking Program on Body Composition and Serum Lipids and Lipoproteins in Overweight Women, *Journal of Sports Medicine and Physical Fitness*, Volume 33, Number 1, pp. 49-58.

Hurley B.F. (1989): Effects of Resistive Training on Lipoprotein-Lipid Profiles: A Comparison to Aerobic Exercise Training, *Medicine and Science in Sports and Exercise*, Volume 21, Number 6, pp. 689-693.

Hurst J.W, King S.B. (1978): Definitions and Classification of Coronary Atherosclerotic Heart Disease, In: J.W. Hurst (Ed.): *The Heart, Arteries and Veins*, McGraw-Hill Book Company, Fourth Edition, USA, pp. 1094-1102.

Ip J.H., stein B., Fuster V., Badimon L. (1991): Antithrombotic Therapy in Cardivascular Diseases, *Annals of the New York Academy of Sciences*, Volume 614, pp. 289-311.

Jenner D.A., Vandongen R., Beilin L. (1992): Relationships Between Blood Pressure and Measures of Dietary Energy Intake, Physical Fitness, and Physical Activity in Australian children aged 11-12 Years, *Journal of Epidemiology and Community Health*, Volume 46, pp. 108-113.

Kanaley J.A., Andresen-Reid M.L., Oenning L., Kottke B.A., Jensen M.D. (1993): Differential Health Benefits of Weight Loss in Upper-Body and Lower-Body Obese Women, *American Journal of Clinical Nutrition*, Volume 57, pp. 20-26.

Kantor M.A., Cullinane E.M., Herbert P.N., Thompson P.D. (1984): Acute Increase in Lipoprotein Lipase Following Prolonged Exercise, *Metabolism*, Volume 33, Number 5, pp. 454-457.

Kantor M.A., Cullinane E.M., Sady S.P., Herbert P.N., Thompson P.D. (1987): Exexrcise Acutely Increases High Density Lipoprotein-Cholesterol and Lipoprotein Lipase Activity in Trained and Untrained Men, *Metabolism*, Volume 36, Number 2, pp. 188-192.

Kiens B., Jörgensen I., Lewis S., Jensen G., Lithell H., Vessby B., Hoe S., Schnohr P. (1980): Increased Plasma HDL-Cholesterol and Apo A-1 in Sedentary Middle-Aged Men after Physical Conditioning, *European Journal of Clinical Investigation*, Volume 10, pp. 203-209.

Kiens B., Lithell H, (1989): Lipoprotein Metabolism Influenced by Training-Induced changes in Human Skeletal Muscle, *Journal of Clinical Investigation*, Volume 83, pp. 558-564.

Klesges R.C., Haddock K.C., Eck L. (1990): A Multimethod Approach to the Measurement of Childhood Physical Activity and Its Relationship to Blood Pressure and Body Weight, *Journal of Pediatrics*, Volume 116, Number 6, pp. 888-893.

Kokkinos P.F., Hurley B.F., Smutok M.A., Farmer C., Reece R., Shulman R., Charabogos C., Patterson J., Will S., DeVane-Bell J., Goldberg A.P. (1991): Strength Training does not Improve Lipoprotein-Lipid Profiles in Men at High Risk for CHD, *Medicine and Science in Sports and Exercise*, Volume 23, Number 10, pp. 1134-1139.

Korsan-Bengtsen K., Wilhlelmsen L., Tibblin G. (1973): Blood Coagulation and Fibrinolysis in Relation to Degree of Physical Activity During Work and Leisure Time, *Acta Medica Scandinavica*, Volume 193, pp. 73-77.

Kummerow F.A. (1985): Lipoprotein Responses and Artery Wall Responses as Factors Affecting the Development of Atherosclerosis, *Annals of the New York Academy of Sciences*, Volume 454, pp. 46-51.

Kuusi T., Nikkilä E.A., Saarinen P., Varjo P., Laitinen L.A. (1982): Plasma High Density Lipoproteins HDL2, HDL3, and Postheparin Plasma Lipases in Relation to Parameters of Physical Fitness, *Atherosclerosis*, Volume 41, pp. 209-219.

Lewicki R., Tchórzewski H., Majewska E., Nowak Z., Baj Z. (1988): Effect of Maximal Exercise on T-Lymphocyte Subpopulations and on Interleukin1 (IL 1) and Interleukin 2 (IL 2) Production in Vitro, *International Journal of Sports Medicine*, Volume 9, pp. 114-117.

Linder C.W., Durant R.H., Gray R.G., Harkess J.W. (1979): The Effects of Exercise on Serum Lipid Levels in Children, *Clinical Research*, Volume 27, p. 797A, Abstract.

Linder C.W., Durant R.H., Mahoney O.M. (1983): The Effect of Physical Conditioning on Serum Lipids and Lipoproteins in White Male Adolescents, *Medicine and Science in Sports and Exercise*, Volume 15, Number 3, pp. 232-236.

Lokey E.A., Tran Z.V. (1989): Effects of Exercise Training on Serum Lipid and Lipoprotein Concentrations in Women: A Meta-Analysis, *International Journal of Sports Medicine*, Volume 10, pp. 424-429.

Loskutoff D.J., Curriden S.A. (1990): The Fibrinolytic System of the Vessel Wall and its Role in the Control of Thrombosis, *Annals of the New York Academy of Sciences*, Volume 598, pp. 238-247.

Mácek M., Bell D., Rutenfranz J., Vavra J., Masopust J., Neidhart B., Schmidt K.H. (1989): A Comparison of Coronary Risk Factors in Groups of Trained and Untrained Adolescents, *European Journal of Applied Physiology*, Volume 58, pp. 577-582.

Mackinnon L.T. (1992): *Exercise and Immunology*, Human Kinetics Publishers, Current Issues in Exercise Science Series, Monograph Number 2, Champaign, Illinois.

Manning J.M., Dooly-Manning C.R., White K., Kampa I., Silas S., Kesselhaut M., Ruoff M. (1991): Effects of a Resistive Training Program on Lipoprotein-Lipid Levels in Obese Women, *Medicine and Science in Sports and Exercise*, Volume 23, Number 11, pp. 1222-1226.

Marieb E.N. (1989): *Human Anatomy and Physiology*, The Benjamin/Cummings Publishing Company, Inc., USA.

Marti B., Knobloch M., Riesen W.F., Howald H. (1991): Fifteen-Year Changes in Exercise, Aerobic Power, Abdominal Fat, and Serum Lipids in Runners and Controls, *Medicine and Science in Sports and Exercise*, Volume 23, Number 1, pp. 115-122.

Marti B., Vartiainen E. (1989): Relation Between Leisure Time Exercise and Cardiovascular Risk Factors Among 15-Year-Olds in Eastern Finland, *Journal of Epidemiology and Community Health*, Volume 43, pp. 228-233.

Martin D.G., Ferguson E.W., Wigutoff S., Gawne T., Schoomaker E.B. (1985): Blood Viscocity Responses to Maximal Exercise in Endurance-Tained and Sedentary Female Subjects, *Journal of Applied Physiology*, Volume 59, Number 2, pp. 348-353.

McKenzie T.L., Buono M., Nelson J. (1984): Modification of Coronary Heart Disease (CHD) Risk Factors in Obese Boys Through Diet and Exercise, *American Corrective Therapy Journal*, Volume 38, March-April, pp. 35-37.

Milesis C.A., Pollock M.L., Bah M.D., Ayres J.J., Ward A., Linnerud A.C. (1976): Effects of Different Durations of Physical Training on Cardiorespiratory Function, Body Composition and Serum Lipids, *Research Quarterly*, Volume 47, Number 4, pp. 716-725.

Ming-Peng S., Ren-Yi X., Bi-Fang R., Zong-Li W., (1990): High Density Lipoproteins and Prevention of Experimental Atherosclerosis with Special Reference to Tree Shrews, *Annals of the New York Academy of Sciences*, Volume 598, pp. 339-251.

Moncada S., Martin J.F., Higgs A. (1993): Symposium on Regression of Atherosclerosis, *European Journal of Clinical Investaigation*, Volume 23, pp. 385-398.

Moore S. (1985): Thrombosis and Atherogenesis-The Chicken and the Egg, *Annals of the New York Academy of Sciences*, Volume 454, pp. 146-153.

Murota S., Morita I., Suda N. (1990): The Control of Vascular Endothelial Cell Injury, *Annals of the New York Academy of Sciences*, Volume 598, pp. 182-187.

Naito H.K. (1985): The Association of Serum Lipids, Lipoproteins and Apoproteins with Coronary Artery Disease Assessed by Coronary Arteriography, *Annals of the New York Academy of Sciences*, Volume 454, pp. 230-238.

Nakamura H., Mizuno K., Shibuya T., Arakawa K. (1990): Increased Triglyceride May Determine the Sites of Coronary Arterial Lesions, *Annals of the New York Academy of Sciences*, Volume 598, pp. 66-70.

Nakamura M. (1990): Experimental Production of Intramural Hemorrhage by Induced Coronary Artery Spasm in Atherosclerotic Miniature Swine, *Annals of the New York Academy of Sciences*, Volume 598, pp. 86-90.

Nelson L., Esler M.D., Jennings G.L., Korner P.I. (1986): Effect of Changing Levels of Physical Activity on Blood Pressure and Haemodynamics in Essential Hypertension, *Lancet*, II, Saturday 30 August, pp. 473-476.

Nikkila E.A. (1986): Lipoproteins and Progression of Coronary Artery Disease, In: N.H. Fidge, P.J. Nestel (Eds.): *Atherosclerosis VII*, Proceedings of the Seventh International Symposium on Atherosclerosis and the 7th Scientific Committee of the National Heart Foundation of Australia, Melbourne, 6-10 October 1985, Elsevier Science Publishers, Amsterdam, International Congress Series No. 696, pp. 85-88.

Northoff H., Berg A. (1993): Strenuous Exercise and Cytokine Reaction, *Presented in the Second International Heinz Nixdorf Symposium on Applied Immunology: Exercise and Sports*, 15 October 1993, Paderborn, Germany.

ODES Investigators (1993): The Oslo Diet and Exercise Study (ODES): Design and Objectives, *Controlled Clinical Trials*, Volume 14, pp. 229-243.

Ohri V.C., Chatterji J.C., Das B.K., Akhtar M., Tewari S.C., Bhattacharji P., Behl A. (1983): Effect of Submaximal Exercise on Haematocrit, Platelet Count, Platelet Aggregation and Blood Fibrinogen Levels, *Journal of Sports Medicine and Physical Fitness*, Volume 23, Number 2, pp. 127-130.

Olsson A.G., Erikson U., Helmius G., Hemmingsson A., Holme I., Ruhn G. (1986): The Effect of Pronounced Serum Lipid Lowering for One Year on the Development of Femoral Atherosclerosis in Asymptomatic Hyperlipoproteinemia, In: N.H. Fidge, P.J. Nestel (Eds.): *Atherosclerosis VII*, Proceedings of the Seventh International Symposium on Atherosclerosis and the 7th Scientific Committee of the National Heart Foundation of Australia, Melbourne, 6-10 October 1985, Elsevier Science Publishers, Amsterdam, International Congress Series No. 696, pp. 89-93.

Ornish D., Brown S.E., Schwerwitz L.W., Billings J.H., Armstrong W.T., Ports T.A., McLanahan S.M., Kirkeeide R.L., Brand R.J., Gould K.L. (1990): Can Lifestyle Changes Reverse Coronary Heart Disease?, *Lancet*, Volume 336, pp. 129-133.

Ortega E. (1993): Influence of Exercise on Phygocytosis, *Presented in the Second International heinz Nixdorf Symposium on Applied Immunology: Exercise and Sports*, 15 October 1993, Paderborn, Germany.

Osterud B., Olsen J.O., Wilsgard L. (1989): Effect of Strenuous Exercise on Blood Monocytes and Their Relation to Coagulation, *Medicine and Science in Sports and Exercise*, Volume 21, Number 4, pp. 374-378.

Paffenbarger R.S., Hyde R.T., Wing A.L., Lee I., Jung D., Kampert J.B. (1993): the Association of Changes in Physical-Activity Level and Other Lifestyle Characteristics With Mortality Among Men, *New England Journal of Medicine*, Volume 328, Number 8, pp. 538-545.

Perry A.C., Shaw M.H., Hsia L., Nash M.S., Kaplan T., Signorile J.F., Appleyate B. (1992): Plasma Lipid Levels in Active and Sedentary Premenopausal Females, *International Journal of Sports Medicine*, Volume 13, pp.210-215.

Rainville S., Vaccaro P. (1984): The Effects of Menopause and Training on Serum Lipids, *International Journal of Sports Medicine*, Volume 5, pp. 137-141.

Ready A.E., Fitzpatrick D.W., Boreskie S.L., Hrycaiko W. (1991): The Response of Obese Females to Low Impact Exercise and Diet Counselling, *Journal of Sports Medicine and Physical Fitness*, Volume 31, Number 4, pp. 587-595.

Reggiani E., Bertolini S., Chiodini G., Elicio N., Montanari D., Valice S., Zannini G., Baruzzo D., Montagna G., Pistocchi G., Lassa G., Croce S. (1984): Effects of Physical Activity and Diet on Lipemic Risk Factors For Atherosclerosis in Women, *International Journal of Sports Medicine*, Volume 5, pp. 183-186.

Röcker L., Drygas W.K., Heyduck B. (1986): Blood Platelet Activation and Increase in Thrombin Activity Following a Marathon Race, *European Journal of Applied Physiology*, Volume 55, pp. 374-380.

Röcker L., Taenzer M., Drygas W.K., Lill H., Heyduck B., Altenkirch H.U. (1990): Effect of Prolonged Physical exercise on the Fibrinolytic System, *European Journal of Applied Physiology*, Volume 60, pp. 478-481.

Roman O., Camuzzi A.L., Villalón E., Klenner C. (1981): Physical Training Program in Arterial Hypertension, *Cardiology*, Volume 67, pp. 230-243.

Ross R. (1986): The Pathogenesis of Atherosclerosis-An Update, *New England Journal of Medicine*, Volume 314, Number 8, pp. 488-500.

