Socialisation of the primary school child into a physically active lifestyle

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SOCIALISATION OF THE PRIMARY SCHOOL CHILD INTO A PHYSICALLY ACTIVE LIFESTLYE

A LIFETIME HEALTH PERSPECTIVE

BY

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VOLUME I OF II

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ABSTRACT

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Mounting epidemiological evidence shows physical inactivity and lack of exercise to be related to the occurrence of several diseases and degenerative conditions in adulthood. The maintenance of a physically active lifestyle, as well as the development of positive attitudes towards physical activity are viewed by many as major components of preventive medicine that should begin in childhood. In a synthesis of study findings of the decade 1985-1995, the observed relationships between physical activity and conditions of public health importance are reviewed. Patterns and trends in children's physical activity behaviour, observed in youth studies of the same period, are outlined. Physical activity of children is described as the product of a complex interweaving of biographical, social and cultural threads, and studies examining such influences on behaviour are discussed.

The population study was designed to increase understanding of physical activity behaviour, and its social context in the lives of young people. Data were collected from a cohort of preadolescent children in 5th and 6th classes of primary school. 1,602 children were interviewed, 810 girls and 792 boys, in a nation-wide random sample of 62 Irish national primary schools. Socio-cultural factors were suggested to contribute to the high activity participation rate observed for this population. Gender differences in recreational activity were significant ($p < .0001$), and a significant decline was observed in girls' activity from 5th to 6th class ($p < .0001$). Evidence of social class effect on behaviour was not convincing. In regression analysis, gender (B, -.209, 95% CI -.277 to -.141, $p < .0001$), sports club membership (B,.201, 95% CI .131 to .272, $p < .0001$), and social integration status (B, .039, 95% CI .024 to .055, $p < .0001$) were identified as significant independent predictors of recreational activity. Parental support and physical self-perception were weak predictors. Primary PE, measured by the physical education index, was significantly and positively associated with activity, and independently of all variables included in the analysis (B,0.016, 95% CI 0.012 to 0.021, $p < .0001$). The physical education index provided a significant increment in the prediction of children's activity over and above the effects explained by demographic and sociometric variables. No association was observed between self-assessed health and well-being and activity. Children's PE curriculum experience and school travel patterns were also examined. Findings attest to the importance of the primary school in the education of children for lifetime health. [References: 1,117]

Keywords: children, health, physical activity, social environment

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All parts of the body which have a function, if used in moderation and exercised in labours in which each is accustomed, become thereby healthy, well-developed and age more slowly, but if unused and left idle they become liable to disease, defective in growth, and age quickly.

Hippocrates

PREFACE

The prevention of ill health and the promotion of health-enhancing behaviour have become increasingly important issues in public health. Central to such issues is an understanding of why people behave as they do with respect to pathogenic and salutogenic processes and activities.

Population health research has been criticised on the grounds that it is still dominated by experimental designs based on simplistic notions of causality that try to remove the variation and complexity of real-life health and disease processes (Fox, 1994). In 1993, the Leeds Declaration issued ten principles for action on population health research and practice. The first of these referred to the urgent need to refocus "upstream" - to move away from the almost exclusive focus of research on individual risk, towards the social structures and processes within which ill-health originates, and which will often be more amenable to modification (Leeds Declaration, 1993). Researchers therefore have begun to focus their study on the combined influence of lifestyles, psychological factors, and social conditions on human well being as a basis for their concepts.

Lifestyle has been defined by WHO researchers as relatively stable patterns of behaviour, habits, attitudes and values which are typical for the groups one belongs to, or the groups one wants to belong to (Aaro et al.,1986). In classical theory of this period, lifestyle denotes an interrelated pattern of conduct for the individual, an expression of belonging to a particular group, and some suggestion of structured life chances (Abel & McQueen,1991). During the 1980s social policy and health promotion theorists refined the concept of lifestyle. In 1991, Giddens discusses lifestyle as an "essential feature of the culture of high modernity, because it implies choices within a plurality of possible options, and is 'adopted' rather than 'handed down"[1]. However, as with classical theorists, he acknowledged that, for all individuals and groups life chances condition lifestyle choices. Conditioned choice is also proposed by contemporary theorists Backett & Davison (1995), who refer to lifestyle as "the point where givens and chosens meet".[2] All such definitions imply that even though the 'entry point' of the phenomenon is the

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1 Giddens, A., 1991. *Modernity and self-identity: self and society in the Late Modern Age*. Polity, Oxford, p. 81.

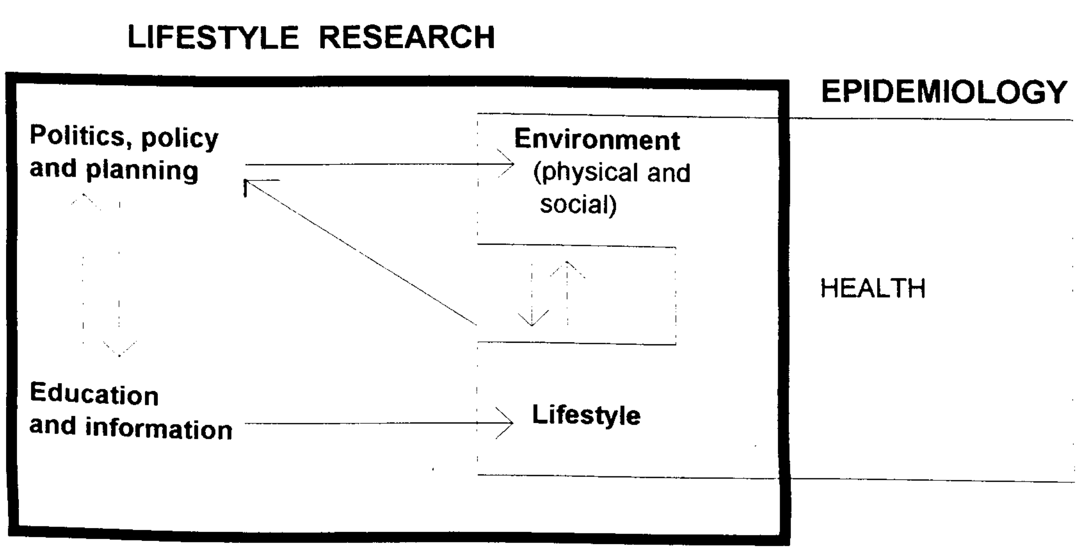
2 Backett, K.C. and C.Davison (1995). Life course and lifestyle: The social and cultural location of health behaviours. *Social Science and Medicine*. 40 (5), p.631.

properties of the individual, these properties are closely linked to social and physical surroundings. Acknowledgement of the holistic and ecological aspects of the concept of lifestyle, as argued by Dean (1989), enables consideration of the complex inter-relationships between structurally and environmentally based 'chances', personal 'choices' and cultural contexts as these impact not just on health, but also on health and well-being.

Lifestyle research therefore is based on a philosophy and assumptions which are qualitatively different from those of epidemiological research. In the latter, the identification and quantification of causal relationships are important. In a lifestyle approach, describing and understanding processes in an evolving social and cultural context are central to the enquiry. The wider set of social and behavioural characteristics represented in the concept of lifestyle includes young people's membership of social groups, use of media, leisure-time activities, and so on.

The scope of lifestyle research must encompass the relationship between person and environment from a socio-psychological and ecological perspective, and, as schematically illustrated, takes into account the macro social context [Figure 1.1].

Figure 1.1 *Interrelationships of the principal components of lifestyle research*



Source: Aaro et al. (1986) A simplified model

The overall goal of this study is to increase understanding of lifestyle and health behaviour and its social context in the lives of young people. The researcher recognises that the physical activity behaviour of children is the product of a complex interweaving of biographical, social and cultural threads. The focus of the primary research component however is predominantly within the social domain. The study posits that choice of an active lifestyle is conditioned not only by the socio-economic environment to which the child is exposed and by the family support structures, but also by the social-educational environment of the primary school and the activity experiences offered therein. The research is prefaced by a synthesis of the findings of epidemiological studies in the activity-health relationship, contextually illustrated above. The primary research approach is not epidemiological, but this does not however exclude the possibility of findings relevant to epidemiology. Activity index data for the 11-12 year olds, for example, provides a national cohort record for this health behaviour. An extremely important goal of the research is to provide information which can guide national policy in education of children for lifetime health.

A major implication of the *upstream* research approach called for in the Leeds Declaration (1993) is the acknowledgement of the contribution of the social sciences and other disciplines in the knowledge base for public health. The investigation of the child's socialisation into an active lifestyle in the formative years charts a path towards such interdisciplinary inquiry.

1

PHYSICAL ACTIVITY AND LIFETIME HEALTH
AN OVERVIEW

1.0 Introduction

The way in which people live and the lifestyles they adopt have profound effects on subsequent health. The change in lifestyle, particularly in the latter part of the 20th century, has led to an increase in 'hypokinetic diseases', or health problems caused by or related to a lack of physical activity (Kraus & Raab 1961). The evidence linking patterns of physical activity with health measures is increasing rapidly. It appears that the effects of physical activity on certain disease and conditions are produced through both direct and indirect mechanisms, and that these relationships may also go in the other direction - disease may influence physical activity or other health behaviours, or both. Health, however, is not merely the absence of disease, and physical activity can play a vital role in the provision of a feeling of well-being, enhanced fitness and psychological states, all of which improve the quality of life.

Current understanding of the health effects of physical activity suggests that, while active children experience some improvements in mental and physical health, health benefits in youth are transitory. Therefore one of the major rationales for promoting physical activity in children is to establish patterns of regular activity that can be maintained throughout life. From a public health viewpoint, the major impact of physical activity is likely to be the reduction of chronic disease risk in adults. Chronic or degenerative non-communicable diseases have been identified by the World Health Organisation as one of the major public health problems in developed countries in terms of morbidity, mortality and disability of the population, and in terms of their social and economic impact on the well-being of society (WHO, 1988). These include heart disease, stroke and cancer, which between them cause more than 70 per cent of all premature deaths in Western society (Mulcahy, 1995).

Many factors, behavioural, genetic, psychological, environmental, educational, and socio-economic influence the health of individuals. Behavioural risks associated with preventable chronic diseases or premature death are increasing. These risk factors are mainly due to lifestyle habits such as poor diet behaviour, inadequate physical activity and psychological stress. Although there is mounting epidemiological evidence that physical inactivity and lack of exercise are related to the occurrence of several diseases and degenerative conditions, many Irish adults and adolescents lead sedentary lives.

The 1980's heralded an emergence of studies which identified the relationship between physical activity even at minimal levels and positive health status (Wiley & Comacho 1980, Allan 1985, Gillett 1988, Gillett & Eisenman 1987, Walker et al, 1988). Numerous studies and reviews of the relationship of physical activity to positive health benefits have followed, e.g. Fentem, Bassey & Turnbull, 1988; Morgan & O Connor, 1988; Powell, 1988; Lenskyj 1988; Powell, Thompson, Caspersen & Kendrick, 1987; Siscovick, Laporte & Newman, 1985; Bouchard et al.,1990; Royal College of Physicians, 1991; Dubbert, 1992; Astrand, 1992; Quinney et al.,1994. Adjunct research has noted that participation in physical activity may act as an entry point to reflect on health behaviour practices, creating a ripple effect to other areas of lifestyle behaviours (O'Hagan 1984; Shestowsky 1983; Blair et al.,1985; Marcus et al.,1992), although this effect is not widely nor conclusively demonstrated.

A synthesis of the information on the activity-health association, reported in studies of the decade 1985-1995, is presented in this overview. The broad spectrum of conditions upon which physical activity has an allegedly favourable influence include diseases and conditions of public health importance such as coronary heart disease, hypertension, osteoporosis, diabetes mellitus, overweight and obesity, and low back pain. The evidence associating physical activity with such conditions is reviewed. The role of activity in relation to the health of specific population groups, viz. women, older adults, and children, is also considered. As exercise may also operate synergistically with other lifestyle factors to promote better health and quality of life, the influence of physical activity on other health-related behaviours is investigated.

The 1985-'95 period has also been marked by major advances in therapeutic and rehabilitative applications of exercise, and by investigations of physical activity as a primary or adjunctive therapy in several important mental health applications. Although these dimensions of physical activity are not discussed within study parameters, their contribution to improving quality of life is unreservedly acknowledged.