Ross R., Masuda J., Raines E.W. (1990): Cellular Interactions, Growth factors, and Smooth Muscle Cell Proliferation in Atherogenesis, *Annals of the New York Academy of Sciences*, Volume 598, pp. 102-124.

Rowland T.W. (1990): *Exercise and Children's Health*, Human Kinetics Publishers, Champaign, Illinois.

Sady S.P., Cullinane E.M., Herbert P.N., Kantor M.A., Thompson P.D. (1984): Training, Diet and Physical Characteristics of Distance Runners with Low or High Concentrations of High Density Lipoprotein Cholesterol, *Atherosclerosis*, Volume 53, pp. 273-281.

Sallis J.F., Patterson T.L., Buono M.J., Nader P.R. (1988): Relation of Cardiovascular Fitness and Physical Activity to Cardiovascular Disease Risk Factors in Children and Adults, *American Journal of Epidemiology*, Volume 127, Number 5, pp. 933-941.

Sasaki B.Y., Urata H., Tanabe Y., Kinoshita A., Tanaka H., Shindo M., Arakawa K. (1989): Mild Exercise Therapy Increases Serum High Density Lipoprotein$_2$ Cholesterol Levels in Patients with Essential Hypertension, *American Journal of Medical Sciences*, Volume 4, pp. 220-223.

Savage M.P., Petratis M.M., Thomson W.H., Berg K., Smith J.L., Sady S. (1986): Exercise Training Effects on Serum Lipids of Prepubescent Boys and Adult Men, *Medicine and Science in Sports and Exercise*, Volume 18, Number 2, pp. 197-204.

Schriewer H., Günnewig V., Assmann G. (1983): Effect of 10 Weeks Endurance Training on the Concentration of Lipids and Lipoproteins as well as on the Composition of High Density Lipoproteins in Blood Serum, *International Journal of Sports Medicine*, Volume 4, pp. 109-115.

Seip R.L., Moulin P., Cocke T., Tall A., Mankowitz K., Semenkovich C.F., Ostlund R., Schonfeld G. (1993): Exercise Training Decreases Plasma Cholesteryl Ester Transfer Protein, *Arteriosclerosis and Thrombosis*, Volume 13, Number 9, pp. 1359-1367.

Shepard R.J., Rhind S., Shek P.N. (1993): Response to Exercise and Training: NKCells, Interleukin-1, Interleukin-2 and Receptor Structures, *Presented in the Second International Heinz Nixdorf Symposium on Applied Immunology: Exercise and Sports*, 15 October 1993, Paderborn, Germany.

Singh R.B., Rastogi S.S., Ghosh S., niaz M.A., Singh N.K. (1993): The Diet and Moderate Exercise Trial (DAMET): Results After 24 Weeks, *Acta Cardiologica*, Vol XLVIII, Number 3, pp. 543-557.

Smutok M.A., Reece C., Kokkinos P.F., Farmer C., Dawson P., Shulman R., DeVane-Bell J., Patterson J., Charabogos C., Goldberg A.P., Hurley B.F. (1993): Aerobic Versus Strength Training for Risk Factor Intervention in Middle-Aged Men at High Risk for Coronary Heart Disease, *Metabolism*, Volume 42, Number 2, pp. 177-184.

Steinberg D. (1990): Arterial Metabolism of Lipoproteins in Relation to Atherogenesis, *Annals of the New York Academy of Sciences*, Volume 598, pp. 125-135.

Steinberg D., Parthasarathy S., Carew T.E., Khoo J.C., Witztum J.L. (1989): Beyond Colesterol, Modifications of Low-Density Lipoprotein That Increase Its Atherogenicity, *New England Journal of Medicine*, Volume 320, Number 14, pp. 915-924.

Stewart K.J. (1992): Weight Training in Coronary Artery Disease and Hypertension, *Progress in Cardiovascular Diseases*, Volume, XXXV, Number 2, pp. 159-168.

Stucchi A.F., Terpstra A.H., Foxall T.L., Nicolosi R.J., Smith S.C. (1991): The Effect of Exercise on Plasma Lipids and LDL Subclass Metabolism in Miniature Swine, *Medicine and Science in Sports and Exercise*, Volume 23, Number 5, pp. 552-561.

Sueishi K., Yasunaga C., Castellanos E., Kumamoto M., Tanaka K. (1990): Sustained Arterial Injury and Progression of Atherosclerosis, *Annals of the New York Academy of Sciences*, Volume 598, pp. 223-231.

Sumiyoshi A., Asada Y. (1990): Vascular Injuries Induced by Materials Released from White Mural Thrombus and Hypercholesterolemia In Vivo, *Annals of the New York Academy of Sciences*, Volume 598, pp. 248-255.

Suter E., Hawes M.R. (1993): Relationship of Physical Activity, Body Fat, Diet, and Blood Lipid Profile in Youths 10-15 Yr, *Medicine and Science in Sports and Exercise*, Volume 25, Number 6, pp. 748-754.

Suter E., Tschopp A., Wanner H.U., Wenk C., Gutzwiller F. (1990): Effects of Self-Monitored Jogging on Physical Fitness, Blood Pressure and Serum Lipids: A Controlled Study in Sedentary Middle-Aged Men, *International Journal of Sports Medicine*, Volume 11, pp. 425-432.

Sutherland W.H.F., Stapely S.A., Robertson M.C., Nye E.R. (1993): Plasma Cholesterol Ester Transfer Protein and Distribution of Cell Cholesterol Among Plasma Lipoproteins In Vitro in Distance Runners and Sedentary Men, *Clinical Physiology*, Volume 13, pp. 143-151.

Tanabe Y., Sasaki J., Urata H., Kiyonaga A., Tanaka H., Shindo M., Arakawa K. (1988): Effect of Mild Aerobic Exercise on Lipid and Apolipoprotein Levels in Patients with Essential Hypertension, *Japanese Heart Journal*, Volume 29, Number 2, pp. 199-206.

Tell G.S., Vellar O.D. (1988): Physical Fitness, Physical Activity, and Cardiovascular Disease Risk Factors in Adolescents: The Oslo Youth Study, *Preventive Medicine*, Volume 17, pp. 12-14.

Thomas T.R., Aderinian S.B., Etheridge G.L. (1984): Effects of Different Running Programs on VO2max, Percent Fat and Plasma Lipids, *Canadian Journal of Applied Sport Sciences*, Volume 9, pp. 55-62.

Tran Z.V., Weltman A. (1985): Differential Effects of Exercise on Serum Lipid and Lipoprotein Levels Seen with Changes in Body Weight, *Journal of The American Medical Association*, Volume 254, Number 7, pp. 919-924.

Tran Z.V., Weltman A., Glass G.V., Mood D.P. (1983): The Effects of exercise on Blood Lipids and Lipoproteins: A Meta-Analysis of Studies, *Medicine and Science in Sports and Exercise*, Volume 15, Number 5, pp. 393-402.

Tremblay A., Després J.P., Maheux J., Pouliot M.C., Nadeau A., Moorjani S., Lupien P.J., Bouchard C. (1991): Normalization of the Metabolic Profile in Obese Women by Exercise and a Low Fat Diet, *Medicine and Science in Sports and Exercise*, Volume 23, Number 12, pp. 1326-1331.

Tuomilehto J., Marti B., Salonen J.T., Virtala E., Lahti T., Puska P. (1987): Leisure-Time Physical Activity is Inversely Related To Risk Factors For Coronary Heart Disease in Middle-Aged Finnish Men, *European Heart Journal*, Volume 8, pp. 1047-1055.

Vaccaro P., Mahon A.D. (1989): The Effects of Exercise on Coronary Heart Disease Risk Factors in Children, *Sports Medicine*, Volume 8, Number 13, pp. 139-153.

Välimaki I., Hursti M.L., Pihlakoski L., Viikari J. (1980): Exercise Performance and Serum Lipids in Relation to Physical Activity in Schoolchildren, *International Journal of Sports Medicine*, Volume 1, pp. 132-136.

Wallace M.B., Moffatt R.J., Haymes E.M., Green N.R. (1991): Acute Effects of Resistance Exercise on Parameters of Lipoprotein Metabolism, *Medicine and Science in Sports and Exercise*, Volume 23, Number 2, pp. 199-204.

Weintraub M.S., Rosen Y., Otto R., Eisenberg S., Breslow J.L. (1989): Physical Exercise Conditioning in the Absence of Weight Loss Reduces Fasting and Postprandial Triglyceride-Rich Lipoprotein Levels, *Circulation*, Volume 79, Number 5, pp. 1007-1014.

Weltman A., Matter S., Stamford B.A. (1980): Caloric Restriction and/or Mild Exercise: Effects on Serum Lipids and Body Composition, *American Journal of Clinical Nutrition*, Volume 33, pp. 1002-1009.

Wheeler M.E., Davis G.L., Gillespie W.J., Bern M.M. (1986): Physiological Changes in Hemostasis Associated with Acute Exercise, *Journal of Applied Physiology*, Volume 60, Number 3, pp. 986-990.

Williams P.T., Krauss R.M., Vranizan K.M., Albers J.J., Terry R.B., Wood P.D.S. (1989): effects of Exercise Induced Weight Loss on Low Density Lipoprotein Subfractions in Healthy Men, *Arteriosclerosis*, Volume 9, pp. 623-632.

Williams S.R., Logue E.E., Lewis J.L., Barton T., Stead N.W., Wallace A.G., Pizzo S.V. (1983): Physical Conditioning Augments the Fibrinolytic Response to Venous Occlusion in Healthy Adults, *New England Journal of Medicine*, Volume 302, Number 18, pp. 987-991.

Williford H.N., Blessing J.M., Barksdale J.M., Smith F.H. (1988): The Effects of Aerobic Dance Training on Serum Lipids, Lipoproteins and Cardiopulmonary Function, *Journal of Sports Medicine and Physical Fitness*, Volume 28, Number 2, pp. 151-157.

Wilmore J.H., McNamara J.J. (1974): Prevalence of Coronary Heart Disease Risk Factors in Boys, 8 to 12 Years of Age, *Journal of Pediatrics*, Volume 84, Number 4, pp. 527-533.

Wissler R.W. (1980): Priciples of the Pathogenesis of Atherosclerosis, In: E. Braunwald (Ed.): *Heart Disease, A Textbook of Cardiovascular Medicine*, Volume 2, W.B. Saunders Company, USA, pp. 1221-1245.

Wood P.D., Haskell W.L., Blair S.N., Williams P.T., Krauss R.M., Lindgren F.T., Albers J.J., Ho P.H., Farquhar J.W. (1983): Increased Exercise Level and Plasma Lipoprotein Concentrations: A One-Year Randomized Controlled Study in Sedentary Middle-Aged Men, *Metabolism*, Volume 32, Number 1, pp. 31-39.

Wood P.D., Stefanick M.L (1990): Exercise, Fitness and Atherosclerosis, In: C. Bouchard, R.J. Shephard, T. Stephens, J.R. Sutton, B.D. McPherson (Eds.): *Exercise, Fitness and Health: A Consensus of Current Knowledge*, Human Kinetics Publishers, Champaign, Illinois, pp.409-423.

Wood P.D., Stefanick M.L., Williams P.T., Haskell W. (1991): The Effects on Plasma Lipoproteins of a Prudent Weight-Reducing Diet With or Without Exercise, in Overweight Men and Women, *New England Journal of Medicine*, Volume 325, pp. 461-466.

Ylä-Herttuala S. (1991): Biochemistry of the Arterial Wall in Developing Atherosclerosis, *Annals of the New York Academy of Sciences*, Volume 623, pp. 40-59.

Yoshida Y., Sue W., Okano M., Oyama T., Yamane T., Mitsumata M. (1990): *Annals of the New York Academy of Sciences*, Volume 598, pp. 256-273.

Young J.C., Ruderman N.B. (1993): Exercise and Metabolic Disorders, In: J.R. Poortmans (Ed.): *Principles of Exercise Biochemistry*, Medicine and Sport Science Series, Volume 38, Basel, Karger, 2nd Edition, pp. 269-298.

## References for Chapter 4

Ainsworth B.E., Haskell W.L., Leon A.S., Jacobs D.R., Montoye H.J., Sallis J.F., Paffenbarger R.S. (1993): Compendium of Physical Activities: Classification of Energy Costs of Human Physical Activities, *Medicine and Science in Sports and Exercise*, Volume 25, Number 1, pp. 71-80.

Ballor D.L., McArthy J.P., Wilterdink E.J. (1990): Exercise Intensity does not Affect the Composition of Diet- and Exercise-Induced Body Mass Loss, *American Journal of Clinical Nutrition*, Volume 51, pp. 142-146.

Becque M.D., Katch V.L., Rocchini A.P., Marks C.R., Moorehead C. (1988): Coronary Risk Incidence of Obese Adolescents: Reduction by Exercise Plus Diet Intervention, *Pediatrics*, Volume 81, Number 5, pp. 605-612.

Belko A.Z., Barbieri T.F., Wong E.C. (1986): Effect of Energy and Protein Intake and Exercise Intensity on the Thermic Effect of Food, *American Journal of Clinical Nutrition*, Volume 43, pp. 863-869.

Bell R.D., Máček M., Rutenfranz J., Saris W.H.M. (1986): Health Indicators and Risk Factors of Cardiovascular Diseases During Childhood and Adolescence, In: J. Rutenfranz, R. Mocellin, F. Klint, (Eds.): *Children and Exercise XII*, Volume 17, Human Kinetics Publishers, Champaign, Illinois, pp. 19-27.

Blaak E.E., Westerterp K.R., Bar-Or O., Wouters L.J.M., Saris W.H.M. (1992): Total Energy Expenditure and Spontaneous Activity in Relation to Training in Obese Boys, *American Journal of Clinical Nutrition*, Volume 55, pp. 777-782.

Blackman L., Hunter G., Hilyer J., Harrison P. (1988): The Effects of Dance Team Participation on Female Adolescent Physical Fitness and Self-Concept, *Adolescence*, Volume XXIII, Number 90, pp. 437-448.

Boileau R.A., Buskirk E.R., Horstman D.H., Mendez J., Nicholas W.C. (1971): Body Composition Changes in Obese and Lean Men during Physical Conditioning, *Medicine and Science in Sports*, Volume 3, Number 4, pp. 183-189.

Bouchard C., Shephard R.J., Stephens T. (1993): *Physical Activity Fitness and Health: Consensus Statement*, Human Kinetics Publishers, Champaign, Illinois.

Bray G.A. (1983): Metabolic Response to Positive Energy Balance, In: Hansen B.C.: *Controversies in Obesity*, Endocrinology and Metabolism Series, Volume 5, Praeger Publishers, New York, pp. 3-14.

Bray G.A., Whipp B.J., Koyar S.N. (1974): The Acute Effects of Food Intake on Energy Expenditure During Cycle Ergometry, *American Journal of Clinical Nutrition*, Volume 27, pp. 254-259.

Broeder C.E., Burrhus K.E., Svanevic L.S., Wilmore J.H. ($1992_a$): The Effects of Aerobic Fitness on Resting Metabolic Rate, *American Journal of Clinical Nutrition*, Volume 55, pp. 795-801.

Broeder C.E., Burrhus K.E., Svanevic L.S., Wilmore J.H. ($1992_b$): The Effects of High Intensity Resistance or Endurance Training on Resting Metabolic Rate, *American Journal of Clinical Nutrition*, Volume 55, pp. 802-810.

Brouns F., Saris W.H.M., Stroecken J., Beckers E., Thijssen R., Rehrer N.J., ten Hoor F. (1989): Eating, Drinking and Cycling. A Controlled Tour de France Simulation Study, Part I, *International Journal of Sports Medicine*, Volume 10, pp. S32-S40.

Brownell K.D., Kaye F.S. (1982): A School-Based Behavior Modification, Nutrition Education and Physical Activity Program for Obese Children, *American Journal of Clinical Nutrition*, Volume 35, pp. 277-283.

Bryant J.G., Garrett H.L., Dean Mostafa M.S. (1984): The Effects of an Exercise Program on Selected Risk Factors to Coronary Heart Disease in Children, *Social Science and Medicine*, Volume 19, Number 7, pp. 765-766.

Calles-Escandón J., Horton E.S. (1992): The Thermogenic Role of Exercise in the Treatment of Morbid Obesity: A Critical Evaluation, *American Journal of Clinical Nutrition*, Volume 55, pp. 533S-537S.

Cohen C.H., McMillan C., Samuelson D.R. (1991): Long-Term Effects of a Lifestyle Modification Exercise Program on the Fitness of Sedentary Obese Children, *Journal of Sports Medicine and Physical Fitness*, Volume 31, Number 2, pp. 183-188.

Cowan M.M., Gregory L.W. (1985): Responses of Pre and Postmenopausal Females to Aerobic Conditioning, *Medicine and Science in Sports and Exercise*, Volume 17, Number 1, pp. 138-143.

Danforth E., Sims J.A.H., Sims E.A.H. (1983): Thermic Effect of Overfeeding: Role of Thyroid Hormones, Catecholamines and Insulin Resistance, In: A. Angel, C.H. Hollenberg, D.A.K. Ronkari (Eds.): *The Adipocyte and Obesity: Cellular and Molecular Mechanisms*, Raven Press, New York, pp. 271-282.

Dausch J.G. (1992): The Problem of Obesity: Fundamental Concepts of Energy Metabolism Gone Awry, *Critical Reviews in Food Science and Nutrition*, Volume 31, Number 4, pp. 271-298.

Després J.P., Bouchard C., Tremblay A., Savard R., Marcotte M. (1985): Effects of Aerobic Training on Fat Distribution in Male Subjects, *Medicine and Science in Sports and Exercise*, Volume 17, Number 1, pp. 113-118.

Després J.P., Pouliot M.C., Moorjani S., Nadeau A., Tremblay A., Lupien P.J., Thériault G., Bouchard C. (1991): Loss of Abdominal Fat and Metabolic Response to Exercise Training in Obese Women, *American Journal of Physiology*, Volume 261, pp. E159-E167.

Després J.P., Tremblay A., Nadeau A., Bouchard C (1988): Physical Training and Changes in Regional Adipose Tissue Distribution, *Acta Medica Scandinavica*, Supplement 723, pp. 205-212.

Deveaux K.F., Bell R.D., Laxdal V.A. (1986): The Effects of a Season of Competitive Soccer on the Serum Lipid and Lipoprotein Cholesterol Profile of Adolescent Boys, In: J. Rutenfranz, R. Mocellin, F. Klint (Eds.): *Children and Exercise XII*, Volume 17, Human kinetics Publishers, Champaign, Illinois, pp. 173-183.

Emes C., Velde B., Moreau M., Murdoch D.D., Trussell R. (1990): An Activity Based Weight Control Program, *Adapted Physical Education Quarterly*, Volume 7, pp. 314-324.

Epstein L.H., Wing R.R., Koeske R., Ossip D., Beck S. (1982): A Comparison of Lifestyle Change and Programmed Aerobic Exercise on Weight and Fitness Changes in Obese Children, *Behavior Therapy*, Volume 13, 651-665.

Epstein L.H., Wing R.R., Koeske R., Valoski A. (1984): Effects of Diet Plus Exercise on Weight Change in Parents and Children, *Journal of Consulting and Clinical Psychology*, Volume 52, Number 3, pp. 429-437.

Epstein L.H., Wing R.R., Koeske R., Valoski A. (1985): A Comparison of Lifestyle Exercise, Aerobic Exercise and Calisthenics on Weight Loss in Obese Children, *Behavior Therapy*, Volume 16, pp. 345-356.

Epstein L.H., Wing R.R., Penner B.C., Kress M.J. (1985): Effect of Diet and Controlled Exercise on Weight Loss in Obese Children, *Journal of Pediatrics*, Volume 107, Number 3, pp. 358-361.

Flatt J.P. (1987): Dietary Fat Carbohydrate Balance and Weight Maintenance: Effects of Exercise, *American Journal of Clinical Nutrition*, Volume 45, pp. 296-306.

Gettman L.R., Ayres J.J., Pollock M.L., Jackson A. (1978): The Effect of Cirquit Weight Training on Strength, Cardiorespiratory Function and Body Composition of Adult Men, *Medicine and Science in Sports*, Volume 10, Number 3, pp. 171-176.

Gettman L.R., Ward P., Hagan R.D. (1982): A Comparison of Combined Running and Weight Training with Cirquit Weight Training, *Medicine and Science in Sports and Exercise*, Volume 14, Number 3, pp. 229-234.

Gilbert J.A., Misner J.A (1993): Failure to Find Increased TEM at Rest and During Exercise in Aerobically Trained and Resistance Trained Subjects, *International Journal of Sport Nutrition*, Volume 3, pp. 55-66.

Gilliam T.B., Freedson P.S. (1980): Effects of a 12-week School Physical Fitness Program on Peak $VO_2$, Body Composition and Blood Lipids in 7 to 9 Year Old Children, *International Journal of Sports Medicine*, Volume 1, pp. 73-78.

Goben K.W., Sforzo G.A., Frye P.A. (1992): Exercise Intensity and the Thermic Effect of Food, *International Journal of Sport Nutrition*, Volume 2, pp. 87-95.

Grilo C.M., Pogue-Geile M.F. (1991): The Nature of Environmental Influences on Weight and Obesity: A Behavior Genetic Analysis, *Psychological Bulletin*, Volume 110, Number 3, pp. 520-537.

Hammer R.L., Barrier C.A., Roundy E.S., Bradford J.M., Fisher A.G. (1989): Calorie-Restricted Low-Fat Diet and Exercise in Obese Women, *American Journal of Clinical Nutrition*, Volume 49, pp. 77-85.

Henson L.C., Poole D.C., Donahoe C.P., Heber D. (1987): Effects of Exercise Training on Resting Energy Expenditure during Caloric Restriction, *American Journal of Clinical Nutrition*, Volume 46, pp. 893.899.

Heymsfield S.B., Casper K., Hearn J., Guy D. (1989): Rate of Weight Loss During Underfeeding: Relation to level of Physical Activity, *Metabolism*, Volume 38, No 3, pp. 215-223.

Hill J.O., Sparling P.B., Shieds T.W., Heller P.A. (1987): Effects of Exercise and Food Restriction on Body Composition and Metabolic Rate in Obese Women, *American Journal of Clinical Nutrition*, Volume 46, pp. 622-630.

Hills G.P. (1991): Effects of Exercise and Diet on the Body Composition of Pre-pubertal Children, *Journal of Physical Education and Sports Sciences*, July, pp. 22-26.

Himms-Hagen J. (1983): Role of Thermogenesis in Brown Adipose Tissue in the Regulation of Energy Balance, In: A. Angel, C.H. Hollenberg,, D.A.K. Ronkari (Eds.): *The Adipocyte and Obesity: Cellular and Molecular Mechanisms*, Raven Press, New York, pp. 259-270.

Hinkleman L.L., Nieman D.C. (1993): The Effects of a Walking Program on Body Composition and Serum Lipids and Lipoproteins in Overweight Women, *Journal of Sports Medicine and Physical Fitness*, Volume 33, Number 1, pp. 49-58.

Horton E.S. (1989): Metabolic Fuels, Utilization and Exercise, *American Journal of Clinical Nutrition*, Volume 49, pp. 931-937.

Hunter G., Demment R., Miller D. (1987): Development of Strength and Maximum Oxygen Uptake during Simultaneous Training for Strength and Endurance, *Journal of Sports Medicine and Physical Fitness*, Volume 27, Number 3, pp. 269-275.

Janssen G.M.E., Graef C.J.J., Saris W.H.M. (1989): Food Intake and Body Composition of Novice Athletes During a Training Period to Run a Marathon, *International Journal of Sports Medicine*, Volume 10, pp. S17-S21.

Jéquier E. (1987): Energy Utilization in Human Obesity, *Annals of the New York Academy of Sciences*, Volume 499, pp. 73-83.

Kafatos A., Apostolaki I., Kantidaki E., Lionis C. (1991): Dietary Habits of Cretan Children during the School Hours, *Paediatriki*, Volume 54, pp. 10-25. Article in Greek.

Kanaley J.A., Andresen-Reid M.L., Oenning L., Kottke B.A., Jensen M.D. (1993): Differential Health Benefits of Weight Loss in Upper-Body and Lower-Body Obese Women, *American Journal of Clinical Nutrition*, Volume 57, pp. 20-26.

Katch V.L., Martin R., Martin J. (1979): Effects of Exercise Intensity on Food Consumption of the Male Rat, *American Journal of Clinical Nutrition*, Volume 32, pp. 1401-1407.

Katch V.L., Becque D.M., Marks C., Moorehead C., Rocchini A. (1988): Basal Metabolism of Obese Adolescents: Inconsistent Diet and Exercise Effects, *American Journal of Clinical Nutrition*, Volume 48, pp. 565-569.

Kelly J.M., Gorney B.A., Kalm K.K. (1978): The Effects of a Collegiate Wrestling Season on Body Composition, Cardiovascular Fitness and Muscular Strength and Endurance, *Medicine and Science in Sports*, Volume 10, Number 2, pp. 119-124.

Klisouras V. (1987): *Ergophysiology*, Kegraft Publishers, Athens. Text in Greek.

Kokkinos P.F., Hurley B.F., Smutok M.A., Farmer C., Reece R., Shulman R., Charabogos C., Patterson J., Will S., DeVane-Bell J., Goldberg A.P. (1991): Strength Training does not Improve Lipoprotein-Lipid Profiles in Men at High Risk for CHD, *Medicine and Science in Sports and Exercise*, Volume 23, Number 10, pp. 1134-1139.

Krotkiewski M. (1988): Can Body Fat Patterning Be Changed?, *Acta Medica Scandinavica*, Supplement 723, pp. 213-223.

Labbé E.E., Welsh C. (1993): Children and Running: Changes in Physical Fitness, Self-efficacy and Health Locus of Control, *Journal of Sport Behavior*, Volume 16, Number 2, pp. 85-97.

LeBlanc J., Diamond P., Coté J., Labrie A. (1984): Hormonal Factors in Reduced Postprandial Heat Production of Exercise Trained Subjects, *Journal of Applied Physiology*, Volume 56, Number 3, pp. 772-776.

LeBlanc J., Mercier P., Samson P. (1984): Diet-Induced Thermogenesis with Relation to Training State in Female Subjects, *Canadian Journal of Physiology and Pharmacology*, Volume 62, pp. 334-337.

Leon A.S., Conrad J., Hunninghake D.B., Serfass R. (1979): *American Journal of Clinical Nutrition*, Volume 32, pp. 1776-1787.

Lerman R.H., Cave D.R. (1989): Medical and Surgical Management of Obesity, *Advances in Internal Medicine*, Volume 34, pp. 127-164.

Lohman T.G. (1992): *Advances in Body Composition Assessment*, Current Issues in Exercise Science Series, Monograph Number 3, Human Kinetics Publishers Champaign, Illinois.

Lukaski H.C. (1987): Methods for the Assessment of Human Body Composition: Traditional and New, *American Journal of Clinical Nutrition*, Volume 46, pp. 537-556.

Lundholm K., Holm G., Lindmark L., Larsson B., Sjöström L., Björntorp P. (1986): Thermogenic Effect of Food in Physically Well-Trained Elderly Men, *European Journal of Applied Physiology*, Volume 55, pp. 486-492.

Lussier L., Buskirk E.R. (1977): Effects of an Endurance Training Regimen on Assessment of Work Capacity in Prepubertal Children, *Annals of the New York Academy of Sciences*, Volume 301, pp. 734-741.

Marieb E.N. (1989): *Human Anatomy and Physiology*, The Benjamin/Cummings Publishing Company, Inc., USA.

Meijer G.A.L., Westerterp K.R., Seyts G.H.P., Janssen G.M.E., Saris W.H.M., Hoor ten F. (1991): Body Composition and Sleeping Metabolic Rate in Response to a 5-Month Endurance-Training Programme in Adults, *European Journal of Applied Physiology*, Volume 62, pp. 18-21.

Meleski B.W., Malina R.M. (1985): Changes in Body Composition and Physique of Elite University Level female Swimmers during a Competitive Season, *Journal of Sports Sciences*, Volume 3, pp. 33-40.