1.1 Physical activity and the prevention of coronary vessel disease

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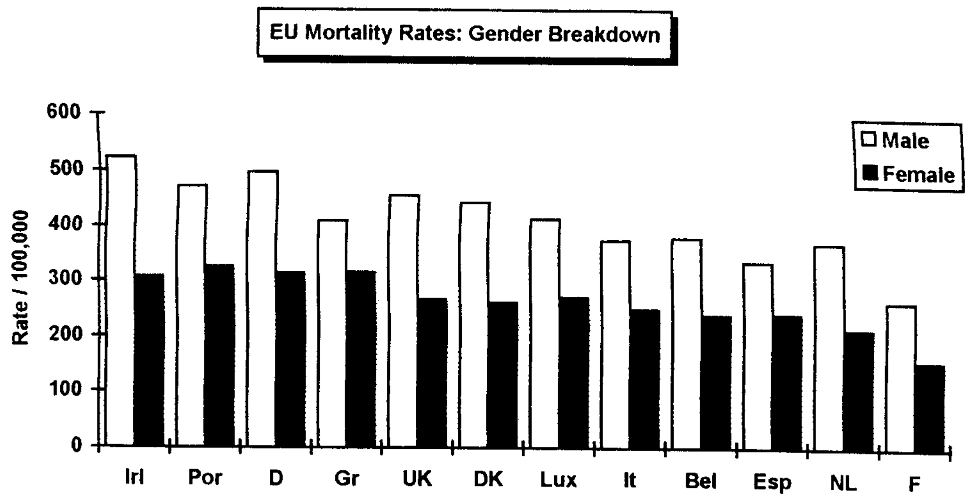
In the 1980's, life expectancy in middle age in Irish men and women was among the lowest of those countries, world-wide, for which this information is calculated (WHO, 1988). Life expectancy at birth in Ireland has now risen to 77.7 years for females and 72.2 years for males (NNSC,1995). This is a slightly lower life expectancy, for both sexes, than the European Community average, 79.4 years (females) and 72.8 years (males).

Mortality rates are still contributed to, in the main, by cardiovascular disease and cancers in which diet and physical activity have a contributory etiologic role. Although the overall death rate in Ireland is decreasing, it is more gradual than our EU counterparts. This is attributed to mortality associated with Ireland's relatively high incidence of cardiovascular disease and certain cancers, which together account for almost 60% of deaths in Ireland (NNSC, 1995). Although the coronary heart disease (CHD) mortality rate has declined in recent decades, disease of the circulatory system is still one of the main killers in Ireland, accounting for 48% of all deaths in 1993. Heart disease, strokes and circulatory disorders accounted for almost one-third of all premature deaths (persons under 65) in 1992 (Department of Health, 1994).

In middle-aged men, cardiovascular diseases are the largest cause of death and the second largest cause of death, after cancer, in middle-aged women (Kilkenny Health Project, 1992). Ireland has the highest cardiovascular mortality rate in the EU for both male and females, Irish males having the highest death rates and females the fourth highest (WHO, 1993) [Fig.1.2].

Figure 1.2 *Age standardised mortality rates (per 100,000) from diseases of the circulatory system*

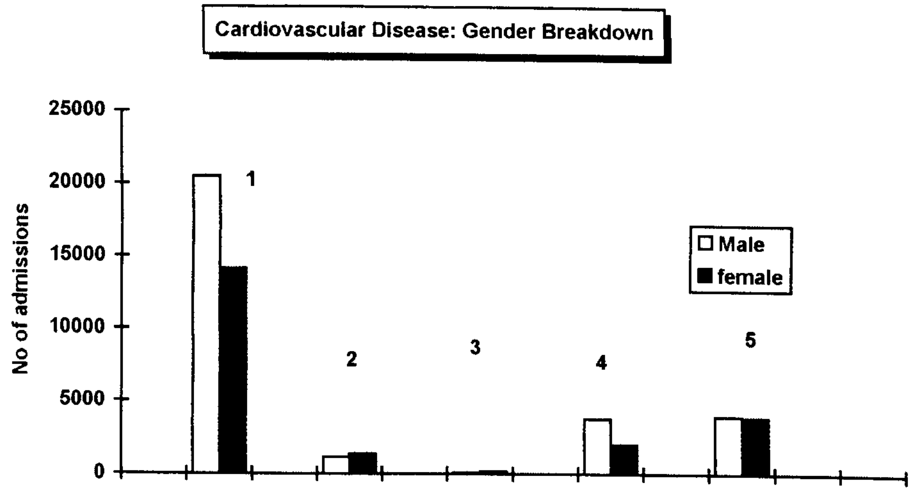


Source: WHO HFA. 1993

An increase in hospital admission rates for cardiovascular disease in Ireland has been observed over the time period 1981 to 1993 (NNSC,1995). This is an increased incidence of disease which is not reflected in the mortality rates The rise in CVD morbidity and fall in CVD mortality rates is a trend experienced in many other northern European countries. In all age groups in Ireland, except the younger 25-44 range, there was a steady increase in admissions rates over the years reported. In the same time period (1981-1993) there was a slight increase in the population within each age group but not to the same degree as the increase in admissions (NNSC, 1995). This may therefore indicate a true reflection of a growth in diseases of the circulatory system.

Cardiovascular disease can be broken down into ischaemic heart disease and cerebrovascular disease. Ischaemic heart disease accounts for a high percentage (84% in 1993) of the total hospital admissions for cardiovascular related diseases A further breakdown of ischaemic heart disease episodes reveal diseases of the circulatory system to be the most common category, with a steady increase in admission rates over the years 1981 to 1993 (NNSC, 1995). Similar to the gender distribution for overall CVD, men account for approximately 60% (58% - 62%) of all admissions duc to diseases of the circulatory system [Fig.1.3].

Figure 1.3 *Gender breakdown of the admissions to hospital for cardiovascular disease in 1994*



1 Diseases of the circulatory system 2 Hypertensive disease 3 Chronic rheumatic heart disease
4 Acute myocardial infarction 5 Cerebrovascular disease

Source: HIPE 1994 [1]

While there have been important medical advances in relation to the treatment of chronic and acute CHD, morbidity and mortality can most effectively be tackled through preventive strategies applied at population level. Population-specific health behaviours have been shown to be involved in differences in the risk of CHD (Bosom et al.,1994). Within countries with high mortality, such as Ireland, this means targeting the entire population, who are all at some measure of risk when compared to their peers living in countries with lower mortality. In addition to reducing the incidence of CHD, such a preventive approach would be expected to be associated with reductions in the incidence of cancer and some other chronic non communicable diseases (Kilkenny Health Project, 1992).

The major risk factors for coronary heart disease have been reported by the World Health Organisation Expert Committee as an inappropriate national diet aggravated by physical inactivity and overweight (reflected in the mass raising of blood lipids and blood pressure), and widespread cigarette smoking (WHO,1982).

[1] Hospital In-Patient Enquiry (HIPE): data coverage level in 1994 is 89%. Private hospitals (10%) not included in data. Records of disease incidence affected by treatment in day care facilities (ESRI, 1994).

Unlike risk factors such as genetic susceptibility, increasing age and gender, diet and lifestyle factors are modifiable. The role of one such lifestyle factor, physical activity, is now reviewed.

1.1.1 The relationship between physical activity and cardiovascular disease

The seminal work of Morris (1953) and his colleagues on occupational activity in the 1950s, the extensive studies by Paffenbarger (1978, 1986,1988) and colleagues in the 1970's, and the extension of the research to leisure-time activities in the 1980's, marked significant stages of development in the research on cardiovascular disease and its relationship to habitual physical activity. In the period 1954 to 1984, more than sixty such epidemiological studies were published. The relationship was observed in a variety of population groups, using a variety of CHD end points, and using several different methods to measure physical activity. These studies have been quite comprehensively reviewed (Haskell,1984; Paffenbarger & Hyde, 1984; Siscovick, LaPorte & Newman,1985). The general consistency of the findings is persuasive evidence of the validity of the inverse relationship documented.

The studies, however, were not often uniform in considering pertinent questions of diet, heredity, stress, cigarette smoking, and other potentially confounding factors that might account for the associations seen. Some studies controlled in the analysis for established risk factors (Garcia-Palmieri et al.,1982; Kannel & Sorlie, 1979; Morris et al.,1980; Paffenbarger et al.,1978; Siscovick et al., 1984). Relatively few prospective studies included female subjects (Brunner et al., 1974; Magnus et al.,1979; Kannel & Sorlie, 1979; Dawber, 1980; Salonen et al, 1982; Lapidus & Bengtsson, 1986), and several seemingly important contributions to gender differences in risk profiles or gender-by-risk factor interactions have not been adequately investigated.

Many of these studies were open to criticism on the difficult epidemiological issues concerning 'self selection' and 'constitutional' factors. Persons with a proclivity for CHD may shun physical activity. Selection bias has been reported by Powell (1985) to be unavoidable in observational studies, affecting the analyses in several ways: e.g. if adequate attention has not been given to assuring the measured activity level preceded the onset of CHD, individual with pre-existing CHD could constitute a disproportionate number of the inactive group Morris et al.(1980) contend that the misclassification produced by minimally ill persons shifting to the inactive group is not large enough to produce the observed results.

Several studies (Morris et al.,1980; Paffenbarger & Hyde, 1975; Paffenbarger, Wing, & Hyde, 1978; Siscovik et al., 1982) had begun with presumably healthy populations in all levels of activity. In the follow-up study of alumni however, Paffenbarger adverts to the fact that although in 1977 the 10,269 alumni were free of diagnosed chronic disease that might limit their physical activity, including sports activity, some men may have had sub clinical or undiagnosed disease that, in turn, resulted in both sedentary habits and premature death.

Research findings of Salonen (1988) reflect such concerns. Salonen states that it is difficult to distinguish an increased risk of coronary disease related to physical inactivity or poor cardiorespiratory fitness from an increased risk due to a prevalent asymptomatic or pre-existing cardiovascular disease in unfit persons (Salonen, 1988). In observational studies, such selective influences cannot be eliminated entirely, as might be possible in appropriately designed clinical trials. But the impracticality of controlled trials that would assess the health effects of a physically active way of life make such an undertaking virtually impossible. Hence, the possibility that self-selection bias can exaggerate the strengths of association observed, is acknowledged even in the most recent research (Lakka et al.,1994).

Difficulties in defining or assessing physical activity levels in diverse international settings also confounds comparisons within or among international groups. Physical activity however is a complex behaviour for which there is no standard measurement (Caspersen et al.,1985; LaPorte et al.,1985; Wilson et al., 1986; Mundal et al.,1987). It is not readily dichotomised, such as smoking versus non-smoking, nor does it conform to a readily measured continuum, such as cholesterol or blood pressure.

Although early epidemiological studies can be criticised on methodological grounds, research in this period 1954-1984 has contributed valuable information on cardiovascular disease causation, although agreement on the relationship between physical activity and coronary heart disease was not unanimous.. In the Seven Countries Study, for example, Keys (1980) found no association between habitual physical activity and coronary risk among Finnish men. Karvonen (1983) observed an inverse relation that disappeared when he evaluated only men who had no coronary disease at entry. Although these findings have been used to argue that physical inactivity is not an important coronary risk factor, accumulated evidence of the period indicated an inverse relationship between CHD risk and physical activity (Siscovick et al.,1984) It was also noted that the difference between the risk for inactive persons and the risk for active persons is greater for persons who are older (Morris et al.,1980; Siscovick et al.,1984), hypertensive (Paffenbarger et al.,1978; Paffenbarger, Hyde, Wing, & Steinmetz, 1984; Siscovick et al.,1984), or obese (Siscovick et al.,1984). Findings from these studies suggested that persons with these other risk factors for CHD, reduce their risk the most by habitual vigorous activity.

Factors not yet determined at this period were:

- At what point in life and for how long one needs to be physically active to achieve the cardiac benefits of activity
- The dose-response effects of physical activity. Whether vigorous activity, such as jogging, that results in physical fitness is necessary to achieve the disease specific benefits of physical activity, previous studies having inadequately examined the relationship between less intense activity, such as walking , and these diseases.

Population Studies:1985-1995

In the period 1985 to 1995, studies and reviews of studies on the relationship between physical activity, physical fitness and CHD confirm and extend earlier work, using more detailed physical activity assessment methodology. And from 1985 onwards, the contribution of physical activity to prevention of CHD emerged as a more serious consideration on public health agenda.

In 1987, a systematic assessment by Powell and colleagues focused on all papers published in the English language that provided sufficient data to calculate relative risk or odds ratios for CHD at different levels of physical activity. It was not a meta-analysis as such although sometimes thus described (Armstrong, 1992). Powell compiled an initial list which included 121 articles representing at least 54 studies. Studies were accepted for inclusion in the review only if (i) incident cases could be separated from prevalent cases, and (ii) it was possible to estimate incidence rates, relative risks, odds ratios or mortality ratios, or if a regression analysis had been done. Forty three studies met the selection criteria.

Analysis of the data compared the risk of CHD between active and inactive persons. Some reports did not present the risk estimate but did present sufficient data to calculate the risk, For 18 studies Powell et al. performed the calculations and presented the relative risk estimates with 95% test-based confidence intervals.

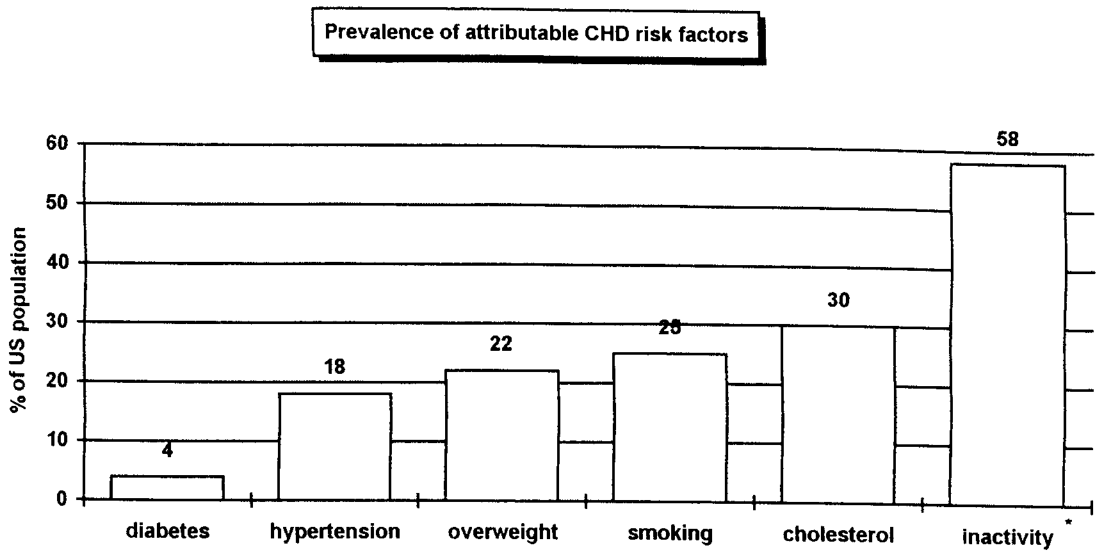
The relative risk of inactivity (1.9: 95% confidence interval =1.4-2.5) appeared to be similar in magnitude to that of hypertension (2.1), hypercholosterlolemia (2.4), and cigarette smoking (2.5). The median relative risk for CHD for inactive persons compared to active persons is 2.0. Their observations suggest that in CHD prevention programmes, regular physical activity should be promoted as vigorously as blood pressure control, dietary modification to lower serum cholesterol, and smoking cessation (Powell et al.,1987).

The second most important observation of their review were that better studies were more likely than poorer studies to report an inverse association between physical activity and CHD incidence. In their review they argue more strongly than had previous authors that the association between physical activity and CHD is causal. In a potent statement, they conclude that the inverse association between physical activity and incidence of CHD is consistently observed, especially in the better designed studies. This association is appropriately sequenced, biologically graded, plausible, and coherent with existing knowledge. Therefore the observations reported in the literature support the inference that physical activity is inversely and causally related to the incidence of CHD (Powell et al.,1987).

While this was the most comprehensive study to-date, it was not inclusive in gender representation. Only five of the 43 studies analysed included an analysis and presentation of data on women separately, although contemporary changes in lifestyle among women in some populations have been stated by investigators as factors which should precipitate research into the gender-risk differential (Dawber, 1980; Kannel & Sorlie,1979; Salonen et al., 1982, Lapidus &Bengtsson, 1986; Scragg et al.,1987). Thirty six of the studies included only men. The 43 studies total providing information primarily about North American and European working aged men.

An article by Heyden and Fodor (1988), however, rather surprisingly does not refer to Powell et al's (1987) review, and suggests that in a "strict" comparison with "traditional" risk factors, physical inactivity plays a lesser role in the development of CHD. They suggested that the elimination of hypercholesterolomeia, hypertension and smoking must remain the greater priorities. At the period, this suggestion was entirely plausible, as data in a Centre for Disease Control analysis indicated that, in 1986, a total of 205,254 deaths associated with CHD were attributed to never or irregularly engaging in physical activity - a number in excess of estimates for smoking (148,879), obesity (190,456) and hypertension (171,121) but similar to the estimates for elevated serum cholesterol (253,194) [Data based on published studies and the U.S. death rate to estimate the number of deaths attributed to several risk factors for nine chronic diseases] (CDC, 1993). The pattern of risk however had already begun to change. And by 1990, similar data analysis indicated that the prevalence of elevated serum cholesterol had declined, and sedentary lifestyle emerged as the most prevalent attributable risk factor (Powell, 1990) [Figure 1.4].

Figure 1.4 *Risk factors for coronary heart disease in the U.S. population (1990)*



Source: Powell, 1990
* Inactivity represents sedentary lifestyle, irregular (< 3 times weekly) or no physical activity

In 1988, the Behavioural Epidemiology and Evaluation Branch of the Centre for Disease Control had considered the significance of inactivity as a risk factor for CHD to be much greater than that of the other risk factors in terms of their ability to have an impact on the population's health (CDC,1988). At the same time, a non-clinical study by Hatziandreu et al.(1988) used a cost-effectiveness analysis to estimate the health and economic implications of a physical activity programme in preventing CHD. The analysis was conducted using a model of two hypothetical cohorts (one physically active and another inactive) of 1,000 men aged 35 years. The analysis was based on a 30 year period to observe differences in the occurrence of CHD events, life expectancy, and quality adjusted life expectancy. Physical activity was associated with 78 fewer CHD events and 1138 quality-adjusted life years gained during the 30-year period. The authors used a median relative risk derived by Powell et al.(1987) in making calculations. The authors concluded that exercise is an economically favourable risk-reduction strategy when compared with other preventive or therapeutic interventions for coronary heart disease (Hatziandreu et al.,1988).

From 1987 onwards, several studies addressed the effects of more moderate intensity leisure time activity and CHD protection, and attempted to establish the dose-response effect.

Leon and colleagues followed a group of men at high risk (in the upper 10% to 15% of a risk score distribution, derived from Framingham Heart Study data, who had no clinical evidence of CHD). In this Multiple Risk Factor Intervention Trial (Leon et al.,1987) 12,138 men were followed for seven years to examine the relation of self-selected leisure time physical activity (LTPA) to first major CHD events and overall mortality. Men in the 2nd and 3rd tertiles of activity had lower coronary heart disease death rates than men in the 1st tertile. There was no advantage for men in the 3rd tertile compared with men in the 2nd tertile of activity. Combined fatal and nonfatal major CHD events however, were 20% lower with high as compared with low LTPA ($P < .05$). Risk differentials persisted after statistical adjustments for possible confounding variables, including baseline risk factors. At the 15.8 year follow-up (Leon & Connett, 1995), the least active tertile continues to show a highest mortality compared to the more active men ($p<0.05$) although the gap between the lowest tertile and others is closing. The 15.8 year relative risk of all-cause mortality in decile 1 was 1.3 as compared to deciles 2-10.

In the 17- to 20-year follow-up study of the U.S. railroad workers' leisure time activity (Slattery et al. 1989), leisure time energy expenditure in light and moderate activities, as well as that of intense effort, showed independent relations to both CHD and all-cause mortality. Risk of CHD death was 1.28 for men who expended 40kcal per week compared with the very active who expended 3,632 kcal per week.

The 9 year follow-up study by Morris and colleagues (1990) examined leisure-time physical activity with regard to all-cause mortality and longevity. Morris et al. reported that when non coronary deaths were added to those from CHD, total death rates were lower in men with an exercise related reduction in CHD, and their survival through middle age and into old age greater than in other men.

The follow-up study of the Harvard Alumni (Paffenbarger et al.,1993) analysed changes in the lifestyles of alumni and the associations of these changes with mortality between

1977 and 1985. Beginning moderately vigorous sports activity (intensity: 4.5 +mets) was associated with a 23% lower risk of death (all-cause), and a 41% lower risk of death from coronary heart disease, than not taking up moderately vigorous sports. The difference in the risk of death (all-cause) associated with an increase in the physical activity index (≥ 2,000 kcal/wk) however, changed from a 55% lower risk to a 10% higher risk as age increased. The authors conclude that the changes in lifestyle made by these men fit the hypothesis that these trends have a favourable effect on mortality. However, the data do not prove a cause-and-effect relation between the adoption of a more active lifestyle and a lower death rate (Paffenbarger et al.,1993).

In the 1990 -1994 period, newer statistical techniques were used to examine the CHD-physical activity association. These methods had been used by researchers in earlier lifestyle association epidemiological studies.(Greenland 1987; Frumkin et al 1988; Longnecker et al., 1988). The meta analyses of Berlin and Colditz (1990) and Kendrick et al.(1991) however, were the first studies to use formal meta-analytic techniques to make *quantitative* summary statements about the relation between physical activity and CHD.

Berlin and Colditz (1990) in three separate analyses, pooled relative risks from studies that had presented separate risks for *sedentary*, *moderate* and *highly active* activity groups. The relative risk for a myocardial infarction among the high activity group compared with the sedentary groups was 2.1 (95% confidence interval 1.1- 4.4). The combined results from comparisons with a moderate activity group gave lower relative risks than those produced by pooling studies with sedentary or mixed comparison groups for each cardiovascular outcome, risks falling in the range 1.1 - 1.6. In the pooled results from three studies of occupational activity, the relative risk for a myocardial infarction among the high activity group compared with the low activity groups from studies that did *not* separate 3 levels of activity (i.e. only low activity) was 2.4 (95% CI 1.8 - 3.2).

The results are consistent with an inverse dose-response relation: increasing physical activity is associated with a decrease in risk of CHD. This quantitative dose-response relation lends support to Paffenbarger's argument that the explanation for a lack of association between increased activity and decreased CHD risk in some studies is the relatively low activity level in the so-called "active" group (Paffenbarger, Hyde & Jung,1984).

In support of the finding of Powell (1987) and his colleagues, the researchers noted that studies with higher quality scores tended to show higher relative risks than those with lower quality scores.

Some of the more recent studies in the meta-analysis had not been included in Powell's assessment.. When unpublished data from the Framingham and Puerto Rico studies (Kannel & Sorlie, 1979; Garcia-Palmieri et al.,1982) were included in the summary of CHD incidence, the pooled relative risks were 1.1 (CI 1.0-1.3) for moderate comparison groups and 1.3 (CI 1.1-1.5) for sedentary comparison groups. In analysis of the studies that had adjusted results for age and other covariates, including cholesterol (Peters et al.,1983; Salonen et al.,1988; Leon et al.,1987; Slattery et al.,1989) multivariate adjustment using regression methods had only a small impact on either the magnitude or the statistical significance of the regression term for physical activity, and physical activity remained an independent predictor of the risk for CHD even after adjustment for other risk factors. This finding conflicts with the evidence provided by the Honolulu Study (Mancini,1994) wherein, after adjustment for other risk factors, physical activity did *not* remain an independent predictor of CHD risk.

Berlin and Colditz (*ibid.*) suggest the possibility that physical activity may modify the harmful effects of other risk factors, but because of lack of requisite data such sub-group analysis was not conducted. In a summary statement, Berlin and Colditz claim that the convincing evidence presented in their study should be important in setting public health priorities. The association shown between lack of physical activity and risk of heart disease implied that sedentary lifestyles could be having a considerable public health impact.

Ireland's main contribution to this area of research is the Kilkenny Health Project (1985-1992), a community cardiovascular disease research and demonstration programme, which studied the prevalence of factors associated with CHD and health behaviours in Kilkenny and in the reference county, Offaly (Shelley, Daly, Graham et al 1991; Shelley, Daly, Kilcoyne, Graham, Mulcahy 1991; The Kilkenny Health Project 1992). The baseline survey in 1985 collected information on factors relevant to CHD in a sample of 784 adults aged 35 to64 years, using similar survey methods and registration procedures which complied with the protocol of the WHO MONICA Project.[2]

A three point physical activity index (PAI) was developed, based on a score assigned to each of the work and leisure exercise categories, with cut-off points determined by using the upper and lower quartiles of its distribution. Using the PAI as an overall measure of exercise, Shelley et al. examined how the traditional coronary risk factors related to activity levels.

The findings showed that in both males and females, high levels of activity were associated with low levels of coronary risk. Females with a high PAI were significantly younger, had lower serum total cholesterol and blood pressure and had a lower body mass index. In males, there were similar differences, but significant results were seen only for age and diastolic blood pressure While smoking was less prevalent in the high PAI group, it did not reach statistical significance. Shelley and colleagues concluded that in view of the high mortality rates in Ireland from CHD, it would be appropriate to promote regular safe participation in physical activity during leisure time.

Northern Ireland researchers, Livingstone et al.(1991) examined the potential contribution of leisure activity to the energy expenditure patterns of sedentary populations in a study of thirty-two healthy adults. the results suggested that discretionary physical activity is now emerging as an equally important determinant of energy expenditure, and therefore that realistically achievable inputs of recreational exercise can have a significant impact in counteracting low levels of energy expenditure which are associated with modern lifestyles and are implicated as a risk factor for coronary heart disease and obesity (Livingstone et al.,1991).