Milesis C.A., Pollock M.L., Bah M.D., Ayres J.J., Ward A., Linnerud A.C. (1976): Effects of Different Durations of Physical Training on Cardiorespiratory Function, Body Composition and Serum Lipids, *Research Quarterly*, Volume 47, Number 4, pp. 716-725.

Miller W.C., Eggert K.A., Wallace J.P., Lindeman A.K., Jastremski C. (1993): Successful Weight Loss in a Self-Taught, Self-Administered Program, *International Journal of Sports Medicine*, Volume 14, pp. 401-405.

Molé P.A., Stern J.S., Schultz C.L., Bernauer E.M., Holcomb B.J. (1989): Exercise Reverses Depressed Metabolic Rate Produced by Severe Caloric Restriction, *Medicine and Science in Sports and Exercise*, Volume 21, Number 1, pp. 29-33.

Nelson K.M., Weinsier R.L., James L.D., Darnell B., Hunter G., Long C.L. (1992): Effect of Weight Reduction on Resting Energy Expenditure, Substrate Utilization and the Thermic Effect of Food in Moderately Obese Women, *American Journal of Clinical Nutrition*, Volume 55, pp. 924-933.

Newsholme E.A. (1988): Effects of Exercise on Aspects of Carbohydrate, Fat and Amino Acid Metabolism, In: C. Bouchard, R.J. Shephard, T. Stephens, J.R. Sutton, B.D. McPherson (Eds.): *Exercise, Fitness and Health: A Consensus of Current Knowledge*, Human Kinetics Publishers, Champaign, Illinois, pp. 293-308.

Nichols J., Ross S., Patterson P. (1988): Thermic Effect of Food at Rest and Following Swim Exercise in Trained College Men and Women, *Annals of Nutrition and Metabolism*, Volume 32, pp. 215-219.

Nieman D.C., Haig J.L., Guia de E.D., Grace P.D., Register U.D. (1988): Reducing Diet and Exercise Effects on Resting Metabolic Rates in Mildly Obese Women, *Journal of Sports Medicine and Physical Fitness*, Volume 28, Number 1, pp. 79-88.

Pavlou K.N., Krey S., Steffee W. (1989): Exercise as an Adjunct to Weight Loss and Maintenance in Moderately Obese Subjects, *American Journal of Clinical Nutrition*, Volume 49, pp. 1115-1123.

Pavlou K.N., Whatley J.E., Jannace P.W., DiBartolomeo J.J., Burrows B.A., Duthie E.A.M., Lerman R.H. (1989): Physical Activity as a Supplement to a Weight Loss Dietary Regimen, *American Journal of Clinical Nutrition*, Volume 49, pp. 1110-1114.

Pi-Sunyer F.X., Woo R. (1985): Effect of Exercise on Food Intake in Human Subjects, *American Journal of Clinical Nutrition*, Volume 42, pp. 983-990.

Poehlman E.T. (1989): A Review: Exercise and its Influence on Resting Energy Metabolism in Man, *Medicine and Science in Sports and Exercise*, Volume 21, Number 5, pp. 515-525.

Poehlman E.T., Melby C.L., Badylak S.F. (1988): Resting Metabolic Rate and Postprandial Thermogenesis in Highly Trained and Untrained Males, *American Journal of Clinical Nutrition*, Volume 47, pp. 793-798.

Poehlman E.T., Melby C.L., Badylak S.F., Calles J. (1989): Aerobic Fitness and Resting Energy Expenditure in Young Adult Males, *Metabolism*, Volume 38, pp. 85-90.

Pochlman E.T., Tremblay A., Nadeau A., Dussault J., Thériault G., Bouchard C. (1986): Heredity and Changes in Hormones and Metabolic Rates with Short-Term Training, *American Journal of Physiology*, Volume 250, pp. E111-E717.

Pollock M.L., Dimmick J., Miller H.S., Kendrick J.R.Z., Linnerud A.C. (1975): Effects of Mode of Training on Cardiovascular Function and Body Composition of Adult Men, *Medicine and Science in Sports*, Volume 7, Number 2, pp. 139-145.

Pollock M.L., Cureton T.K., Greninger L (1969): Effects of Frequency of Training on Working Capacity, Cardiovascular Function, and Body Composition of Adult Men, *Medicine and Science in Sports*, Volume 1, Number 2, pp. 70-74.

Ramsay J.A., Blimkie C.J.R., Smith K., Garner S., MacDougall J.D., Sale D.G. (1990): Strength Training Effects in Prepubescent Boys, *Medicine and Science in Sports and Exercise*, Volume 22, Number 5, pp. 605-614.

Ravussin E., Bogardus C. (1989): Relationship of Genetics, Age and Physical Fitness to Daily Energy Expenditure and Fuel Utilization, *American Journal of Clinical Nutrition*, Volume 49, pp. 968-975.

Ready A.E., Fitzpatrick D.W., Boreskie S.L., Hrycaiko W. (1991): The Response of Obese Females to Low Impact Exercise and Diet Counselling, *Journal of Sports Medicine and Physical Fitness*, Volume 31, Number 4, pp. 587-595.

Reybrouck T., Vinckx J., Berghe van den G., Vanderschueren-Lodeweyckx M. (1990): Exercise Therapy and Hypocaloric Diet in the Treatment of Obese Children and Adolescents, *Acta Paediatrica Scandinavica*, Volume 79, pp. 84-89.

Rocchini A.P., Katch V.L., Anderson J., Hinderliter J., Becque M.D., Martin M., Marks C. (1988): Blood Pressure in Obese Adolescents: Effect of Weight Loss, *Pediatrics*, Volume 82, Number 1, pp. 16-23.

Rosenbaum M., Leibel R.L. (1988): Pathophysiology of Childhood Obesity, *Advances in Pediatrics*, Volume 35, pp. 73-138.

Ross R., Léger L., Martin P., Roy R. (1989): Sensitivity of Bioelectrical Impedance to Detect Changes in Human Body Composition, *Journal of Applied Physiology*, Volume 67, Number 4, pp. 1643-1648.

Rowland T.W. (1990): *Exercise and Children's Health*, Human Kinetics Publishers, Champaign, Illinois.

Schaberg-Lorei G., Ballard J.E., McKeown B.C., Zinkgraf S.A. (1990): Body Composition Alterations Consequent to an Exercise Program for Pre and Postmenopausal Women, *Journal of Sports Medicine and Physical Fitness*, Volume 30, Number 4, pp. 426-433.

Schwartz R.S., Shuman W.P., Larson V., Cain K.C., Fellingham G.W., Beard J.C., Kahn S.E., Stratton J.R., Cerqueira M.D., Abrass I.B. (1991): The Effect of Intensive Endurance Exercise Training on Body Fat Distribution in Young and Older Men, *Metabolism*, Volume 40, Number 5, pp. 545-551.

Segal K.R., Gutin B. (1983): Thermic Effects of Food and Exercise in Lean and Obese Women, *Metabolism*, Volume 32, Number 6, pp. 581-589.

Segal K.R., Gutin B., Nyman A.M., Pi-Sunyer F.X. (1985): Thermic Effect of Food at Rest, during Exercise and after Exercise in Lean and Obese Men of Similar Body Weight, *Journal of Clinical Investigation*, Volume 76, pp. 1107-1112.

Segal K.R., Presta E., Gutin B. (1984): Thermic Effect of Food during Graded Exercise in Normal Weight and Obese Men, *American Journal of Clinical Nutrition*, Volume 40, pp. 995-1000.

Seltzer C.C., Mayer J. (1970): An Effective Weight Control Program in a Public School System, *American Journal of Public Health*, Volume 60, Number 4, pp. 679-689.

Smutok M.A., Reece C., Kokkinos P.F., Farmer C., Dawson P., Shulman R., DeVane-Bell J., Patterson J., Charabogos C., Goldberg A.P., Hurley B.F. (1993): Aerobic Versus Strength Training for Risk Factor Intervention in Middle-Aged Men at High Risk for Coronary Heart Disease, *Metabolism*, Volume 42, Number 2, pp. 177-184.

Staten M.A. (1991): The Effect of Exercise on Food Intake in Men and Women, *American Journal of Clinical Nutrition*, Volume 53, pp. 27-31.

Sweeney M.E., Hill J.O., Heller P.A., Baney R., DiGirolamo M. (1993): Severe vs Moderate Restriction with and without Exercise in the Treatment of Obesity: Efficiency of Weight Loss, *American Journal of Clinical Nutrition*, Volume 57, pp. 127-134.

Tagliaferro A.R., Kertzer R., Davis J.R., Janson C., Tse S.K. (1986): Effects of Exercise-Training on the Thermic Effect of Food and Body Fatness of Adult Women, *Physiology and Behavior*, Volume 38, pp. 703-710.

Thomas D.P., Belko A.Z., Mulroy G.L., Haas D.J., Roe D.A. (1986): Combined Effects of Exercise and Restriction of Energy Intake on Moderately Obese Women, *British Journal of Sports Medicine*, Volume 20, Number 2, pp. 84-88.

Thompson D.A., Wolfe L.A., Eikelboom R. (1988): Acute Effects of Exercise Intensity on Appetite in Young Men, *Medicine and Science in Sports and Exercise*, Volume 20, Number 3, pp. 222-227.

Thompson J.K., Jarvie G.J., Lahey B.B., Cureton K.J. (1982): Exercise and Obesity: Etiology Physiology and Intervention, *Psychological Bulletin*, Volume 91, Number 1, pp. 55-79.

Tremblay A., Coté J., LeBlanc J. (1983): Diminished Dietary Thermogenesis in Exercise-Trained Human Subjects, *European Journal of Applied Physiology*, Volume 52, pp. 1-4.

van Dale D., Saris W.H.M. (1989): Repetitive Weight Loss and Weight Regain: Effects on Weight Reduction, Resting Metabolic Rate and Lipolytic Activity Before and After Exercise and/or Diet Treatment, *American Journal of Clinical Nutrition*, Volume 49, pp. 409-416.

Wade C.E. (1976): Effects of a Season's Training on the Body Composition of Female College Swimmers, *Research Quarterly*, Volume 47, Number 2, pp. 292-295.

Walter H.J., Hofman A., Connelly P.A., Barrett L.T., Kost K.L. (1985): Primary Prevention of Chronic Disease in Childhood: Changes in Risk Factors after One Year of Intervention, *American Journal of Epidemiology*, Volume 122, Number 5, pp. 772-781.

Weltman A., Janney C., Rians C.B., Strand K., Berg B., Tippitt S., Wise J., Cahill B.R., Katch F.I. (1986): The Effects of Hydraulic Resistance Strength Training in Pre-Pubertal Males, *Medicine and Science in Sports and Exercise*, Volume 18, Number 6, pp. 629-638.

Weltman A., Matter S., Stamford B.A. (1980): Caloric Restriction and / or mild Exercise: Effects on Serum Lipids and Body Composition, *American Journal of Clinical Nutrition*, Volume 33, pp. 1002-1009.

Williford H.N., Blessing J.M., Barksdale J.M., Smith F.H. (1988): The Effects of Aerobic Dance Training on Serum Lipids, Lipoproteins and Cardiopulmonary Function, *Journal of Sports Medicine and Physical Fitness*, Volume 28, Number 2, pp. 151-157.

Wilmore J.H. (1983): Body Composition in Sport and Exercise: Directions for Future Research, *Medicine and Science in Sports and Exercise*, Volume 15, Number 1, pp. 21-31.

Wilmore J.H., Royce J., Girandola R.N., Katch F.I., Katch V.L. (1970): Body Composition Changes with a 10-Week Program of Jogging, *Medicine and Science in Sports*, Volume 2, Number 3, pp. 113-117.

Woo R., Garrow J.S., Pi-Sunyer F.X. ($1982_a$): Effect of Exercise on Spontaneous Calorie Intake in Obesity, *American Journal of Clinical Nutrition*, Volume 36, pp. 470-477.

Woo R., Garrow J.S., Pi-Sunyer F.X. ($1982_b$): Voluntary Food Intake During prolonged Exercise in Obese Women, *American Journal of Clinical Nutrition*, Volume 36, pp. 478-484.

Woo R., Pi-Sunyer F.X. (1984): Effect of Increased Physical Activity on Voluntary Intake in Lean Women, *American Journal of Clinical Nutrition*, Volume 39, p. 655.

Wood P.D., Haskell W.L., Blair S.N., Williams P.T., Krauss R.M., Lindgren F.T., Albers J.J., Ho P.H., Farquhar J.W. (1983): Increased Exercise Level and Plasma Lipoprotein Concentrations: A One-Year Randomized Controlled Study in Sedentary Middle-Aged Men, *Metabolism*, Volume 32, Number 1, pp. 31-39.

Young J.C., Ruderman N.B. (1993): Exercise and Metabolic Disorders, In: J.R. Poortmans (Ed.): *Principles of Exercise Biochemistry*, Medicine and Sport Science Series, Volume 38, Basel, Karger, 2nd Edition, pp. 269-298.

## References for Chapter 5

Adams R.S. (1963): Two Scales for Measuring Attitude Toward Physical Education, *Research Quarterly*, Volume 34, Number 1, pp. 91-94.

Biddle S. (1992): Sport and Exercise Motivation: A Brief Review of Antecedent Factors and Psychological Outcomes of Participation, *Physical Education Review*, Volume 15, Number 2, pp. 98-110.

Brill P.A., Burkhalter H.E., Kohl H.W., Blair S.N. (1989): The Impact of Previous Athleticism on Exercise Habits, Physical Fitness, and Coronary Heart Disease Risk Factors in Middle-Aged Men, *Research Quarterly for Exercise and Sport*, Volume 60, Number 3, pp. 209-215.

Brodkin P., Weiss M.R. (1990): Developmental Differences in Motivation for Participating in Competitive Swimming, *Journal of Sport and Exercise Psychology*, Volume 12, pp. 248-263.

Burton D. (1988): The Dropout Dilemma in Youth Sports: Documenting the Problem and Identifying Solutions, In R.M. Malina (Ed.): *Young Athletes, Biological, Psychological and Educational Perspectives*, Human Kinetic Books, Champaign, Illinois, pp. 245-266.

Burton D., Martens R. (1986): Pinned by Their Own Goals: An Exploratory Investigation Into Why Kids Drop Out of Wrestling, *Journal of Sport Psychology*, Volume 8, pp. 183-197.

Dennison B.A., Straus J.H., Mellits E.D., Charney E. (1988): Childhood Physical Fitness Tests: Predictor of Adult Physical Activity Levels ?, *Pediatrics*, Volume 82, Number 3, pp. 324-330.

Dishman R.K. (1988): Supervised and Free-Living Physical Activity: No Differences in Former Athletes and Nonathletes, *American Journal of Preventive Medicine*, Volume 4, Number 3, pp. 153-160.

Duda J.L. (1987): Toward a Developmental Theory of Children's Motivation in Sport, *Journal of Sport Psychology*, Volume 9, pp. 130-145.

Edgington C.W. (1968): Development of an Attitude Scale to Measure Attitudes of High School Freshman Boys Toward Physical Education, *Research Quarterly*, Volume 39, Number 3, pp. 505-512.

Feltz D.L., Petlichkoff L. (1983): Perceived Competence Among Interscholastic Sport Participants and Dropouts, *Canadian Journal of Applied Sport Sciences*, Volume 8, Number 4, pp. 231-235.

Figley G.E. (1985): Determinants of Attitudes Toward Physical Education, *Journal of Teaching in Physical Education*, Volume 4, pp. 229-240.

Fishbein M., Ajzen I. (1975): *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesley Publishing Company, USA.

Goudas M., Biddle S. (1993): Pupil Perceptions of Enjoyment in Physical Education, *Physical Education Review*, Volume 16, Number 2, pp. 145-150.

Gould D., Horn T. (1984): Participation Motivation in Young Athletes, In: J.M. Silva, R.S. Weinberg (Eds.): *Psychological Foundations of Sport*, Human Kinetics Publishers Inc., Champaign, Illinois, pp. 359-370.

Gould D., Petlichkoff L. (1988): Participation Motivation and Attrition in Young Athletes, In: F.L. Smoll, R.A. Magill, M.J. Ash (Eds.): *Children in Sport*, Human Kinetics Books, Champaign, Illinois, pp. 161-178.

Greendorfer S.L. (1992): Differences in Childhood Socialization Influences of Women Involved in Sport and Women not Involved in Sport, In: A. Yiannakis, S.L. Greendorfer (Eds.): *Applied Sociology of Sport*, Human Kinetics Books, Champaign, Illinois, pp. 111-124.

Greer D.L., Stewart M.J. (1989): Children's Attitudes Toward Play: An Investigation of Their Context Specificity and Relationship to Organized Sport Experiences, *Journal of Sport and Exercise Psychology*, Volume 11, pp. 336-342.

Harter S. (1978): Effectance Motivation Reconsidered, *Human Development*, Volume 21, pp. 34-64.

Kenyon G.S. (1968): A Conceptual Model for Characterizing Physical Activity, *Research Quarterly*, Volume 39, Number 1, pp. 96-105.

Kuh D.J.L., Cooper C. (1992): Physical Activity at 36 Years: Patterns and Childhood Predictors in a Longitudinal Study, *Journal of Epidemiology and Community Health*, Volume 46, pp. 114-119.

Nicholls J.G. (1978): The Development of the Concepts of Effort and Ability, Perception of Academic Attainment, and the Understanding That Difficult Tasks Require More Ability, *Child Development*, Volume 49, pp. 800-814.

Nicholls J.G. (1984): Achievement Motivation: Conceptions of Ability, Subjective Experience, Task Choice, and Performance, *Psychological Review*, Volume 91, Number 3, pp. 328-346.

Nicholls J.G., Miller A.T. (1984): Development and Its Discontents: The Differentiation of the Concept of Ability, In: J.G. Nicholls (Ed.): *The Development of Achievement Motivation*, JAI Press Inc., London, pp. 185-218.

Petlichkoff L.M. (1992): Youth Sport Participation and Withdrawal: Is It Simply a Matter of FUN ?, *Pediatric Exercise Science*, Volume 4, pp. 105-110.

Petlichkoff L.M. (1993): Relationship of Player Status and Time of Season to Achievement Goals and Perceived Ability in Interscholastic Athletes, *Pediatric Exercise Science*, Volume 5, pp. 242-252.

Powell K.E., Dysinger W. (1987): Childhood Participation in Organized School Sports and Physical Education as Precursors of Adult Physical Activity, *American Journal of Preventive Medicine*, Volume 3, Number 5, pp. 276-281.

Reed J.L., Chevrette J.M. (1993): Participation and Attrition in Organized Youth Sport Programs, *Applied Research in Coaching and Athletics Annual*, pp. 177-187.

Roberts G.C. ($1984_a$): Toward a New Theory of Motivation in Sport: The Role of Perceived Ability, In: J.M. Silva, R.S. Weinberg (Eds.): *Psychological Foundations of Sport*, Human Kinetics Publishers Inc., Champaign, Illinois, pp. 214-228.

Roberts G.C. ($1984_b$): Achievement Motivation in Children's Sport, In: J.G. Nicholls (Ed.): *The Development of Achievement Motivation*, JAI Press Inc., London, pp. 250-281.

Roberts G.C. (1986): The Growing Child and the Perception of Competitive Stress in Sport, In: G. Gleeson (Ed.): *The Growing Child in Competitive Sport*, Hodder and Stoughton, London, pp. 130-144.

Roberts G.C. (1992): Children in Competition: A Theoretical Perspective and Recommendations for Practice, In: A. Yiannakis, S.L. Greendorfer (Eds.): *Applied Sociology of Sport*, Human Kinetics Books, Champaign, Illinois, pp. 179-192.

Roberts G.C., Kleiber D.A., Duda J.L. (1981): An Analysis of Motivation in Children's Sport: The Role of Perceived Competence in Participation, *Journal of Sport Psychology*, Volume 3, pp. 206-216.

Scanlan T., Simons J.P. (1992): The Construct of Sport Enjoyment, In: G.C. Roberts (Ed.): *Motivation in Sport and Exercise*, Human Kinetics Books, Champaign, Illinois, pp. 199-215.

Scanlan T.K., Carpenter P.J., Lobel M., Simons J.P. (1993): Sources of Enjoyment for Youth Sport Athletes, *Pediatric Exercise Science*, Volume 5, pp. 275-285.

Scanlan T.K., Lewthwaite R. (1988): From Stress to Enjoyment: Parental and Coach Influences on Young Participants, In: E.W. Brown, C.F. Branta (Eds.): *Competitive Sports for Children and Youth, An Overview of Research and Issues*, Human Kinetics Books, Champaign, Illinois, pp. 41-47.

Schutz R.W., Smoll F.L., Carre F.A., Mosher R.E (1985): Inventories and Norms for Children's Attitudes Toward Physical Activity, *Research Quarterly for Exercise and Sport*, Volume 56, Number 3, pp. 256-265.

Schutz R.W., Smoll F.L., Wood T.M. (1981): A Psychometric Analysis of an Inventory for Assessing Children's Attitudes Toward Physical Activity, *Journal of Sport Psychology*, Volume 4, pp. 321-344.

Stahlberg D., Frey D. (1988): Attitudes I: Structure, Measurement and Functions, In: M. Hewstone, W. Stroebe, J.P. Codol, G.M. Stephenson (Eds.): *Introduction to Social Psychology*, Basil Blackwell Ltd., Cambridge, pp. 142-166.

Taylor W.C., Blair S.N., Snider S.A., Wun C.C.C. (1993, abstract): The Influence of Physical Activity in Childhood and Adolescence on Adult Exercise Habits, *Pediatric Exercise Science*, Volume 5, pp. 198-199.

Telama R., Laakso L., Yand X. (1994): Physical Activity and Participation in Sports of Young People in Finland, *Scandinavian Journal of Medicine and Science in Sports*, Volume 4, pp. 65-74.

Wankel L.M., Kreisel P.S.J. (1985): Factors Underlying Enjoyment of Youth Sports: Sport and Age Group Comparisons, *Journal of Sport Psychology*, Volume 7, pp. 51-64.

Wankel L.M., Sefton J.M. (1989): A Season-Long Investigation of Fun in Youth Sports, *Journal of Sport and Exercise Psychology*, Volume 11, pp. 355-366.

Wear C.L. (1951): The Evaluation of Attitude Toward Physical Education as an Activity Course, *Research Quarterly*, Volume 22, pp. 114-126.

Wold B., Kannas L. (1993): Sport Motivation Among Young Adolescents in Finland, Norway and Sweden, *Scandinavian Journal of Medicine and Science in Sports*, Volume 3, pp. 283-291.

## References for Chapter 6


Ajzen I. (1985): From Intentions to Actions: A Theory of Planned Behavior, In: J. Kuhl, J. Beckmann (Eds.): *Action Control: From Cognition to Behavior*, Springer Verlag, Germany.

Ajzen I. (1988): *Attitudes, Personality and Behavior*, Open University Press, Milton Keynes.

Ajzen I. (1991): The Theory of Planned Behavior, *Organizational Behavior and Human Decision Processes*, Volume 59, pp. 179-211.

Ajzen I., Driver B.L. (1991): Prediction of Leisure Participation from Behavioral, Normative, and Control Beliefs: An Application of the Theory of Planned Behavior, *Leisure Sciences*, Volume 13, pp. 185-204.

Ajzen I., Driver B.L. (1992): Application of the Theory of Planned Behavior to Leisure Choice, *Journal of Leisure Research*, Volume 24, Number 3, pp. 207-224.

Ajzen I., Fishbein M. (1980): *Understanding Attitudes and Predicting Social Behavior*, Prentice Hall, Inc., New Jersey, USA.

Ajzen I., Madden T.J. (1986): Prediction of Goal-Directed Behavior: Attitudes, Intentions, and Perceived Behavioral Control, *Journal of Experimental Social Psychology*, Volume 22, pp. 453-474.

Allison P.D. (1977): Testing for Interaction in Multiple Regression, *American Journal of Sociology*, Volume 83, Number 1, pp. 144-153.

Bagozzi R.P., Kimmel S.K. (1992): A Comparison of Leading Theories for the Prediction of Goal-Directed Behaviors, *Unpublished Manuscript*, School of Business Administration, The University of Michigan.

Beale D.A., Manstead A.S.R. (1991): Predicting Mothers' Intentions to Limit Frequency of Infants' Sugar Intake: Testing the Theory of Planned Behavior, *Journal of Applied Social Psychology*, Volume 21, Number 5, pp. 409-431.

Chan D.K.S., Fishbein M. (1993): Determinants of College Women's Intentions to Tell Their Partners to Use Condoms, *Journal of Applied Social Psychology*, Volume 23, Number 18, pp. 1455-1470.

Cohen J. (1978): Partialed Products Are Interactions; Partialed Powers Are Curve Components, *Psychological Bulletin*, Volume 85, Number 4, pp. 858-866.

Cohen J., Cohen P. (1975): *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*, Lawrence Erlbaum Associates, Publishers, Hillsdale, New Jersey.

Courneya K.S., McAuley E. (1993): Predicting Physical Activity from Intention: Conceptual and Methodological Issues, *Journal of Sport and Exercise Psychology*, Volume 15, pp. 50-62.

Evans M.G. (1991): The Problem of Analyzing Multiplicative Composites: Interactions Revisited, *American Psychologist*, Volume 46, Number 1, pp. 6-15.

Fishbein M., Ajzen I. (1975): *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesley Publishing Company, USA.

Fishbein M., Ajzen I., McArdle J. (1980): Changing the Behavior of Alcoholics: Effects of Persuasive Cummunication, In: I. Ajzen, M. Fishbein (Eds.): *Understanding Attitudes and Predicting Social Behavior*, Prentice Hall, Inc., New Jersey, USA, pp. 219-241.

Gatch C.L., Kendzierski D. (1990): Predicting Exercise Intentions: The Theory of Planned Behavior, *Research Quarterly for Exercise and Sport*, Volume 61, Number 1, pp. 100-102.

Godin G., Shephard R.J. (1990): Use of Attitude-Behaviour Models in Exercise Promotion, *Sports Medicine*, Volume 10, Number 2, pp. 103-121.

Godin G., Valois P., Lepage L. (1993): The Pattern of Influence of Perceived Behavioral Control upon Exercising Behavior: An Application of Ajzen's Theory of Planned Behavior, *Journal of Behavioral Medicine*, Volume 16, Number 1, pp. 81-102.

Hounsa A.M., Godin G., Alihonou E., Valois P., Girard J. (1993): An Application of Ajzen's Theory of Planned Behaviour to Predict Mothers' Intention to Use Oral Rehydration Therapy in a Rural Area of Benin, *Social Science and Medicine*, Volume 37, Number 2, pp. 253-261.

Kimiecik J. (1992): Predicting Vigorous Physical Activity of Corporate Employees: Comparing the Theories of Reasoned Action and Planned Behavior, *Journal of Sport and Exercise Psychology*, Volume 14, pp. 192-206.

Liska A.E. (1984): A Critical Examination of the Causal Structure of the Fishbein / Ajzen Attitude-Behavior Model, *Social Psychology Quarterly*, Volume 47, Number 1, pp. 61-74.

Madden T.J., Ellen P.S., Ajzen I. (1992): A Comparison of the Theory of Planned Behavior and the Theory of Reasoned Action, *Personality and Social Psychology Bulletin*, Volume 18, Number 1, pp. 3-9.

Schifter D.E., Ajzen I. (1985): Intention, Perceived Control, and Weight Loss: An Application of the Theory of Planned Behavior, *Journal of Personality and Social Psychology*, Volume 49, Number 3, pp. 843-851.

Sheppard B.H., Hartwick J., Warshaw P.R. (1988): The Theory of Reasoned Action: A Meta-Analysis of Past Research with Recommendations for Modifications and Future Research, *Journal of Consumer Research*, Volume 15, pp. 325-343.

Theodorakis Y. (1992): Prediction of Athletic Participation: A Test of Planned Behavior Theory, *Perceptual and Motor Skills*, Volume 74, pp. 371-379.