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2 MONICA [Multinational Monitoring of Trends and Determinants in Cardiovascular Disease]

English researchers Shaper and Wannamethee (1991,1992) followed middle aged men for CHD and stroke events over an 8.5 year period, using a complex classification system of six grades of energy expenditure that combines total effort and intensity of effort into six groups. Overall, men who reported sports playing (vigorous) activities weekly had lower CHD rates than men reporting no sports playing. After the exclusion of sports playing (vigorous) from the analysis, there remained a significant inverse relationship between physical activity and CHD incidence. Moderate or moderately vigorous activity groups reported less than half the rate for inactive men, but most vigorously active men experienced higher rates, similar to those classified as occasionally or lightly active.

The Copenhagen Male Study (Hein et al.,1992) followed a cohort of 4,999 middle-aged men over a 17 year period, examining the role of physical fitness or physical activity as a predictor of ischaemic heart disease. A key question posed in this study was whether a very fit man has a lower risk of ischaemic heart disease (IHD), even if he is inactive. Results of the study showed that in sedentary men, fitness was no predictor of future risk of IHD whatsoever, whereas in medium or highly active men, fitness was a strong predictor. Adjusted for age, social class and smoking, the unfit but active men had a lower IHD mortality rate than unfit, but sedentary men ($P < 0.01$) and a lower all-cause mortality rate ($P=0.02$).The least active had a 70% increased mortality rate from IHD. Adjusted relative risk was 1.7 (95% CI,1.2 - 2.3) compared with the more active men, i.e. at least 4 hours light physical activity per week (Table 1.1). Inclusion of blood pressure did not explain this association, and unlike physical fitness, physical activity remained a significant predictor of death from IHD (RR = 1.59) (CI, 1.14-2.21). The finding that men with modest and high activity had the same risk of IHD, meaning that only sedentary men had increased risk of IHD, confirmed the results of the 'MRFIT' study (Leon et al.,1987).

The Honolulu Heart Health Program, as reported by Rodriguez et al.(1994) and Abbott et al.(1994) is a large-scale prospective study for cardiovascular disease in 8006 Japanese-American men aged 45-68 years. The follow-up now exceeds 20 years. Cohorts were classified as *inactive, partially active* or *active* on estimates of current 24 hour habitual physical activity. Using the inactive category as reference group, the researchers found that age-adjusted relative risks for CHD incidence and mortality were significantly diminished among the active men to 0.83 (CI 0.70-0.99) and 0.74 (CI 0.56-0.97), respectively. However, after simultaneous adjustment for many risk factors, the relative risk reductions disappeared. Thus, while activity level per se was not a predictor of coronary disease, the results confirm that increased physical activity is associated with a favourable profile of cardiovascular risk factors, especially with respect of prevalence of diabetes, high body mass index, hypercholesterolaemia, and hypertension (Rodriguez et al.,1994). The authors conclude that this association seems to explain how physical activity improves CHD morbidity and mortality, an explanation proposed by Fletcher (1994) in his most recent review.

The Honolulu Heart study also revealed that inactive and partially active men, compared with those who were active, had fourfold increases in intracerebral haemorrage and threefold increases in subarachnoid haemorrage. Total stroke or stroke of specific types were not related, however, to physical activity in younger middle-age men, whereas in older middle-aged men survival of any kind showed a graded and positive association with activity level. This appears to support earlier findings of the Framingham study (Kannel & Sorlie, 1979). In the 16-year follow-up study of cargo handlers, the relationship between sedentary work and stroke was not statistically significant, but mortality was threefold higher among those who were sedentary.

Mancini (1994) advises that promotion of higher activity levels among younger men should not be discounted on the basis of the Honolulu Heart Study evidence, as it is entirely probable that positive health behaviours and physical activity in younger men will improve their inclination and capacity to continue such behaviours into older years, when the benefits in terms of reducing the risk of stroke and other cardiovascular disease are most pronounced. Mancini concludes that while pharmacotherapeutic approaches are available for some of the modifiable risk factors such as hypertension, diabetes mellitus, hypercholestrolaemia, these approaches are not totally effective as preventive therapies in high-risk individuals, nor are they suitable as first line approaches in primary prevention in low risk subjects (Mancini, 1994). Thus while activity level per se was not a predictor for coronary disease in the Honolulu study, inactivity must be regarded as a specific and potentially modifiable risk factor for stroke. The mechanism by which this salutary result is achieved for stroke but not for CHD remains unclear.

Contrary to this evidence, the results of a Danish study by Lindenstrom and colleagues on lifestyle factors of 12,961 subjects, and their estimated causal contribution to stroke, showed no independent association between leisure time physical activity and stroke risk. A significant independent effect was found for smoking and body mass index (BMI), and BMI in smokers had a significant effect on stroke risk (Lindenstrom et al.,1993).

In a 9.5 year follow-up of the Kaunas-Rotterdam Intervention Study (KRIS), population-specific behaviours, including physical activity, were shown to be involved in differences in the risk of CHD. Although all-cause mortality rates were 30% higher in the Lithuanian population, the risk of fatal and non-fatal heart disease was smaller in Kaunas (RR= 0.72). The lower risk closely corresponded with the Lithuanian risk profile which could be described by less smoking, lower cholesterol levels, and higher physical activity (Bosma et al.,1994).

Most of the research on physical activity and coronary heart disease has involved only men. Thus, there is scant direct evidence that physical activity reduces the incidence of coronary heart disease in women. A cross-sectional analysis of data from the Healthy Women study, however, has shown associations between physical activity and reduced weight, lower blood pressure, and favourable lipid and insulin profiles in peri-menopausal women (Owens et al.,1990). After three years of follow-up, the women who exercised more had gained less weight, and had a smaller drop in HDL cholesterol levels than the more sedentary women. Physical activity, however, was not linked to blood pressure or triglyceride, LDL cholesterol or insulin levels, as it had been in the cross-sectional analysis (Owens et al.,1992). The association between physical activity and coronary risk factors suggests that such benefits would be apparent in large, long-term studies (Rich-Edwards et al.,1995).

Assessing the information on the activity/CHD relationship, Fletcher (1994) concludes that lifestyle and behaviour modifications that include exercise are effective in the prevention of both cardiovascular disease and stroke. The practical implication of the findings of current studies suggest that risk modification programmes that do not incorporate a strategy to increase activity will achieve suboptimal results (Fletcher, 1994).

1.1.2 The relationship between physical fitness and coronary heart disease

While the focus of this study is on physical activity, a behavioural variable, and not the physiological variable of fitness, it is important nevertheless to look at studies which have examined the association between physical fitness and cardiovascular health, as physical activity is a mediator of cardiovascular fitness in adulthood (Astrand & Rodahl, 1986; Bar-Or,1983; Bar-Or, 1987; Pate, 1988; Blair 1985; Haskell et al., 1985; Bouchard et al.,1990), although the strength and significance of the association in childhood is equivocal (Simons-Morton et al.,1987; Cureton, 1987; Bar-Or, 1987; Armstrong et al., 1991; Sallis,1993; Armstrong, 1994; Armstrong & Welsman, 1994; Wigglesworth, 1995). The adult activity / fitness relationship has been depicted in models by Cureton (1987) and Bouchard (1990), and the triad of physical activity, fitness and health has been illustrated in models by Bouchard et al.(1990) and Bouchard & Shephard (1993).

Since physical activity is more difficult to quantify than the level of physical fitness, the latter has gained popularity in the assessment of both cardiovascular function and long-term cardiovascular health. Studies in the early eighties had indicated an association between physical fitness, especially cardiovascular fitness, and positive health outcomes (Gyntelberg et al., 1980; Leon et al., 1981; Wilhelmson et al.,1981; Schroll, 1982; Peters, 1983; Gibbons et al., 1983; Blair et al., 1984; Blair 1985; Duncan et al., 1985) . In the same decade, a number of studies had indicated low physical fitness to be a risk factor for all-cause mortality (Clarket al 1988; Gibbons et al, 1988; Kohl & Blair, 1988; Ekelund et al.,1988; Blair et al 1989) And throughout the period 1985-1995, several studies were conducted which simultaneously investigated the associations of physical activity and cardioresporatory fitness with the risk of coronary disease (Leon et al., 1987; Sobolski et al., 1987; Slattery et al., 1988; Sallis et al., 1988; Slattery et al.,1989;

Hein et al., 1992; Sandvik et al., 1993; Lakka et al.,1994).

Although the positive impact of physical activity on CHD prevention has been well established by the mid-eighties, the specific role of physical fitness was a source of some controversy. An early cohort study by Wilhelmsen (1976) suggested no relationship between fitness and CHD, but the follow-up study (1981), (and consequently more disease end points) found a higher incidence of CHD in men with lower fitness levels at baseline. In Gibbons et al.'s study (1983), fitness as measured by treadmill time, accounted for only a small portion (0.3% to 2.3%) of the variance in risk factors in a group of 1,700 Caucasian women. However, when age and BMI were added, the percent ranged from 2% to 2.1% [no mention of oestrogen status was made in this study: the interactive effect of oestrogen and fitness has yet to be determined]. Sallis and colleagues demonstrated a significant relationship between cardiovascular fitness and cardiovascular risk factors in a study of adults and children. The researchers reported that cardiovascular fitness was consistently correlated with risk factors, such as blood pressure, lipid levels, and body mass index, ($p<0.001$). However, when adjustments were made to control for body mass index, most of the relationships were non-significant, indicating that cardiovascular fitness may not be a strong independent correlate for risk of CHD (Sallis et al.,1988).

Other researchers noted their concerns at the suggested association between physical fitness and CHD prevention (LaPorte, Adams et al., 1984; LaPorte, Dearwater et al., 1985). The Gyntelberg et al. study (1980), for example, determined that the primary association was with the lowest quintile of fitness, where participants were two to three times more likely to have a heart attack than those in the upper quintile. In his critique of the fitness-health sequitur, LaPorte and colleagues contended that the lower 20% already may have had underlying disease that reduced their VO_{2max} rather than that the upper 20% were protected by their fitness. These researchers were also critical of the randomised aerobic trials (May et al 1982) which, they suggest, contribute little support for the concept that increased fitness is associated with reduced CHD risk According to LaPorte and colleagues, epidemiological evidence suggested risk of disease was likely to decrease by merely increasing activity, irrespective of its aerobic nature. Aerobic training had been shown to be inconsistent, for example, in its ability to increase HDL-C (e.g. Williams et al., 1982; Brownell et al.,1984). The Lipid Research Clinic (LRC) trial, found no relationship between treadmill measures of fitness yet found a strong relationship to the activity responses (Haskell et al., 1980). The increase in HDL-C reported in training programmes had typically approached 5mg/100ml. LaPorte et al (*ibid.*) suggest that individuals who engage in aerobic exercise may have higher HDL-C levels and higher fitness levels than sedentary controls, and that there is a circular enhancing relationship between innate physiological make-up and the selection of a lifestyle. Yet on a population basis, activity tends to be highly associated with HDL-C, with highly active groups demonstrating HDL-C levels 15mg/100ml above those of sedentary individuals.(e.g. Farrell et al., 1982; Vodak et al., 1980). There is evidence also that anaerobic exercise may raise HDL-C (Goldberg et al., 1984). Thus LaPorte hypothesises that the physical activity pattern needed to raise HDL-C may not be the same as that needed to improve fitness (LaPorte et al., 1985).

While much of the earlier evidence is equivocal, findings of the later studies indicate positive associations between acceptable fitness levels and CHD risk.

Population Studies 1985-1990

The Oslo study conducted by Lie et al.(1985), followed up a group of male cross-country skiers and 2014 male government and industry workers over a period of seven years. CHD death rates were calculated for each quartile of physical conditioning in both populations. CHD death rates for the best conditioned workers and skiers were comparable, about 1% over the 7-year period. The CHD death rate in the least conditioned quartile was 4.8 times higher than the rate in the best conditioned quartile. This high relative risk was considerably greater than the approximate twofold risk of CHD in sedentary compared with active participants in other studies (Powell, 1987).

In the Lipid Research Clinics Mortality Follow-up Study (Ekelund et al.1988), four fitness categories were defined by submaximal treadmill test, and deaths due to cardiovascular disease were recorded during 8.5 years of follow-up. There was a strong inverse gradient for all-cause and cardiovascular disease mortality across the quartiles of physical fitness (cumulative rates across the conditioning categories : 2.21, 1.56. 1.30 and 0.26). The relative risk for cardiovascular disease mortality was approximately 7.0 when the least physically fit quartile was compared to the most fit quartile (Table 1.2). In Slattery and Jacobs US Railroad Workers study (1988), the association between physical conditioning and mortality was observed in a cohort of 3,043 workers during a 17- to 20-year follow-up period. The relation between level of conditioning and CHD mortality was attenuated (to a relative risk of 1.20) after adjustment for other risk factors, but remained significantly elevated in the least conditioned workers.