Theodorakis Y., Doganis G., Bagiatis K., Gouthas M. (1991): Preliminary Study of the Ability of Reasoned Action Model in Predicting Exercise Behavior of Young Children, *Perceptual and Motor Skills*, Volume 72, pp. 51-58.

Theodorakis Y., Goudas M., Bagiatis K., Doganis G. (1993): Reasoned Action Theory and the Prediction of Training Participation in Young Swimmers, *British Journal of Physical Education*, Research Supplement, Number 13, Autumn, pp. 10-12.

Yordy G.A., Lent R.W. (1993): Predicting Aerobic Exercise Participation: Social Cognitive, Reasoned Action and Planned Behavior Models, *Journal of Sport and Exercise Psychology*, Volume 15, pp. 363-374.

## References for Chapter 7

Thomas J.R., Nelson J.K. (1990): *Research Methods in Physical Activity*, Human Kinetic Books, Champaign, Illinois, Second Edition.

## References for Chapter 8


Ajzen I., Driver B.L. (1992): Application of the Theory of Planned Behavior to Leisure Choice, *Journal of Leisure Research*, Volume 24, Number 3, pp. 207-224.

Ajzen I., Madden T.J. (1986): Prediction of Goal-Directed Behavior: Attitudes, Intentions, and Perceived Behavioral Control, *Journal of Experimental Social Psychology*, Volume 22, pp. 453-474.

Atsalakis M. (1991): *Folk Dances of Crete: Perspectives for Development Through the Educational System*, Unpublished MSc Dissertation, Department of Education, University of Sheffield.

Chatzicharistos D., Zounhia K., Kotzamanidis X. (1989): Factors that Influence the Interest of Students in Studying in Physical Education Departments, *Physical Education and Sport*, Volume 26, pp. 32-48. Article in Greek.

Cohen J., Cohen P. (1975): *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*, Lawrence Erlbaum Associates, Publishers, Hillsdale, New Jersey.

Evans M.G. (1991): The Problem of Analyzing Multiplicative Composites: Interactions Revisited, *American Psychologist*, Volume 46, Number 1, pp. 6-15.

Hill S. (1993): *Fitness Challenge, Activity Ideas Booklet for Playleaders, Teachers and Coaches*, Unpublished Manuscript, Department of Education, The University of Hull.

Kyriklidou V. (1987): *Pedagogical Games, Lecture Notes for the Department of Physical Education and Sport*, Democritus University of Thrace, Komotini, Greece, Sakoulas Publishers, Komotini, Greece. Text in Greek.

Moser C.A., Kalton G. (1971): *Survey Methods in Social Investigation*, Gower Publishing Company Limited, Hants, England, Second Edition.

Norusis M.J. (1990): *SPSS/PC+ Statistics™ 4.0*, SPSS Inc., USA.

Osgood C.E., Suci G.J., Tannenbaum P.H. (1957): *The Measurement of Meaning*, University of Illinois Press, Urbana, USA.

Pirgiotakis I. (1993): Professor of Education and Deputy Rector of the University of Crete / Greece, *Interview*.

Reid S. (1987): *Working with Statistics, An Introduction to Quantitative Methods for Social Scientists*, Polity Press, Basil Blackwell Ltd., United Kingdom.

Theodorakis I. (1992): *Social Psychological Factors in Predicting Adults Female Participation in Physical Fitness Programs*, PhD Thesis, Department of Physical Education and Sport, Aristotle University of Thessaloniki, Greece. Text in Greek.

Thomas J.R., Nelson J.K. (1990): *Research Methods in Physical Activity*, Second Edition, Human Kinetic Books, Champaign, Illinois.

West R. (1991): *Computing for Psychologists*, Harwood Academic Publishers, Glascow, United Kingdom.

## References for Chapter 9


Aiken L.R. (1988): *Psychological Testing and Assessment*, Allyn and Bacon, Inc., USA, Sixth Edition.

Ajzen I., Driver B.L. (1992): Application of the Theory of Planned Behavior to Leisure Choice, *Journal of Leisure Research*, Volume 24, Number 3, pp. 207-224.

Ajzen I., Madden T.J. (1986): Prediction of Goal-Directed Behavior: Attitudes, Intentions, and Perceived Behavioral Control, *Journal of Experimental Social Psychology*, Volume 22, pp. 453-474.

Bryman A., Cramer D. (1990): *Quantitative Data Analysis for Social Scientists*, Routledge, London.

Chatzicharistos D., Zounhia K., Kotzamanidis X. (1989): Factors that Influence the Interest of Students in Studying in Physical Education Departments, *Physical Education and Sport*, Volume 26, pp. 32-48. Article in Greek.

Cronbach L.J., Meehl P.E. (1978): Construct Validity in Psychological Tests, In: J. Bynner, K.M. Stribley (Eds.): *Social Research: Principles and Procedures*, Longman Group Limited / Open University Press, New York, pp. 225-238.

Darlington R. (1990): *Regression and Linear Models*, McGraw-Hill Publishing Company, USA.

Evans M.G. (1991): The Problem of Analyzing Multiplicative Composites: Interactions Revisited, *American Psychologist*, Volume 46, Number 1, pp. 6-15.

Hamburg M. (1987): *Statistical Analysis for Decision Making*, Harcourt Brace Jovanovich, Inc., USA, Fourth Edition.

McKennel A. (1978): Attitude Measurement: Use of Coefficient Alpha with Cluster or Factor Analysis, In: J. Bynner, K.M. Stribley (Eds.): *Social Research: Principles and Procedures*, Longman Group Limited / Open University Press, New York, pp. 239-257.

Norusis M.J. ($1990_a$): *SPSS/PC+ Statistics*$^{TM}$ *4.0*, SPSS Inc., USA.

Norusis M.J. ($1990_b$): *SPSS/PC+ Advanced Statistics*$^{TM}$ *4.0*, SPSS Inc., USA.

Osgood C.E., Suci G.J., Tannenbaum P.H. (1957): *The Measurement of Meaning*, University of Illinois Press, Urbana, USA.

Schifter D.E., Ajzen I. (1985): Intention, Perceived Control, and Weight Loss: An Application of the Theory of Planned Behavior, *Journal of Personality and Social Psychology*, Volume 49, Number 3, pp. 843-851.

Theodorakis I. (1992): *Social Psychological Factors in Predicting Adults Female Participation in Physical Fitness Programs*, PhD Thesis, Department of Physical Education and Sport, Aristotle University of Thessaloniki, Greece. Text in Greek.

West R. (1991): *Computing for Psychologists*, Harwood Academic Publishers, Glascow, United Kingdom.

## References for Chapter 10


Ajzen I. (1985): From Intentions to Actions: A Theory of Planned Behavior, In: J. Kuhl, J. Beckmann (Eds.): *Action Control: From Cognition to Behavior*, Springer Verlag, Germany, pp. 11-39.

Ajzen I. (1988): *Attitudes, Personality and Behavior*, Open University Press, Milton Keynes.

Ajzen I. (1991): The Theory of Planned Behavior, *Organizational Behavior and Human Decision Processes*, Volume 59, pp. 179-211.

Ajzen I., Driver B.L. (1992): Application of the Theory of Planned Behavior to Leisure Choice, *Journal of Leisure Research*, Volume 24, Number 3, pp. 207-224.

Ajzen I., Fishbein M. (1980): *Understanding Attitudes and Predicting Social Behavior*, Prentice Hall, Inc., New Jersey, USA.

Ajzen I., Madden T.J. (1986): Prediction of Goal-Directed Behavior: Attitudes, Intentions, and Perceived Behavioral Control, *Journal of Experimental Social Psychology*, Volume 22, pp. 453-474.

Bagozzi R.P., Yi Y., Baumgartner, J. (1990): The Level of Effort Required for Behaviour as a Moderator of the Attitude-Behaviour Relation, *European Journal of Social Psychology*, Volume 20, pp. 45-59.

Baranowski T., Simons-Morton B., Hooks P., Henske J., Tiernan K., Dunn J.K., Burkhalter H., Harper J., Palmer J. (1990): A Center-Based Program for Exercise Change among Black-American Families, *Health Education Quarterly*, Volume 17, Number 2, pp. 172-196.

Beale D.A., Manstead A.S.R. (1991): Predicting Mothers' Intentions to Limit Frequency of Infants' Sugar Intake: Testing the Theory of Planned Behavior, *Journal of Applied Social Psychology*, Volume 21, Number 5, pp. 409-431.

Connor M.K., Smith L.G., Fryer A., Erickson S., Fryer S., Drake J. (1986): Future Fit: A Cardiovascular Health Education and Fitness Project in an After-School Setting, *Journal of School Health*, Volume 56, Number 8, pp. 329-333.

Courneya K.S., McAuley E. (1993): Predicting Physical Activity from Intention: Conceptual and Methodological Issues, *Journal of Sport and Exercise Psychology*, Volume 15, pp. 50-62.

Dramytinos E. (1993): Director of the Department of Sport in the Municipality of Heraklion / Crete / Greece, *Interview*.

Epstein L.H., Wing R.R., Koeske R., Ossip D., Beck S. (1982): A Comparison of Lifestyle Change and Programmed Aerobic Exercise on Weight and Fitness Changes in Obese Children, *Behavior Therapy*, Volume 13, pp. 651-665.

Evans M.G. (1991): The Problem of Analyzing Multiplicative Composites: Interactions Revisited, *American Psychologist*, Volume 46, Number 1, pp. 6-15.

Fishbein M., Stasson M. (1990): The Role of Desires, Self-Predictions, and Perceived Control in the Prediction of Training Session Attendance, *Journal of Applied Social Psychology*, Volume 20, Number 3, pp. 173-198.

Fredricks A.J., Dossett D.L. (1983): Attitude-Behavior Relations: A Comparison of the Fishbein-Ajzen and the Bentler-Speckart Models, *Journal of Personality and Social Psychology*, Volume 45, Number 3, pp. 501-512.

Freedson P. (1992): Physical Activity Among Children and Youth, *Canadian Journal of Sport Sciences*, Volume 17, Number 4, pp. 280-283.

Gatch C.L., Kendzierski D. (1990): Predicting Exercise Intentions: The Theory of Planned Behavior, *Research Quarterly for Exercise and Sport*, Volume 61, Number 1, pp. 100-102.

Godin G., Valois P., Lepage L. (1993): The Pattern of Influence of Perceived Behavioral Control upon Exercising Behavior: An Application of Ajzen's Theory of Planned Behavior, *Journal of Behavioral Medicine*, Volume 16, Number 1, pp. 81-102.

Hounsa A.M., Godin G., Alihonou E., Valois P., Girard J. (1993): An Application of Ajzen's Theory of Planned Behaviour to Predict Mothers' Intention to use oral Rehydration Therapy in a Rural Area of Benin, *Social Science and Medicine*, Volume 37, Number 2, pp. 253-261.

Kafatos A. (1993): Professor of Community Medicine at the University of Crete / Greece, *Interview*.

Kafatos A., Apostolaki I., Kantidaki E., Lionis C. (1991): Dietary Habits of Cretan Children during the School Hours, *Paediatriki*, Volume 54, pp. 10-25. Article in Greek.

Kimiecik J. (1992): Predicting Vigorous Physical Activity of Corporate Employees: Comparing the Theories of Reasoned Action and Planned Behavior, *Journal of Sport and Exercise Psychology*, Volume 14, pp. 192-206.

Korsten-Reck U., Bauer S., Keul J. (1993): Sport und Ernärung - ein ambulantes Programm für adipöse Kinder, *Pädiatrie und Pädologie*, Volume 28, pp. 145-152. Text in German.

Liska A.E. (1984): A Critical Examination of the Causal Structure of the Fishbein / Ajzen Attitude-Behavior Model, *Social Psychology Quarterly*, Volume 47, Number 1, pp. 61-74.

Manstead A.S.R., Semin G.R. (1988): Methodology in Social Psychology: Turning Ideas into Actions, In: M. Hewstone, W. Stroebe, J.P. Codol, G.M. Stephenson (Eds.): *Introduction to Social Psychology*, Basil Blackwell Ltd., Cambridge, pp. 60-85.

Moser C.A., Kalton G. (1971): *Survey Methods in Social Investigation*, Gower Publishing Company Limited, Hants, England, Second Edition.

Norusis M.J. (1990): *SPSS/PC+ Advanced Statistics™ 4.0*, SPSS Inc., USA.

Nuutinen O. (1992): *Long-Term Weight Reduction in Obese Children*, PhD Thesis, Kuopio University Publications D. Medical Sciences 11, Kuopio, Finland.

Osgood C.E., Suci G.J., Tannenbaum P.H. (1957): *The Measurement of Meaning*, University of Illinois Press, Urbana, USA.

Pirgiotakis I. (1993): Professor of Education and Deputy Rector of the University of Crete / Greece, *Interview*.

Ross J.G., Gilbert G.G. (1985): The National Children and Youth Fitness Study I, A Summary of Findings, *Journal of Physical Education Recreation and Dance*, Volume 56, pp. 45-50.

Ross J.G., Pate R.R. (1987): The National Children and Youth Fitness Study II, A Summary of Findings, *Journal of Physical Education Recreation and Dance*, Volume 58, pp. 51-56.

Saris W.H.M. (1985): The Assessment and Evaluation of Daily Physical Activity in Children, *Acta Paediatrica Scandinavica*, Supplement 318, pp. 37-48.

Schifter D.E., Ajzen I. (1985): Intention, Perceived Control, and Weight Loss: An Application of the Theory of Planned Behavior, *Journal of Personality and Social Psychology*, Volume 49, Number 3, pp. 843-851.

Theodorakis I. ($1992_a$): *Social Psychological Factors in Predicting Adults Female Participation in Physical Fitness Programs*, PhD Thesis, Department of Physical Education and Sport, Aristotle University of Thessaloniki, Greece. Text in Greek.

Theodorakis Y. ($1992_b$): Prediction of Athletic Participation: A Test of Planned Behavior Theory, *Perceptual and Motor Skills*, Volume 74, pp. 371-379.

Theodorakis Y., Doganis G., Bagiatis K., Gouthas M. (1991): Preliminary Study of the Ability of Reasoned Action Model in Predicting Exercise Behavior of Young Children, *Perceptual and Motor Skills*, Volume 72, pp. 51-58.

Theodorakis Y., Goudas M., Bagiatis K., Doganis G. (1993): Reasoned Action Theory and the Prediction of Training Participation in Young Swimmers, *British Journal of Physical Education*, Research Supplement, Number 13, Autumn, pp. 10-12.

Walter H.J., Hofman A., Connelly P.A., Barrett L.T., Kost K.L. (1985): Primary Prevention of Chronic Disease in Childhood: Changes in Risk Factors after One Year of Intervention, *American Journal of Epidemiology*, Volume 122, Number 5, pp. 772-781.

Yordy G.A., Lent R.W. (1993): Predicting Aerobic Exercise Participation: Social Cognitive, Reasoned Action and Planned Behavior Models, *Journal of Sport and Exercise Psychology*, Volume 15, pp. 363-374.

## References for Chapter 11

Brustad R.J. (1992): Integrating Socialization Influences Into the Study of Children's Motivation in Sport, *Journal of Sport and Exercise Psychology*, Volume 14, pp. 59-77.

# APPENDICES

# APPENDIX 1

## Contents

a. Letter sent to the parents of the control group (in Greek).
b. Letter sent to the parents of the experimental group (in Greek).
c. Questionnaire (in Greek).
d. Translation of the letter sent to the parents of the control group.
e. Translation of the letter sent to the parents of the experimental group.
f. Translation of the questionnaire.

Μιχάλης Ατσαλάκης
Υποψήφιος Διδάκτωρ του
Πανεπιστημίου του Χάλλ,
Οδυσσέως 25, Ηράκλειο
τηλ. 239632.

Δρ. ΙΕ. Πυργιωτάκης
Καθηγητής Παιδαγωγικού
Τμήματος Πανεπιστημίου
Κρήτης.

Αγαπητοί γονείς,

Σας γνωρίζουμε ότι με ευθύνη του Αγγλικού Πανεπιστημίου του Χαλλ και του Παιδαγωγικού Τμήματος του Πανεπιστημίου Κρήτης στο Ρέθυμνο δημιουργούμε προγράμματα γυμναστικής για παιδιά της πρώτης τάξης του δημοτικού σχολείου.

Τα προγράμματα αυτά δυναμώνουν την καρδιά και προσφέρουν βασικές γνώσεις γύρω από τη γυμναστική και τη φυσική δραστηριότητα. Δεν είναι υποχρεωτικά και δεν κοστίζουν χρήματα. Θα αρχίσουν στις 3 Μαίου στο γήπεδο Τέννις (πίσω από το Αρχαιολογικό Μουσείο Ηρακλείου) και θα κρατήσουν 4 εβδομάδες. Στα προγράμματα αυτά μπορείτε κι εσείς να φέρετε το παιδί σας επειδή αυτό κληρώθηκε. Οχι άλλα συγγενικά παιδιά ή γειτονόπουλα. Το μόνο που ζητούμε από σας είναι να συμπληρώσετε το ερωτηματολόγιο αυτό και να το επιστρέψετε στο σχολείο. Παρακαλούμε κάντε το είτε πρόκειται να φέρετε το παιδί σας είτε όχι.

Είναι εύκολο και συμπληρώνεται πολύ γρήγορα. Δεν υπάρχει σωστό ή λάθος. Γράψτε ελεύθερα τη γνώμη σας. Αυτή μας ενδιαφέρει. Είναι για σας ανώνυμο και δεν πρόκειται να το δει κανείς. Αν έχετε ερωτήσεις τηλεφωνήστε στο Μιχάλη Ατσαλάκη τηλ. 239632.

Τελικές δηλώσεις συμμετοχής στο γήπεδο Τέννις Ηρακλείου:
12, 13, 14 Απριλίου και από 26 - 30 Απριλίου και ώρες 10.30 - 1.30 πρωί και 4.30 - 7.30 απόγευμα.

Μιχάλης Ατσαλάκης
Υποψήφιος Διδάκτωρ του
Πανεπιστημίου του Χάλλ,
Οδυσσέως 25, Ηράκλειο
τηλ. 239632.

Δρ. ΙΕ. Πυργιωτάκης
Καθηγητής Παιδαγωγικού
Τμήματος Πανεπιστημίου
Κρήτης.

Αγαπητοί γονείς,

Σας γνωρίζουμε ότι με ευθύνη του Αγγλικού Πανεπιστημίου του Χαλλ και του Παιδαγωγικού Τμήματος του Πανεπιστημίου Κρήτης στο Ρέθυμνο δημιουργούμε προγράμματα γυμναστικής για παιδιά της πρώτης τάξης του δημοτικού σχολείου.

Τα προγράμματα αυτά δυναμώνουν την καρδιά και προσφέρουν βασικές γνώσεις γύρω από τη γυμναστική και τη φυσική δραστηριότητα. Δεν είναι υποχρεωτικά και δεν κοστίζουν χρήματα. Θα αρχίσουν στις 3 Μαίου στο γήπεδο Τέννις (πίσω από το Αρχαιολογικό Μουσείο Ηρακλείου) και θα κρατήσουν 4 εβδομάδες. Στα προγράμματα αυτά μπορείτε κι εσείς να φέρετε το παιδί σας επειδή αυτό κληρώθηκε. Οχι άλλα συγγενικά παιδιά ή γειτονόπουλα. Το μόνο που ζητούμε από σας είναι να συμπληρώσετε το ερωτηματολόγιο αυτό και να το επιστρέγετε στο σχολείο. Παρακαλούμε κάντε το είτε πρόκειται να φέρετε το παιδί σας είτε όχι.

Είναι εύκολο και συμπληρώνεται πολύ γρήγορα. Δεν υπάρχει σωστό ή λάθος. Γράγτε ελεύθερα τη γνώμη σας. Αυτή μας ενδιαφέρει. Είναι για σας ανώνυμο και δεν πρόκειται να το δει κανείς. Αν έχετε ερωτήσεις τηλεφωνήστε στο Μιχάλη Ατσαλάκη τηλ. 239632.

Τελικές δηλώσεις συμμετοχής στο γήπεδο Τέννις Ηρακλείου:
12, 13, 14 Απριλίου και από 26 - 30 Απριλίου και ώρες 10.30 - 1.30 πρωί και 4.30 - 7.30 απόγευμα.

Το πρόγραμμα δεν περιλαμβάνει ποδόσφαιρο, τέννις, μπάσκετ, βόλλευ ή άλλα αθλήματα. Η διδασκαλία θα γίνεται κυρίως με παιχνίδια.

# ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ

## Οδηγιες

Το ερωτηματολογιο συμπληρωνεται απο τη ΜΗΤΕΡΑ.
– Βαλτε ενα Χ πανω απο την απαντηση που σας ταιριαζει περισσοτερο.
– Θυμηθειτε δεν υπαρχει σωστο η λαθος.
– Φροντιστε να απαντησετε σε ολες τις ερωτησεις.
– Σε καθε ερωτηση βαλτε ενα μονο Χ.

---

Α. Το να γραψω το παιδι μου στα προγραμματα ειναι: (Βαλτε ενα Χ πανω απο την απαντηση που σας ταιριαζει)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ καλο | αρκετα καλο | σχετικα καλο | ετσι κι ετσι | σχετικα κακο | αρκετα κακο | πολυ κακο |
| 2 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ κουρα-στικο | αρκετα κουρα-στικο | σχετικα κουρα-στικο | ετσι κι ετσι | σχετικα ξεκου-ραστο | αρκετα ξεκου-ραστο | πολυ ξεκου-ραστο |
| 3 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ ενδιαφε-ρον | αρκετα ενδιαφε-ρον | σχετικα ενδιαφε-ρον | ετσι κι ετσι | σχετικα βαρετο | αρκετα βαρετο | πολυ βαρετο |
| 4 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ ανοητο | αρκετα ανοητο | σχετικα ανοητο | ετσι κι ετσι | σχετικα εξυπνο | αρκετα εξυπνο | πολυ εξυπνο |
| 5 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ ευχαρι-στο | αρκετα ευχαρι-στο | σχετικα ευχαρι-στο | ετσι κι ετσι | σχετικα δυσαρε-στο | αρκετα δυσαρε-στο | πολυ δυσαρε-στο |
| 6 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ αχρηστο | αρκετα αχρηστο | σχετικα αχρηστο | ετσι κι ετσι | σχετικα χρησιμο | αρκετα χρησιμο | πολυ χρησιμο |
| 7 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ βολικο | αρκετα βολικο | σχετικα βολικο | ετσι κι ετσι | σχετικα αβολο | αρκετα αβολο | πολυ αβολο |
| 8 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ ασημα-ντο | αρκετα ασημα-ντο | σχετικα ασημα-ντο | ετσι κι ετσι | σχετικα σημα-ντικο | αρκετα σημα-ντικο | πολυ σημα-ντικο |

Β. Το να μη γραψω το παιδι μου στα προγραμματα ειναι:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ καλο | αρκετα καλο | σχετικα καλο | ετσι κι ετσι | σχετικα κακο | αρκετα κακο | πολυ κακο |
| 2 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ αβολο | αρκετα αβολο | σχετικα αβολο | ετσι κι ετσι | σχετικα βολικο | αρκετα βολικο | πολυ βολικο |
| 3 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ σημα-ντικο | αρκετα σημα-ντικο | σχετικα σημα-ντικο | ετσι κι ετσι | σχετικα αημα-ντο | αρκετα ασημα-ντο | πολυ ασημα-ντο |
| 4 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ δυσαρε-στο | αρκετα δυσαρε-στο | σχετικα δυσαρε-στο | ετσι κι ετσι | σχετικα ευχαρι-στο | αρκετα ευχαρι-στο | πολυ ευχαρι-στο |
| 5 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ θετικο | αρκετα θετικο | σχετικα θετικο | ετσι κι ετσι | σχετικα αρνητι-κο | αρκετα αρνητι-κο | πολυ αρνητι-κο |
| 6 | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| | πολυ ενεργη-τικο | αρκετα ενεργη-τικο | σχετικα ενεργη-τικο | ετσι κι ετσι | σχετικα παθητι-κο | αρκετα παθητι-κο | πολυ παθητι-κο |

---

Γ. Νομιζετε οτι τα περισσοτερα ατομα που ειναι σημαντικα για σας θα διαφωνουσαν αν γραφατε το παιδι σας στα προγραμματα;

| | | | | | | |
|---|---|---|---|---|---|---|
| _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| σιγουρα ναι | μαλλον ναι | μπορει ναι | ουτε ναι ουτε οχι | μπορει οχι | μαλλον οχι | σιγουρα οχι |

Δ. Νομιζετε οτι τα περισσοτερα ατομα που ειναι σημαντικα για σας πιστευουν οτι πρεπει να γραψετε το παιδι σας στα προγραμματα;

| | | | | | | |
|---|---|---|---|---|---|---|
| _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| πολυ πιθανο | αρκετα πιθανο | σχετικα πιθανο | ετσι κι ετσι | σχετικα απιθανο | αρκετα απιθανο | πολυ απιθανο |

Ε. Το να γραψετε το παιδι σας στα προγραμματα πιστευετε οτι ειναι:

| | | | | | | |
|---|---|---|---|---|---|---|
| _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| πολυ ευκολο | αρκετα ευκολο | σχετικα ευκολο | ετσι κι ετσι | σχετικα δυσκολο | αρκετα δυσκολο | πολυ δυσκολο |

ΣΤ. Πιστευετε οτι εχετε τις δυνατοτητες ωστε να γραψετε το παιδι σας στα προγραμματα;

| | | | | | | |
|---|---|---|---|---|---|---|
| σιγουρα ναι | μαλλον ναι | μπορει ναι | ουτε ναι ουτε οχι | μπορει οχι | μαλλον οχι | σιγουρα οχι |

Ζ. Σκοπευετε να γραψετε το παιδι σας στα προγραμματα;

| | | | | | | |
|---|---|---|---|---|---|---|
| πολυ πιθανο | αρκετα πιθανο | σχετικα πιθανο | ετσι κι ετσι | σχετικα απιθανο | αρκετα απιθανο | πολυ απιθανο |

Η. Θα προσπαθησετε να γραψετε το παιδι σας στα προγραμματα;

| | | | | | | |
|---|---|---|---|---|---|---|
| σιγουρα ναι | μαλλον ναι | μπορει ναι | ουτε ναι ουτε οχι | μπορει οχι | μαλλον οχι | σιγουρα οχι |

---

1. Ονομα παιδιου:_____
2. Διευθυνση:_____
3. Τηλεφωνο:_____
4. Επαγγελμα πατερα:_____
5. Γραμματικες γνωσεις πατερα:_____
6. Ετος γεννησης πατερα:_____
7. Επαγγελμα μητερας:_____
8. Γραμματικες γνωσεις μητερας:_____
9. Ετος γεννησης μητερας:_____
10. Συμμετεχει το παιδι σας σε αλλα οργανωμενα αθληματα (με την επιβλεψη δασκαλου, προπονητη, γυμναστη) εξω απο το σχολειο;

ΟΧΙ_____

ΝΑΙ_____ Αν ΝΑΙ σε ποια; _____

11. Ποσα παιδια εχετε συνολικα;_____
12. Εχετε αυτοκινητο; ΝΑΙ_____ ΟΧΙ_____

---

Mihalis Atsalakis
PhD Candidate of the
University of Hull
Odisseos 25, Heraklion
tel. 239632

Dr. I. Pirgiotakis
Professor in the Department
of Education at the
University of Crete

Dear Parents,

We inform you that under the responsibility of the English University of Hull and the Department of Education of the University of Crete in Rethymnon we are running physical activity programmes for first grade elementary school children.

These programmes strengthen the heart and offer basic knowledge about exercise and physical activity. They are voluntary and are free of charge. The will start on the 3rd of May at the Heraklion Tennis Club (behind the Archaeological Museum of Heraklion) and they will last 4 weeks. Your child has been chosen at random. The only thing we are asking from you is to complete the enclosed questionnaire and to return it to school. Please complete the questionnaire even if you are not going to register your child in the programme.

It is easy and fast to complete. There are no right or wrong answers. Feel free to express your opinion. We are interested in your opinion. The questionnaire is anonymous. If you have any queries, please call Mihalis Atsalakis, tel. 239632.