Blair's later study (Blair et al.,1989), a large-scale prospective study of healthy men and women with an 8-year follow up, supported the hypothesis that fitness is related to lowered CHD risk. In the 4- and 5- year follow-up analyses, increases in fitness were associated with improved lipoprotein profiles in men, and low physical fitness at baseline was associated with a 52% increase in the incidence of hypertension. (Blair et al.1983; Blair et al.,1984). In the five fitness categories defined by treadmill test in the sample, all-cause death rates attributable to CHD showed significantly greater risk for the lower fitness groups, after statistical adjustment for age, smoking, cholesterol, systolic blood pressure, fasting glucose, and parental history of CHD. The age-adjusted relative risk for low compared with high levels is 9.25 (CI -5.1 to 0.5) for women and 7.93 (CI -8.8 to -3.3) for men (Table 1.2). These values are comparable with the relative risks reported for the Lipid Research Clinics and Oslo studies. Blair had earlier commented on the findings of the 1983 and 1984 studies, and that of Gibbons et al.(1983). when he reported that a threshold of fitness significantly reduces risk, with benefits concentrated at the upper end of the fitness distribution (Blair, 1985). However, a particularly important finding of the 1989 study with significant clinical and public health implications, was that the major reduction in mortality occurred between the lowest and the next lowest quintiles of fitness, thus reversing his earlier assumption.

Population Studies 1990-1995

Recent studies confirm the association between fitness levels and CVD prevention, and delimit the dose-response relationship (Blair et al, 1991; Tipton, 1991; Kohl et al, 1992; Arraiz et al., 1992; Lakka & Salonen, 1993; Lakka et al, 1994)

In the Canada Health Survey, Arraiz and colleagues studied a Canadian population sample in a 7-year follow-up, using three defined fitness groups. Findings by fitness level for risks of cardiovascular disease mortality and all-cause mortality were similar, relative risks ranging from 1.6 (95% CI) for subjects with minimally acceptable fitness levels, to 2.7 for subjects with unacceptable levels, when both were compared with the most fit subjects (Arraiz et al.,1992), (Table 1.2).

In the Copenhagen Male Study (Hein et al.,1992), the two major new findings were (a) that being very fit, provides no protection against CHD - nor all-cause mortality - in sedentary men, and (b) that unfit but sedentary men have a higher risk of CHD than unfit but active men. The least fit physically active men had a lower CHD mortality rate (6%) than the least fit sedentary men (10%): adjusted RR = 1.67 (95% CI, 1.06-2.64) [Table1.2]. The least fit men, those in the lowest quintile of fitness values, had an almost doubled risk (RR =1.9) (CI, 1.2-2.9) compared with the most fit, adjusting for age, smoking and social class. However, when adjusted for blood pressure as well, fitness was no longer a statistically significant predictor. Previous studies on physical fitness as a predictor of CHD had not discussed the problem of blood pressure as a confounding factor [Men with high BP values were excluded in studies by Blair et al.(1989), Ekelund et al. (1988) and Sobolski et al.(1987)].

In a 16-year follow-up investigation of Norwegian men that began in 1972, Sandvik et al.(1993) studied the association of physical fitness to cardiovascular and all-cause mortality. The adjusted relative risk of death from cardiovascular causes in fitness quartile 4 as compared with quartile 1 was 0.41 (CI 0.20-0.84) [Table1.2]. In this study, physical fitness appeared to be a graded, independent, long-term predictor of mortality from cardiovascular causes. Although a close, direct correlation between reported physical activity and level of physical fitness was found in the study, a high level of physical activity, as defined, had no independent prognostic value. The authors suggest that their estimates of physical activity during leisure hours were too "crude" to allow speculation about its role in cardiovascular disease prevention, supporting the inference made by Powell et al.(1987) and Berlin & Colditz (1990) concerning design of activity measures. The authors are confident however, in drawing their conclusion from studies of physical fitness and cardiovascular health. The aggregate data in the literature represent a body of evidence that, according to epidemiologic principles,[3] suggests a causal relation between physical fitness and mortality from cardiovascular causes (Sandvik et al.,1993).

During the period 1984 to 1989, Lakka and colleagues (1994) investigated the independent associations of physical activity during leisure time and maximal oxygen uptake (a measure of cardiorespiratory fitness) with the risk of acute myocardial infarction. In the period 1984-'89, baseline examinations of 1,453 Finnish men aged 42-60 years, who did not report having cardiovascular disease or cancer, were performed. Although some studies had observed that either leisure-time activity (Leon et al.1987; Hein et al.1992) or cardiorespiratory fitness (Sobolski et al. 1987; Sandvik et al.1993) alone had an inverse and significant relation to the risk of CHD, to this date, little was known about the level of cardiorespiratory fitness required to protect against the disease. There were three important findings in this study.

1. After up to 17 confounding variables were controlled for, the relative hazardsfor the third of subjects with the highest level of physical activity (0.34; 95% CI, 0.12 to 0.90) and maximal oxygen uptake (0.35; 95% CI, 0.13 to 0.92), as compared with the values in the lowest third, were significantly ($p = 0.05$) less than 1.0.[4] The decrease in risk among the most active and fit men was greater than that observed in most previous studies (Leon et al., 1987; Slattery et al.,1989; Shaper & Wannamathee, 1991; Hein et al.,1992; Sandvik et al.1993). but similar to the risk calculated for inactivity in Powell's analysis.

[3] Statistical evidence and inference. In: Bradford Hill A., 1971. *Principles of medical statistics.* 9th ed. New York: Oxford University Press. 309-323.

[4] Relative hazards adjusted for risk factors were estimated as antilogarithms of coefficients from multivariate models

2. After adjustment for a number of coronary risk factors, men who engaged in more than two hours conditioning physical activity a week had a risk 60% lower than that of the least active men. Men with a maximal oxygen uptake of at least 2.7 litres per minute, had a risk 55% lower than that of the least fit men (Table 1.2). These findings do not support earlier findings of a plateau (Paffenbarger et al. 1978; Leon et al.1987; Slattery et al.1989) or an increase (Garcia-Palmieri et al.1982; Shaper & Wannamethee,1991) in risk *above* a certain level of physical activity.

3. Neither non-conditioning physical activity nor walking or bicycling to work was associated with coronary risk

The quantitative methods used in this study enabled Lakka et al to investigate the dose-response relations of leisure-time physical activity and cardiorespiratory fitness to the risk of myocardial infarction. Findings are consistent with the notion that lower levels of both conditioning leisure time physical activity and cardiorespiratory fitness are important, independent coronary risk factors.

It appears, therefore, that both physical fitness (at least cardiovascular fitness) and habitual physical activity are inversely related to CHD risk in adults. Some studies have suggested that physical inactivity increases the risk of coronary disease by a factor of two (Siscovick et al.,1984, Powell et al.,1987, Lakka et al.,1994). In further analysis (and additional follow-up) of early cohort studies (Morris et al.,1990; Paffenbarger et al.,1993; Leon et al.,1995) relative risk of inactivity is attenuated to 1.25 - 1.3 [Table1.1]. Relative risks calculated using physical fitness measures are much higher [Table 1.2]. Although the reasons for these differences in relative risk are unclear, there may be less misclassification in the fitness studies, habitual physical activity being difficult to assess reliably. Evidence from three North European studies of populations who share a broadly similar lifestyle to the Irish population is remarkably similar [Table1.2]. Findings in the two British studies of physical activity and cardiovascular disease are similarly consistent [Table1.1]. Cumulative observations clearly support the designation of sedentary lifestyle as an antecedent risk factor in cardiovascular disease.

An assessment of expert medical and epidemiological opinion about the role of lifestyle in health was recently carried out in a number of academic departments in Western European universities (Steptoe & Wardle, 1994). More than 70% considered exercise to be a definite or probable influence on heart disease, while the only links to be endorsed as definite by over 90% of respondents were those between smoking and both heart disease and cancer. Interestingly, experts from the UK and Ireland were generally less likely to endorse lifestyle disease links than those from other European countries.

Although some opinion on the influence of physical activity is equivocal, accumulated evidence indicates that an active way of life appears to prevent or delay coronary heart disease and stroke incidence.

Table 1.1 *Summary of results from studies on physical activity and cardiovascular events*

Study / Pop	Design	Activity Measure	End Point	Relative Risk
Morris et al. (1990) 9.376 men	Prospective 9 year follow-up	Leisure	CHD attacks 217 fatal 272 non-fatal	not reported
Shaper & Wannamathee. (1991, 1992) 7735 men	Prospective 8 - 8.5 year follow-up	Leisure	CHD attacks 217 fatal 271 non-fatal	1.0τ
Hein et al. (1992) 4.999 men	Prospective 17 year follow-up	Leisure 4 -category weekly activity	CHD mortality 266 deaths	1.70 ∞
Paffenbarger et al(1993) 10.269 men	Prospective 8 year follow-up (1977-1985)	Leisure < 2.000 kcal per week	All-cause mortality 476 deaths	1.25 *f*
Lakka et al (1994) 1.166 men	Prospective 4 - 8 year follow-up	Leisure 12 - month history	Acute myocardial infarction 57 events	0.34 *ff*
Leon et al., (1995) 12.138 men **	Prospective 15.8 year follow-up	LTPA in minutes per day	CHD and all cause mortality	1.3*

τ Inactive / vigorous activity [index measured]
∞ Sedentary / moderate and vigorous leisure activity
f Sedentary living / active living
ff Highest third / lowest third
* Lowest decile / deciles 2-10
** MRFIT subjects in upper 10-15% of a risk score distribution

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Table 1.2 *Summary of results from studies on physical fitness and cardiovascular events*

Study/Pop	Design	Conditioning Measure	End Point	Relative Risk
Lipid Research Clinics (1988) Ekelund et al. 3,106 men	Prospective 8.5 year follow-up	Submaximal treadmill test	CHD and CVD deaths: 45	6.5 (CI,1.5-28.7) for CHD death 8.5 (CI, 2.0-36.7) for CVD death *
Aerobics Center Blair et al (1989) 3,120 women 10,224 men	Prospective 8.2 year follow-up	Maximal exercise tolerance, treadmill test	CVD deaths: 73 (7 women, 66 men)	9.25 (CI, -5.1to 10.5) for women 7.93 (CI, -8.8 to-3.3) for men **
Canada Health Survey:Arraiz et al.(1992) 2,174 men and women	Prospective 7 year follow-up	Submaximal step test	CVD deaths: 37	2.7 (CI,1.4 to 5.5) adjusted for age and other major CHD risk factors *f*
Copenhagen Male Study Hein et al (1992) 4,999 men	Prospective 17 year follow-up	Bicycle ergometer test	IHD mortality 266 deaths	1.9 (CI, 1.2 - 2.9) adjusted for age, social class, smoking (but not BP) ∞
Sandvik et al. (1993) 1,960 Norwegian men	Prospective 16 year follow-up	Symptom limited exercise tolerance, bicycle ergometer test	CVD deaths 144	0.41 (CI, 0.20-0.84) adjusted for age, smoking and baseline risk factors *ff*
Kuopio Study Finland: Lakka et al (1994) 1,453 men	Prospective 5 year follow-up	Maximal exercise tolerance,bicycle ergometer test	First acute myocardial infarction: 42	0.35 (CI, 0.13 - 0.92) adjusted for confounding variables and base line risk factors *fff*

* Least conditioned / best conditioned quartile
** Least conditioned / most conditioned quintile
f Unacceptable conditioning / recommended level of conditioning
∞ Least fit quintile / most fit quintile
ff Best conditioned quartile / least conditioned quartile
fff Best conditioned tertile / least conditioned tertile

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1.1.3 Physical activity and mechanisms in CVD prevention

The beneficial effect of activity in cardiovascular disease prevention appears to be conferred through more than one mechanism. Some earlier researchers (Dyer et al. 1980; Haskell,1984; Blair,1985) considered activity-induced changes in the myocardium to be important mechanisms in CHD prevention. Recent evidence, however, supports the thesis of Laporte et al.(1985) and Sallis et al.(1988), that the effect of activity is largely through modification of the cardiovascular disease risk factors (Mersy, 1991; Mori and Arakawa, 1993; Ikeda et al.,1993; Ruderman & Schneider, 1992; Rodriguez et al.,1994; Mancini,1994; Fletcher, 1994).

The level of high density lipoprotein cholesterol (HDL-C) is a primary risk factor for coronary heart disease (Miller & Miller, 1975,Gordon et al., 1977; Fletcher,1994), and appears to be associated with activity levels (Adner & Castelli, 1980; Clarkson et al., 1981; Hartung et al., 1980; Enger et al., 1977; Farrell et al., 1982; Lehtonen & Vikari, 1980; Vodak et al., 1980; Thorland & Gilliam, 1981; Blair et al., 1983; Hardman et al, 1989). The rise in HDL concentrations appears to reflect an increase in lipid transport to HDL as a result of increased lipoprotein lipase activity (Thompson, 1990). HDL-cholesterol, however, may revert quite rapidly to pre-training levels unless exercise is maintained (Dresendorfer et al., 1982). There is also a very modest effect on total cholesterol in people who exercise, however this effect is more substantial if they also modify their diet and lose weight (Fletcher,1993). Diabetes and obesity are other risk factors which are modifiable through activity . Exercise also adds an independent effect in the lowering of blood pressure in certain hypertensive groups (Fletcher, 1994). Physicians have also considered the possibility that the main benefit may lie in other less easily documented changes, for example those which underlie thrombus formation (Royal College of Physicians,1991).

Fentem's taxonomy encompasses the possible mechanisms of protection documented in the literature.:

- A reduction in classic risk factors: cigarette smoking, hypertension, body mass index
- Modifications in the natural history of atherosclerosis: improved lipid profile, glucose tolerance/insulin sensitivity and lower arterial blood pressure
- Favourable effects on acute precipitants: inhibition of clotting processes and platelet aggregation. and enhanced electrical stability (Fentem, 1992)

All the relevant major processes appear to be moderated by vigorous, continuing and current physical exercise. In the case of the profile of blood lipid concentrations, clotting factors and possibly the level of arterial blood pressure, the operative factor may be *recent* exercise. Other factors are more likely to benefit from the long-term adaptations which occur with the improvements in stamina and cardiorespiratory fitness.

Dubbert (1992) and Mancini (1994) advert to the fact that none of the suggested mechanisms has been clearly proven. Data are also unavailable on intermediate variables - such as dyslipoproteinemia, hyperinsulinemia, hyperglycemia, cardiac dysfunction, and actual blood pressure levels - that might provide a causal pathway between physical inactivity and higher death rates from coronary heart disease and from all causes (Paffenbarger et al.,1993). Although there is much debate over the underlying mechanisms, and some of the available evidence is equivocal, the circumstantial evidence amassed by epidemiological studies and the known cardiovascular benefits of physical activity justify a public health emphasis on coronary heart disease prevention through the medium of physical activity.

1.1.4 Risks of physical activity: sudden death in CVD

Reports of sudden cardiac death rates per 100,000 hours of exercise range from 0 to 2.0 per 100,000 in general populations. and from 0.13 to 0.61 per 100,000 in cardiac rehabilitation programmes (Haskell, 1978; Van Camp & Peterson, 1986; Koplan et al., 1985).

Based on numerous case reports and series, and given biological plausibility, there is concern that vigorous activity might precipitate sudden cardiac death. Occasional deaths during running events and other sporting activites underline the point that exercise can be dangerous, especially in those with unsuspected underlying heart disease (Northcote & Ballantyne, 1984). Asymptomatic persons after a long period of inactivity are at risk of cardiac events, (particularly ventricular fibrillation), during vigorous exercise, and explosive exercise, such as squash, may be particularly dangerous in the untrained (Royal College of Physicians, 1991). Siscovick and colleagues agree that the observation that habitual activity may protect overall from coronary heart disease does not preclude the possibility that there is a transient increase in the risk of sudden cardiac death during the act of exercise itself (Siscovick et al., 1985).

Data from the community-based study of primary cardiac arrest (Siscovick et al.,1984a) a population based case-control study, suggested that the risk of cardiac arrest during activity was higher than during inactivity, at each level of habitual activity. However, the magnitude of the increased risk during activity was reduced with increasing levels of habitual activity. Further, among persons in the upper levels of habitual vigorous activity, their transient increase in risk during activity was outweighed by a decrease in risk during non-exercise periods; thus , their overall risk of primary cardiac arrest was lower than that of men in the lower levels of habitual activity. Notwithstanding these results, in a later report Siscovick and colleagues concluded that it remains unclear whether there are groups of apparently healthy persons who have a particularly large increase in risk during vigorous activity (Siscovick et al., 1985).

Oberman (1985) and Haskell (1985) both report the potential risk of sudden cardiac death during vigorous exercise in people with existing coronary risk factors. Vigorous exercise risk for such people is also noted by Shaper and Wannamethee (1991, 1992). In men symptomatic from CHD or stroke at entry to their study, those engaged in moderately vigorous or vigorous activity tended to experience a higher risk of CHD than that of inactive men. In asymptomatic men at entry, vigorous sports playing activity was also associated with an increased rate of CHD as compared with that for men engaged only in moderate or moderately vigorous activity. However, in the Multiple Risk Factor

Intervention Trial, where subjects were in the upper 10% to 15% of a risk score distribution, habitual vigorous leisure-time physical activity was not associated with excess sudden death (Leon et al 1987).

In the Harvard Alumni follow-up study (Paffenbarger et al.,1993), associations of increases in the physical activity index with age-specific mortality were examined. The difference in the risk of death associated with an increase in the physical activity index changed from a 55% lower risk to a 10% higher risk as age increased, while moderately vigorous activity (intensity: 4.5 METs)[5] conferred a steady advantage from the youngest to the oldest age group.

In general, risk factors which epidemiological studies have shown to be important for CVD in its other manifestations are similar to those for sudden death (Siscovick et al., 1984b) In a study of risk factors for exercise-induced silent myocardial ischemia (SI), older age, male gender, abdominal obesity and reduced HDL levels (all well-established risk factors for overt CAD) were risk factors for exercise induced SI in the 281 asymptomatic volunteers (Katzel et al.,1994).

There is however general agreement among physicians that the hazards of exercise appear to be substantially outweighed by benefits. Fentem (1992) suggests that protection in activity might accrue from the cardiovascular and sympatho-adrenal response to acute exercise, and exercise-induced increases in the electrical stability of the heart muscle, thereby reducing the risk of fatal cardiac arrhythmias and possibly of sudden death. Severe problems can usually be avoided by careful attention to the presence of warning symptoms (Royal College of Physicians, 1991)

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[5] MET denotes metabolic equivalents of oxygen consumption. A metabolic unit is the ratio of the metabolic rate during exercise to the metabolic rate at rest. One MET corresponds to an energy expenditure of approx. 1 kcal per kilogram of body weight per hour and an oxygen uptake of 3.5 ml. per kilogram per minute. For a 60-kg person, 1MET is approx. $1 kcal.min^{-1}$ (Sallis et al.,1985)

1.1.5 Efficacy of physical activity in CHD protection: Implications for activity prescription

The ever-escalating cost of management of atherosclerotic heart disease, in economic and human terms, gives the prescription of such preventive measures as exercise renewed imperative, and such prescription should apply to people of all ages (Fletcher,1993).

While few would argue with Fletcher's statement, the specific nature of such prescription remains controversial. It has been established that physical activity acts directly to reduce the risk of coronary heart disease and stroke (Secretary of State for Health, 1992), yet data on the type, duration, and intensity of physical activity needed to protect against such are limited and inconsistent. The level of cardiorespiratory fitness required to protect against coronary heart disease is also still unclear. Lakka (1994) has suggested that the inconsistency derives from the absence of truly quantitative assessments of physical activity in most studies, and absence of information on the relation of direct measurements of maximal oxygen uptake, the most accurate method for assessing cardiorespiratory fitness to CHD risk (Haskell et al.,1991). Many extant studies are relatively short term, and this complicates the establishment of an intensity threshold. A 12-month history gives a more accurate estimate of the past level of physical activity than short-term measurements (Lakka & Salonen, 1992).

Early researchers advocated that activity must be of vigorous intensity to exert protective effects (Morris et al., 1980; Paffenbarger et al., 1978). In the first British Civil Servant Study, only vigorous physical activity was associated with a decreased risk of coronary heart disease. Morris and colleagues further analysed the fate, after 9 years, of a 1-in-4 sample of 9376 civil servants who first entered the study in 1976. Men aged 45 to 54 years required more energy expenditure to achieve beneficial levels of exercise against CHD than their elders, aged 55 to 64 years, who had lower functional capacity with advancing age. Non-vigorous sports play showed little benefit in reducing CHD risk over none at all. These results confirmed their previous conclusion, that it is *vigorous* exercise during leisure time (>7.5 kcal/min or > 6 Mets) which leads to a reduction in risk for heart attack. Morris and his colleagues reported therefore that habitual vigorous aerobic exercise for sustained periods, involving the movement of large muscle mass, is the only exercise factor which is consistently and substantially associated with a lower incidence of CHD (Morris et al.,1990).

In the all-cause mortality and longevity of college alumni study (Paffenbarger et al.,1986) the protective effect of exercise, in terms of cardiovascular disease, was related to the total amount of energy expended during regular physical activity, rather than to the amount of vigorous exercise taken. Risk of death became progressively lower as the physical-activity level increased from below 500 to about 3500 kcal per week - the level at which the relative risk was less than half that associated with the least activity. Thus an activity level of around 2,000kcal per week was identified as the 'threshold' level. In this study, moderate intensity activity (light sports) did not influence the incidence of coronary heart disease. Vigorous sports tended to avert CHD, but there was a reversing trend at three or more hours of play, or expenditure level greater than 3,500 kcal per week. *All-cause* mortality rates, however, were lowered by increased hours of light sports play, somewhat more than by walking.

Differences in subjects' selection, however, must be considered in interpreting the outcomes of both studies. Morris et al.(1990) characterised their subjects as more active than average Britons, and more fit and active than age comparable alumni, hence the alumni might show benefit from less exercise than the British. Definition of the term "vigorous", as applied by Morris et al., might also be misleading. Peak energy expenditure greater than 6 METS is defined as "vigorous", but on Laporte's investigation, the primary form of vigorous energy expended by participants in this study was gardening (Laporte 1985). This type of activity is typically classified as 'moderate'intensity (4.3-5.4 Mets) by physicians (Royal College of Physicians,1991).

Results of the Civil Servant and Alumni studies, as reported, suggest that the activity-health relationship for CHD risk reduction may not, in fact, be mediated by threshold levels of *moderate* intensity activity. This hypothesis is supported by Fentem (1992) and Lakka et al.(1994). Data from Lakka et al.'s large-scale prospective study indicate that physical activity with a mean intensity of 6 METs (or six times higher than resting metabolic rate) may be required to decrease the risk.

The vigorous intensity activity prescription is controverted by Haskell (1985), Powell et al.(1987), Leon et al.(1987), Slattery et al.(1989) and Shaper & Wannmethee (1992). Evidence in these studies indicates that exercise of moderate duration and intensity is sufficient to reduce the risk, and that low to moderate intensity leisure time physical activity performed daily, may exert important protective effects against ischaemic heart disease events. In the US Railroad Study (Slattery et al.1989), both low-to-moderate and vigorous physical activity were inversely associated with mortality from coronary disease. Results of the Multiple Risk Factor Intervention Trial (Leon et al.1987) showed the optimal amount of energy expenditure for reducing CHD mortality to be accomplished by 30 to 69 minutes of predominantly light and moderate intensity activities (Tertile 2 - mean 234 kcal /day), high intensity exercise (Tertile 3 - mean 638 kcal / day) affording little additional benefit. Observations of a plateau effect in vigorous activity are also reported in Shaper & Wannamethee's study. Their findings and those of Garcia-Palmieri (1982) suggest that, in fact, more frequent vigorous and recreational (competitive) activities may be associated with higher rates than those for less vigorous, regular physical activity.

From the preventive medicine and public health standpoints, the protective effects of moderate intensity activity is an encouraging finding, since most people should be able to schedule this type of activity as part of their daily routine (Hovell et al.,1989). The plateau of intensity is also an important consideration, in the light of potential risk of sudden cardiac death during vigorous exercise, particularly for people with existing or occult coronary disease (Oberman, 1985; Haskell, 1985), although data in the recent Finnish study (Lakka et al.,1994) do not support findings of such a plateau or an increase in risk above a certain level of physical activity. Analysis of data in a study of physical activity and mortality among elderly men (Linsted et al.,1991) showed that crossover of risk for moderate activity occurred at 95.4 years of age, and for higher activity at 78.2 years of age. These findings revealed that moderate physical activity continues to be important well into old age, but at each age class all-cause death rates were higher for the highly active than the moderately active.

Perhaps the most encompassing statement on activity and CHD risk reduction is that made by Powell and colleagues (1986). Observing the relationship between activity and CHD in graphical analysis of risk data from six studies: the Framingham Study (Kannel & Sorlie,1979), the Puerto Rico Study (Garcia Palmieri et al.,1982), the King County W.A. study (Siscovick et al.,1982), the US Railroad Study (Slattery et al.,1985), and the Longshoremen and Harvard Alumni Studies (Thomas et al.,1981), they conclude that the logarithmic decline in risk suggests that, for a given increment in activity, the reduction in the risk of CHD is greatest at the lower end of the activity spectrum. The level of activity at which a statistically significant improvement is shown should not be equated with a threshold below which there are no benefits. Benefits accrue with any increment in activity, except perhaps at the highest levels of activity (Powell et al. 1986).