Registration at the Heraklion Tennis Club: 12, 13, 14 April and 26-30 April, 10.30-1-30 in the morning and 4.30-7.30 in the afternoon.

Mihalis Atsalakis
PhD Candidate of the
University of Hull
Odisseos 25, Heraklion
tel. 239632

Dr. I. Pirgiotakis
Professor in the Department
of Education at the
University of Crete

Dear Parents,

We inform you that under the responsibility of the English University of Hull and the Department of Education of the University of Crete in Rethymnon we are running physical activity programmes for first grade elementary school children.

These programmes strengthen the heart and offer basic knowledge about exercise and physical activity. They are voluntary and are free of charge. The will start on the 3rd of May at the Heraklion Tennis Club (behind the Archaeological Museum of Heraklion) and they will last 4 weeks. Your child has been chosen at random. The only thing we are asking from you is to complete the enclosed questionnaire and to return it to school. Please complete the questionnaire even if you are not going to register your child in the programme.

It is easy and fast to complete. There are no right or wrong answers. Feel free to express your opinion. We are interested in your opinion. The questionnaire is anonymous. If you have any queries, please call Mihalis Atsalakis, tel. 239632.

Registration at the Heraklion Tennis Club: 12, 13, 14 April and 26-30 April, 10.30-1-30 in the morning and 4.30-7.30 in the afternoon.

The programme will not contain football, tennis, basketball, volleyball or other sports. Instruction will be based on playful activities.

# Questionnaire

## Instructions

The questionnaire must be completed by the mother.
- Put an X over the responses you feel represent you.
- Remember, there are no right or wrong answers. We are interested in your own opinion.
- Answer all the questions.
- In each question put only one X.

---

## (Attitude Toward Success)[1]

A. Registering my child in the programme is

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | very good | quite good | relatively good | neutral | relatively bad | quite bad | very bad |
| 2 | very laborious | quite laborious | relatively laborious | neutral | relatively effortless | quite effortless | very effortless |
| 3 | very interesting | quite interesting | relatively interesting | neutral | relatively boring | quite boring | very boring |
| 4 | very unintelligent | quite unintelligent | relatively unintelligent | neutral | relatively intelligent | quite intelligent | very intelligent |
| 5 | very pleasant | quite pleasant | relatively pleasant | neutral | relatively unpleasant | quite unpleasant | very unpleasant |
| 6 | very worthless | quite worthless | relatively worthless | neutral | relatively valuable | quite valuable | very valuable |
| 7 | very comfortable | quite comfortable | relatively comfortable | neutral | relatively uncomfortable | quite uncomfortable | very uncomfortable |
| 8 | very unimportant_ | quite unimportant | realtively unimportant | neutral | relatively important | quite important | very important |

---

1 Heading not included in the original questionnaire.

## (Attitude Toward Failure)[1]

B. Not registering my child in the programme is

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | very good | quite good | relatively good | neutral | relatively bad | quite bad | very bad |
| 2 | very uncom-fortable | quite uncom-fortable | relatively uncom-fortable | neutral | relatively comfor-table | quite comfor-table | very comfor-table |
| 3 | very important | quite important | relatively important | neutral | relatively unimpor-tant | quite unimpor-tant | very unimpor-tant |
| 4 | very unplea-sant | quite unplea-sant | relatively unplea-sant | neutral | relatively pleasant | quite pleasant | very pleasant |
| 5 | very positive | quite positive | relatively positive | neutral | relatively negative | quite negative | very negative |
| 6 | very active | quite active | relatively active | neutral | relatively passive | quite passive | very passive |

## (Subjective Norms)[2]

C. Most people who are important to me would disapprove if I registered my child in the programme

| | | | | | | |
|---|---|---|---|---|---|---|
| surely yes | probably yes | maybe yes | neutral | maybe not | probably not | surely not |

D. Most people who are important to me believe I should register my child in the programme

| | | | | | | |
|---|---|---|---|---|---|---|
| very likely | quite likely | relatively likely | neutral | relatively unlikely | quite unlikely | very unlikely |

1 Heading not included in the original questionnaire.
2 Heading not included in the original questionnaire.

## (Perceived Behavioural Control)[1]

E. Registering my child in the programme is

| | | | | | | |
|---|---|---|---|---|---|---|
| very easy | quite easy | relatively easy | neutral | relatively difficult | quite difficult | very difficult |

F. I think I have the resources to register my child in the programme

| | | | | | | |
|---|---|---|---|---|---|---|
| surely yes | probably yes | maybe yes | neutral | maybe not | probably not | surely not |

## (Intention)[2]

G. I intend to register my child in the programme

| | | | | | | |
|---|---|---|---|---|---|---|
| very likely | quite likely | relatively likely | neutral | relatively unlikely | quite unlikely | very unlikely |

H. I shall try to register my child in the programme

| | | | | | | |
|---|---|---|---|---|---|---|
| surely yes | probably yes | maybe yes | neutral | maybe not | probably not | surely not |

---

1. Chid's name:_____
2. Adress::_____
3. Phone number::_____
4. Father's profession::_____
5. Father's educational level::_____
6. Father's year of birth::_____
7. Mother's profession::_____
8. Mother's educational level::_____
9. Mother's year of birth::_____
10. Does your child participate in other out of school organized physical activity or sport programmes under the supervision of a teacher, coach or instructor ?
NO_____
YES_____ If yes in which?_____
11. How many children do you have in total ?_____
12. Do you have a car ? YES_____ NO_____

---

1 Heading not included in the original questionnaire.
2 Heading not included in the original questionnaire.

# APPENDIX 2

## Contents

a. Licence issued from the Institute of Education.
b. Translation of the licence.

ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΥΠΟΥΡΓΕΙΟ ΕΘΝ. ΠΑΙΔΕΙΑΣ & ΘΡΗΣΚΕΥΜΑΤΩΝ
ΠΑΙΔΑΓΩΓΙΚΟ ΙΝΣΤΙΤΟΥΤΟ
ΤΜΗΜΑ ΕΡΕΥΝΩΝ, ΤΕΚΜΗΡΙΩΣΗΣ
ΚΑΙ ΕΚΠΑΙΔΕΥΤΙΚΗΣ ΤΕΧΝΟΛΟΓΙΑΣ
ΕΔΡΑ: ΜΕΣΟΓΕΙΩΝ 396 - 153 41 ΑΓΙΑ ΠΑΡΑΣΚΕΥΗ - ΑΤΤΙΚΗΣ
ΤΗΛ.: 65 67 367 - FAX: 65 67 370



Αγία Παρασκευή, 17 - 3 - 1993

## ΒΕΒΑΙΩΣΗ

Η υπογραφόμενη Ευαγγελία Βαρνάβα-Σκούρα, πρόεδρος του τμήματος Ε.Τ.Ε.Τ. του Παιδαγωγικού Ινστιτούτου, βεβαιώνω ότι, μετά την υποβολή της αίτησης τ.ο.υ. κ. Μιχ. Αντωνάκη (αριθ.πρωτ. Π.Ι. 3.0.0./28.1.93) το τμήμα με την πράξη του αριθ. 0.47.8-3-93 ομόφωνα γνωμοδότησε θετικά υπέρ της χορήγησης άδειας για διεξαγωγή της σχετικής του έρευνας.

Η βεβαιούσα

Ευαγγελία Βαρνάβα-Σκούρα
Πρόεδρος του τμήματος Ε.Τ.Ε.Τ.

Hellenic Republic
Ministry of Education and Religion
Institute of Education
Department of Research and Educational Technology

Agia Paraskevi, 17.3.1993

## CERTIFICATE

It is hereby certified from the president of ETET of the Institute of Pedagogy that after application of Mr Mihalis Atsalakis (number P.I. 300 / 28.1.93) the department decided to issue the permition (number 04 / 8.3.93) to conduct his research.

Evagelia Varnava Skoura

President of ETET

# APPENDIX 3

## Contents

a. Registration form.
b. Translation of the registration form.

# Δ Η Λ Ω Σ Η  Σ Υ Μ Μ Ε Τ Ο Χ Η Σ

ΟΝΟΜΑ:

ΕΠΙΘΕΤΟ:

ΟΝΟΜΑ ΠΑΤΕΡΑ:

ΟΝΟΜΑ ΜΗΤΕΡΑΣ:

ΤΗΛΕΦΩΝΟ:

ΔΙΕΥΘΥΝΣΗ

ΟΔΟΣ:  ΑΡΙΘΜΟΣ:  ΠΕΡΙΟΧΗ:

ΣΧΟΛΕΙΟ:

---

ΠΡΟΓΡΑΜΜΑ ΣΥΜΜΕΤΟΧΗΣ

ΗΜΕΡΑ:  ΩΡΑ:

ΗΜΕΡΑ:  ΩΡΑ:

ΗΜΕΡΑ:  ΩΡΑ:

ΥΠΕΥΘΥΝΟΙ ΠΡΟΓΡΑΜΜΑΤΟΣ: Δρ. ΙΕ Πυργιωτάκης, Καθηγητής Πανεπιστημίου Κρήτης.

Μιχάλης Ατσαλάκης, Καθηγητής Φυσικής Αγωγής, Φοιτητής επιπέδου Διδακτορικού, Οδυσσέως 25, Ηράκλειο, Τηλ: 239632.

---

ΙΑΤΡΙΚΗ ΒΕΒΑΙΩΣΗ

Βεβαιώνεται ότι ο/η ανωτέρω μαθητής/μαθήτρια είναι υ γ ι ή ς και μπορεί να συμμετέχει σε προγράμματα γυμναστικής.

ΗΜΕΡΟΜΗΝΙΑ:

ΣΦΡΑΓΙΔΑ και ΥΠΟΓΡΑΦΗ ΙΑΤΡΟΥ:

# REGISTRATION FORM

Name:
Surname:
Father's Name:
Mother's Name:
Phone Number:
Address:
Street: Number: Area:
School:

---

## INDIVIDUAL SCHEDULE

Day: Time:
Day: Time:
Day: Time:

Responsible for the Programme: Dr. I.E. Pirgiotakis,
Professor at the University of Crete
Mihalis Atsalakis, Physical Education Teacher,
PhD Candidate,
Odisseos 25, Heraklion, tel: 239632

---

## MEDICAL CERTIFICATE

It is hereby certified that the above named student is healthy and is able to participate in physical acticity programmes.

Stamp and Signature of the Doctor

# APPENDIX 4

## Contents

a. Letter that was given to the parents at the end of the programmes.
b. Translation of the letter given to the parents at the end of the programmes.

Ηράκλειο, Μάϊος 1993.

Αγαπητοί γονείς,

η γυμναστική θεωρείται σήμερα ως ένα "μοντέρνο φάρμακο" για την πρόληψη χρονίων ασθενειών (καρδιακές παθήσεις, παχυσαρκία κ.λ.π). Έχει αξία με την προϋπόθεση ότι γίνεται συστηματικά, τουλάχιστον 3 φορές την εβδομάδα από 25-45 λεπτά τη φορά.

Με βάση τα παραπάνω δημιουργήθηκαν τα προγράμματα γυμναστικής που παρακολούθησε το παιδί σας.

Οι στόχοι τους ήταν να κεντρίσουν το ενδιαφέρον τόσο του παιδιού όσο και το δικό σας για ενασχόληση με τη γυμναστική και να προσφέρουν βασικές γνώσεις γύρω από τη γυμναστική.

Έγινε προσπάθεια ώστε τα παιδιά να μάθουν :

1. Γιατί γυμναζόμαστε
2. Ποιά μέρη του σώματος γυμνάζονται όταν εκτελούνται συγκεκριμένες ασκήσεις.
3. Να μάθουν ορισμένες ασκήσεις ώστε με την καθοδήγησή σας να μπορούν να τις κάνουν μόνα τους στο σπίτι.

Οι ασκήσεις αυτές είναι οι παρακάτω:

α. Ζέσταμα: τρέξιμο μπροστά - πίσω - πλάγια, ανεμόμυλος, κερασάκια, βάρκα, πιάνουμε τις μύτες των ποδιών.

β. Κύριο μέρος : γαλίδια, ποδήλατο, τρέξιμο από διάφορες θέσεις με παλαμάκι, κουτσό, καγκουρώ, γάτα, πελαργός, αεροπλανάκι.

γ. Ξεκούραση: πελαργός, βάρκα, πιάνουμε τις μύτες των ποδιών.

Συνεχίσετε την προσπάθεια αυτή δίνοντας στα παιδιά την ευκαιρία να συμμετέχουν σε διάφορες φυσικές δραστηριότητες όπως : περπάτημα, τρέξιμο, ποδήλατο, κολύμβηση και ορειβασία.

Σας ευχαριστώ για την συνεργασία.

Μιχάλης Ατσαλάκης

Υ.Γ.: Αν έχετε κάποια απορία μπορείτε να μου γράψετε στην παρακάτω διεύθυνση:

M. Atsalakis c/o Iraklidis
Shamrockstr 60
Herne 1 W-4690
GERMANY.

Heraklion, May 1993

Dear Parents,

Exercise is viewed today as a "modern medicine" for the prevention of chronic diseases (cardiovascular diseases, obesity etc.). It is valuable if it is done systematically, at least 3 times per week 25 to 45 minutes each time.
The programme that your child attended was based on these principles.
Their target was to stimulate you and your child's interest in physical activities and to offer basic knowledge about exercise.
It attempted to teach the children:
1. Why exercise.
2. Which parts of the body are trained when performing certain exercises.
3. Certain exercises that they could perform at home under your supervision.

These exercises are the following:

a. Warming up: running in various directions, wind-mill, cherries, boat, touch your toes.
b. Main part: scissors, kangaroo, bicycle, running from various positions with signal, running on one foot, cat, bird, aircraft.
c. Cool down: bird, boat, touch your toes.

Please continue this effort offering the opportunity to your children to participate in various physical activities such as: walking, jogging, cycling, swimming and mountain climbing.
Thank you for your commitment.

Mihalis Atsalakis

NB: If you have any queries you can write to the following address:

M. Atsalakis c/o Iraklidis
Shamrockstr. 60
Herne 1 W-4690
Germany