In studies which used measures of 'fitness' to establish disease protective effects, there is considerable variation amongst researchers on threshold conditioning levels. Studies conducted by Juneau et al.(1987) and King et al.(1987) showed a significant physiological effect of moderate-intensity exercise training in healthy middle-aged men and women. In Lakka et al.'s study, only moderate to high intensity (conditioning) activity was associated with decreased coronary risk Analysis of results in Blair et al.'s study (1989) showed that the major reduction in mortality occurred between the lowest and the next lowest quintiles of fitness. Findings of this study have been interpreted by Dubbert to mean that most men and women can attain the level of fitness, associated with the plateau in death rates in the study, by engaging in exercise equivalent to a brisk daily 30 to 60 minute walk (Dubbert, 1992).

Evidence from studies based on standard physiological tests (such as maximal oxygen uptake) has been used by the American College of Sports Medicine to establish standard exercise prescriptions. The guidelines initially recommended aerobic exercise of an intensity of 70% of VO_2 max. These guidelines were subsequently revised to include an intensity of 60% - 90%, and now revised downwards to an intensity of 50% (VO_{2max}) as being 'protective' in cardiovascular disease (ACSM,1978; ACSM,1986; ACSM,1990). In attempting to combat CHD however, which is essentially a behavioural/environmental disease, it is not wholly appropriate to focus on VO_2 max. In this context, Biddle & Mutrie (1991) consider that due to the strong influence of heredity on aerobic power, 20th century lifestyle has not had quite the same effect upon VO2 max (Morris et al, 1987; Hopkins & Robinson, 1988), and standard physiological tests are not the most relevant or most changeable aspect of the person's physiological response to exercise (Biddle & Mutrie,1991). From a public health perspective it seems clear that recommendations should focus on behaviour rather than on physiological status.

While a unanimous view does not exist as to whether there is a graded benefit with increasing levels of exercise, or whether a critical amount of activity is required before benefit is produced there is a consensus of opinion on regularity of activity. Physicians concur that all *regular* exercise has a training effect which can reverse the physiological and biochemical changes caused by inactivity (Royal College of Physicians,1991).

Regularity of vigorous activity has been described as three times per week (Heartbeat Wales, 1987; ACSM, 1990; Kilkenny Health Project, 1992; Astrand, 1992) or the equivalence of a weekly energy output exceeding 2000 kcal.(Paffenbarger et al.,1990). Moderate or low intensity activity is recommended on a daily basis (Åstrand, 1992; CDC,1993). Many physicians and physiologists adhere to the duration prescription of 20-30 minutes continuous vigorous exercise three times weekly (Fentem, 1992). Whether this is an optimal or a minimum amount is unclear (Monahan, 1987) More recent research has examined the efficacy of shorter periods (of moderate intensity) which may be more acceptable recommendations for time constrained population groups (DeBusk et al.,1990). Even short duration, low intensity activity, performed daily, has been suggested by Biddle & Mutrie (1991) to provide considerable psychological gain.

DeBusk and colleagues' study was the first investigation of the physiologic effects of exercise provided in sessions as brief as 10 minutes versus the effects of longer bouts of exercise. Multiple short bouts of exercise increased peak oxygen uptake 57% as much as a single long bout of exercise of the same total duration. Maximal oxygen uptake increased 13.9% in the long bout group from 33.3 ± 3 to 37.7 ± 7 ml/kg/min and 7.6% in the short bout group from 32.1 ± 3.5 to 34.6 ± 3.4 ml/kg/min. Other indices of training, including the increase in treadmill test duration and the decrease in heart rate at submaximal exercise, were similar in both groups. Decreases in weight after training were similar for both (1.75 and 1.79 kg respectively), approximately the weight loss expected from the increased caloric expenditure attributable to exercise. The researchers concluded that multiple short bouts of moderate-intensity exercise training significantly increase peak oxygen uptake (DeBusk et al.1990).

Devising population prescriptions for health-related activity is a complex task. Effective exercise prescription which will meet the health needs of a given target group will vary according to the health of the individuals, their current physical status, and the particular improvement which is sought (Bouchard, 1988; Dargie & Grant,1991; Dionne et al.,1991). Compliance problems in particular (Dishman, 1988) and to a lesser extent, the hazards associated with high intensity activity, have caused considerable reflection on the appropriateness of vigorous intensity activity in public health promotion. The optimal amount of activity (giving maximum benefit with minimum risk and cost) and the minimal amount of activity (public perception of the minimum one needs to do) are polarised, and finding the acceptable middle ground remains a formidable challenge. In a commentary on the primary prevention of disease, King & Dowd (1990) affirm the difficulties in public health prescription. Although obvious or widespread risk factors in populations appear the natural candidates for intervention, their reduction may not be practicable (as is the case for age) or widely acceptable (as may be the case for obesity or physical inactivity) (King & Dowd, 1990).

Moderate levels of activity are now receiving increased attention as they have been shown to be better maintained over time than vigorous activities (Sallis et al., 1986; Dishman, 1988; Sallis & Mckenzie,1991; Health of the Nation,1992), and women are as active as men in these activities (Hovell et al.,1989; Sallis et al.,1985). Accumulating knowledge indicates that the health advantages (including cardiovascular health) of vigorous physical activity appear to be relative, rather than absolute, and that light to moderate intensity activity can have significant health benefits. Epidemiologists (Laporte et al., 1985; Ramlow et al., 1987; Haskell,1985) point out that certain health related biologic measures (e.g. high density lipoprotein cholesterol), respond to exercise throughout the full spectrum of activity status.

Therefore, although frequent vigorous activity may be required for optimal cardiovascular fitness, newer data would seem to support the value of regular moderate activity with brief bursts of vigorous activity for the *active* population. For those who are just beginning to exercise, the very unfit and the elderly (Harris et al.,1989), current research and clinical guidelines strongly emphasise the potential benefits of lower intensity activity. Much of the medical opinion, however, is still guarded on the specificity of activity prescription. What kinds of physical activity should be unreservedly prescribed, how much, how intense, and for whom if optimal health and longevity are to be achieved remain unanswered questions that require further clarification (Paffenbarger et al.,1993).

Exercise participation targets for the Irish population, set out in the most recent health strategy document are not age-cohort specific, and do not incorporate any *vigorous* intensity exercise component. The strategy aims to achieve a

> .... 30% increase in the proportion of the population aged 15 and over who engage in an accumulated 30 minutes of light physical exercise most days of the week

and

> .... a 20% increase in the proportion of the population who engage in moderate exercise for at least twenty minutes, three times a week by the year 2000 (Department of Health, 1994).

As baseline patterns of activity had not been established (prior to publication of this report) the increments proposed are meaningless. It is proposed to review these aims in the light of data being collated in the Happy Heart National Survey (Irish heart Foundation,1994). The latter however is not an epidemiological study of physical activity per se, and hence the activity measures are limited.

To make regional and international comparisons and to measure behaviour change, it is important to establish detailed baseline patterns of physical activity, such as the data collated in the Allied Dunbar National Fitness Survey (1992). It is regrettable that the Irish Health Strategy document gives such token mention to physical activity and to the methods by which exercise targets might be achieved.

1.2 The role of physical activity in the prevention of mild/moderate systemic arterial hypertension

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It has been established that the relationship between blood pressure and CHD is continuous and of the same order as the relationship between blood cholesterol and CHD, while the relationship between blood pressure and stroke is stronger (Health of the Nation, 1992).

In the United States, an estimate of the population-attributable risk for CHD mortality associated with hypertension among a selected group of men from 1977 through 1985 was 20% (Paffenbarger et al.,1993). In comparison, the risk for cigarette smoking was 13%; physical inactivity 14%; and for a positive family history of premature parental death, 20%.

In Ireland, the baseline survey of factors associated with CHD carried out in Kilkenny in 1985, showed that 23.4% of males and 23.6% of females were hypertensive[6] with blood pressures of ≥ 160/100mmHg. In 1990, this figure had declined somewhat to 20% of males and 18% of females in Kilkenny, and to similar percentages in the reference county Offaly (Kilkenny Health Project, 1992). Comparison of the findings in Kilkenny with those in the two nearest MONICA centres, Belfast and Glascow, populations which share similar lifestyles and high mortality rates from CHD, showed age-standardised prevalence of hypertension to be similar to that reported for Belfast (21.0%) but lower than that for Glasgow (27.5%) (Shelley et al.,1991b).

While there were no actual measurements of blood pressure done to validate the histories of raised blood pressure in respondents in the Happy Heart National Survey (Irish Heart Foundation,1994), the recorded steep rise of such a history with age and the higher prevalence of such a history in the manual working class are similar to the findings of the Kilkenny Health Project.

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6 Hypertension = systolic BP > 159mmHg and /or diastolic BP > 94 mmHg, whether or not on treatment

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1.2.2 Physical activity and the development of arterial hypertension

The epidemiological evidence suggests that habitual activity level is a factor in determining the frequency with which arterial hypertension develops in previously normotensive men and women In cross-sectional studies of the general population, more physically active and physically fit adults generally were reported as having lower blood pressure and less hypertension, than inactive or low fit persons across all levels of activity and fitness (Hicky et al., 1975; Kukkonen et al., 1982; Paffenbarger et al., 1983; Gibbons et al., 1983; Cade et al.,1984; Blair et al., 1984; Kiyonaga et al.,1984; Duncan et al.,1985; Fagard, 1985; Jennings et al., 1986; Reaven et al.,1991). The possible effects may be produced through both direct and indirect mechanisms. Physical activity may directly help prevent hypertension by lowering elevated plasma catecholamine levels, and may indirectly affect hypertension risk by producing weight loss.

In a review of the results of 15 early epidemiological studies, Montoye et al.(1972) concluded that, when a difference was noted between active and inactive populations, the active group always had the lower blood pressure. Early cross-cultural studies by Cassell (1975) showed that populations that are less industrialised generally have lower blood pressures and show little or no increase in blood pressure with age. Montoye (*ibid.*) also observed that, in studies that measured body fatness, when higher activity levels were associated with lower blood pressures, the more active populations were also found to be leaner. Thus, although previous epidemiological data indicated that higher levels of daily activity may result in lower systolic and diastolic blood pressures, the effect observed, and as noted by Fagard (1990), may also be the result of less body weight and fatness in active individuals rather than a direct result of exercise.

In the large cohort study of Harvard College Alumni (Paffenbarger et al., 1983), alumni who did not engage in vigorous sports play were at 35% greater risk of hypertension than those who were active. This relationship was independent of other predictors of increased risk. Siscovick and colleagues noted, that in the alumni study, the inverse relationship between contemporary vigorous activity and hypertension risk was primarily among those alumni who were overweight-for-height, thus suggesting that this group might particularly benefit from activity (Siscovick et al., 1985).

In an assessment of a large cohort (6,000 Ss) of healthy normotensive men and women, Blair and colleagues (1984) used maximal treadmill testing to determine if the level of fitness was related to the incidence of physician-diagnosed hypertension. When compared with highly "fit" persons, persons with low levels of fitness were at 52% greater risk for the development of hypertension, and risk was also independent of other CHD risk factors (*ibid.*).

In the large cross sectional studies that demonstrated an inverse relationship between the level of physical activity or physical fitness and systolic and diastolic blood pressure levels, among apparently healthy, primarily normotensive persons, although blood pressure was lower among persons who were active or fit, compared with non-active or unfit persons, the magnitude of the effect in the populations appeared small (2 to 5mmHg). Cross-sectional design of these studies makes them particularly vulnerable to potential confounding. The possibility of less healthy people avoiding physical activity, for example, cannot be ignored (Royal College of Physicians,1991). Data from the UK Health and Lifestyle Survey (HPRT, 1987) for example, show a greater percentage of normotensives amongst respondents who took part in *active* leisure, and similarly if treated hypertensives were excluded, systolic and diastolic blood pressures were found to be lower in those groups (e.g. in the 60 - 79 year old female category, 65% of normotensives were *active*). [7]

In a study of the relationship of blood pressure to physical activity status in older women (Reaven et al.,1991), it is important to note that a relatively small difference in mean blood pressure in more active women was associated with a quite large difference in the prevalence of hypertension. This is very important from a public health perspective given the possible role of physical activity in the prevention of hypertension as compared to its role in the treatment of hypertensives.

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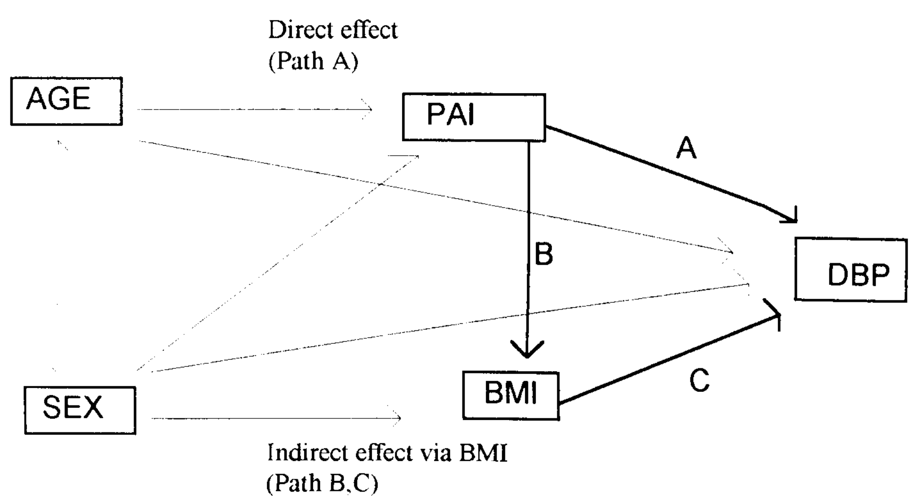
[7] Treated hypertensives are those actively being treated for high blood pressure with drugs but variable levels of measured blood pressure.

In the Kilkenny Health Project (1985-92) interrelations between exercise, body mass index (BMI) and diastolic blood pressure were examined. A path analysis model (Goldsmith, 1983) using multiple regression techniques was developed to estimate the potential benefits from physical activity for blood pressure reduction (DPB) in the population This technique first imposes a causal ordering in the variables which in this situation also included age, sex and body mass index (BMI) [Figure1.5]. illustrates the direct effect (path A), an indirect effect mediated through BMI (paths B and C), and non-causal effects due to the interrelationships between age, sex, physical activity and BMI.

Figure 1.5 *Path analysis model to examine the relationship between the physical activity index (PAI) and diastolic blood pressure*



Source: Shelley, Daly & Mulcahy, 1991 - Reproduced with permission

Results of the analysis found that most (68%) of the effect of physical activity on blood pressure was direct, while 7% was due to exercise being related to lower BMI which in turn had a beneficial effect on blood pressure. The remaining 25% of the activity /blood pressure relationship could be attributed to relationships between age and sex. In statistical inference, Shelley reports that increasing physical activity levels in the Irish population could lead to substantial reductions in blood pressure, some of which would be mediated through changes in body weight (Shelley, Daly & Mulcahy,1991).

1.2.2 Physical activity and extant hypertension

In the prevention of cardiovascular disease and stroke, while exercise plays an important role in the control of certain modifiable risk factors, exercise also adds an independent effect in the lowering of blood pressure in certain hypertensive groups. (Leclers,1992; Fletcher,1994). Numerous studies examining the blood-pressure lowering effects of endurance-exercise training on individuals with essential hypertension have been published (Hagberg, 1990). Several of the controlled intervention studies (Boyer, 1970; Cade et al., 1984; Duncan et al., 1985; Kiyonga et al., 1985; Kukkonen et al.,1982; Roman, 1981), have demonstrated that regular physical activity reduces both systolic and diastolic arterial blood pressure with participants in these studies experiencing a reduction in arterial blood pressure of 13/10 mmHg, on average. Adolescents who participated in one study (Hagberg et al.,1983) and severe hypertensive women who took part in another (Roman, 1981) also showed reductions. There is also, good evidence of a graded hypotensive response to physical activity among mild to moderate hypertensives (Hagberg et al., 1987; Royal College of Physicians,1991) Among patients with base-line blood pressures in the region of 148/99mmHg, a fall in pressure of 11/9mmHg resulted from regular exercise, 45 minutes at 70% maximum working capacity three times a week, with a greater reduction of 16/11 mmHg when exercise was taken daily (Nelson et al.,1986) Recent well-controlled clinical trials have also confirmed clinically significant blood pressure reductions in mild hypertensives (Martin et al., 1990; Mori & Arakawa, 1993; Ikeda et al., 1993). Mechanisms for this hypotensive effect have been investigated (Siegal & Blumenthal, 1990), but not conclusively.

There is some clinical concern that vigorous exercise may be less safe for persons with high blood pressure than for those who are normotensive. Siscovick (1985) concludes that there is little empirical evidence relating to the hazards of vigorous activity among this population. Fentem (1992) is cautionary, and commenting on the possible reductions predicted by Boyer's study (1970) of mild/moderate hypertensive men and of the severe hypertensives observed by Cade et al.(1984), he suggests that for this population, exercise should be considered and adjunct to other therapy, rather than the sole "treatment " advised.

Much of the currently available evidence seems to suggest that habitual activity and physical fitness may reduce the risk of developing hypertension., and it appears that physical activity has a possible role in inhibiting the age-dependent rise reported (Siconolfi et al., 1985). Although the declines suggested appear small, changes of this magnitude are important from a public health perspective. In a meta-analysis of randomised drug-treatment trials (Ss 37,000) for example, a mean decrease of 6mm Hg in diastolic blood pressure significantly reduced overall mortality from vascular disease by 21%, fatal and non-fatal stroke by 42%, and fatal and non-fatal coronary heart disease by 14% (Collins et al.,1990). Targets set in Britain's White Paper include a reduction of mean systolic blood pressure in the adult population of at least 5mm Hg by the year 2005. It is estimated in this report, that a reduction in mean blood pressure in a population of 5mmHg would result in a 10% reduction in mortality from CHD and stroke (Health of the Nation, 1991).

Intervention project findings have been positive in achieving reductions in mean systolic blood pressures. In the Stanford Five City Project, results showed declines of 7.4 and 5.5 mmHg in follow up measures, and independent (new sample) surveys in the intervention cities after 64 months (Farquhar et al.,1985). The outcome target set in the Kilkenny Health Project was a 3.9 mmHg reduction in the five year period 1985 to 1990. The actual decline was greater than targeted, -7.7mmHg in women and -5.3mmHg in men in the intervention county, Kilkenny (Kilkenny Health Project, 1992). It is difficult to assess the extent to which increased physical activity levels contributed to this decline, particularly as BMI levels increased during the intervention period. Shelley et al.(1991a) conclude that increasing physical activity in the Irish population would be expected to lead to a reduction in the prevalence of hypertension.

I

1.3 Physical activity in the prevention and control of diabetes mellitus (NIDDM)

Diabetes is a complex metabolic disorder in which the body's ability to utilise insulin is impaired (Vranic & Wasserman, 1990). NIDDM diagnosed patients are variably symptomatic and frequently obese, hyperlipidemic and hypertensive. NIDDM is not a mild form of diabetes, and patients may face early mortality as a consequence of a condition which is essentially preventable (Tomkin,G.,1995). One per cent of total deaths in Ireland are attributed to diabetes (Type I and Type II) (CSO,1993).

1.3.1 Prevalence of non-insulin dependent diabetes mellitus (NIDDM)

The prevalence of diabetes in the general population is estimated as 2-3%. Late-onset NIDDM or Type II diabetes is normally found in those aged 40 and upwards, being present in about 5% of those over 50, and increasing further with additional age. NIDDM accounts for 75 to 90% of the diabetic population, and it is estimated that occult or latent diabetes is present in a further 1% of the general population (DA, 1994).Diabetes prevalence varies widely, depending on geographic and racial differences. The greatest genetic disposition to the disease is encountered in developing communities. (King & Dowd, 1990) and as such it is associated with lifestyle variables, particularly with diet.

Diabetes has increased three-fold since 1987, with almost six out of every 100 of the world's population suffering from NIDDM. The World Health Organisation (WHO,1993) has defined the disease as a growing problem, and forecasts a figure in excess of 100 million for NIDDM incidence by the end of this century. It can be expected that NIDDM is on the increase in Ireland as well as world-wide, as obesity levels increase (NNSC,1995). Accurate reporting of the prevalence and growth of this condition, however, is compounded by several factors. HIPE data do not reflect the true incidence as most NIDDM diabetics will not be admitted to hospital for initial treatment. An indication of the suggested increase is observed in the Kilkenny Health Report (1992), where prevalence was reported as 1.0% of the Kilkenny population in the 1985 baseline survey, and 1.6% in 1990. Data supplied by the Irish Diabetics Association indicate that the total number of cases of this disease in Ireland in 1995 is 66,000 of which approximately 54,000 are non-insulin dependent. The prevalence in Ireland is therefore on a par with the European average, which is 2% of the population (Wilson, 1995)

1.3.2 Physical activity and the prevention of NIDDM

Despite the biological plausibility of physical activity in the prevention of NIDDM, epidemiological evidence is limited. Indirect evidence is provided by descriptive comparisons of the prevalence of NIDDM in active rural and inactive urban populations (Zimmet et al.,1981; Zimmet, Dowse et al., 1990). Support for a benefit of exercise also comes from cross-sectional studies, which showed the prevalence of diabetes or abnormal glucose tolerance to be greater among sedentary individuals than among their more active counterparts, independent of age and body mass index (Taylor et al.,1984; King et al.,1984; Dowse et al.,1991). However, in other studies, physical activity was not independently associated with post-load plasma glucose concentrations (King et al.,1986; Jarrett et al.,1986). A retrospective longitudinal study suggested that women who participated regularly in sports as college students had reduced risks of subsequent diabetes (Frisch et al.,1986).

A symposium on diabetes and exercise was held in 1990.[8] One of the most intriguing aspects of this symposium was the fact that it addressed the issue of whether physical activity might be therapeutically more efficacious in young individuals at risk for developing type II diabetes than in people with established diabetes. As reviewed by Schneider & Ruderman (1986), at the time of diagnosis a significant percentage (20-40) of patients with type II diabetes have clinically significant ischaemic heart disease. These authors, among others, reviewed evidence that hyperinsulinemia, insulin resistance, and possibly central obesity precede the onset of type II diabetes and may be improved by regular physical activity. In keeping with this notion, since the symposium was held, four important publications have appeared that suggest physical activity may prevent

[8] Symposium: Diabetes and Exercise 1990. *Diabetes Care*. 1992, 15 (Suppl.4), S1675-S1813.

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type II diabetes in both men and women (Helmrich et al., 1991; Manson et al., 1991 and 1992; Eriksson & Lindgard, 1991).

Helmrich et al.'s study (1991) of nearly 6,000 male college alumni found a strong inverse relationship between weekly energy expenditure and NIDDM incidence: the effect was independent of obesity, hypertension, and parental history of diabetes. Research on the prevention of NIDDM by both diet *and* physical exercise is reported in the 6-year Malmo feasibility study by Eriksson & Lindgard (1991). In the study of early Type II subjects and subjects with impaired glucose tolerance, glucose tolerance was normalised in greater than 50% of subjects (with impaired glucose tolerance), the accumulated incidence of diabetes was 10.6%, and more than 50% of the diabetic patients were in remission after a mean follow-up of 6 years. Improvement in glucose tolerance was correlated to weight reduction ($r=0.19$, $p<0.02$) and increased fitness ($r=0.22$, $p<0.02$). Treatment was safe, and mortality was low, in fact 33% lower than in the remainder of the cohort (Eriksson & Lindgard, 1991).

In a prospective study of 87,253 women (Manson,1991), those who engaged in vigorous exercise at least once per week had an age-adjusted relative risk (RR) of NIDDM of 0.67 ($p<0.0001$) compared with women who did not exercise weekly. After adjustment for body mass index, the reduction in risk was attenuated but remained statistically significant ($RR=0.84$, $p=0.005$). These authors conclude that physical activity appears to have an important role in the prevention of NIDDM through its association with reduced body weight and through independent effects on insulin resistance and glucose tolerance (Manson et al.,1991).

Thus there is an increasing body of evidence, including the recent investigations by Katz & Lowenthal (1994), which indicates that moderate to vigorous physical activity may be a promising approach to the primary prevention of NIDDM.

1.3.3 Physical activity and the management of NIDDM

Although few experimental studies use exercise as an independent variable, the potential positive effects of exercise on Type 11 diabetes are well documented.(Fentem et al.,1988). It is known that physical activity reduces blood glucose levels, increases the number of insulin receptors and increases the effect of insulin in NIDDM (Siscovic et al.,1985). Enhanced fat metabolism and reduced body weight are also among the exercise benefits identified.Berg (1986). The relationship, however, between exercise and metabolic control, is complex (Vranic & Wasserman, 1990), and findings on the management of NIDDM through physical activity are unclear.

An NIH consensus panel[9] issued in 1987 a somewhat controversial, rather sobering statement ... that downplayed the role of exercise in the management of type 11 diabetes. The 1990 symposium held in part as a response to the NIH statement, discussed new knowledge that had been gained by physicians using exercise as part of an effort to improve the quality of life and /or metabolic parameters in patients with diabetes (Ruderman, N. 1993). Among the items discussed at this symposium were reports of trials by Horton (1988) and Kaplan et al.,(1987), in which expected improvement in glucose tolerance was not demonstrated, but improvements in quality of life and glycosylated hemogolobin were observed.

Findings of subsequent trials were mixed. In a study by Selam et al.(1992) of 100 (Type 1 and Type 11) diabetics, there was no correlation between the degree of activity and HbAIc levels[10] or hypoglycaemic events. The authors conclude that physical exercise is not necessarily associated with good blood glucose control. This conclusion is contra-indicated in the findings of a one-year exercise and diet intervention study by Vanninen et al.(1992), where HbA_{1c} showed an inverse correlation with oxygen uptake at anaerobic threshold ($r=0.27$, $p<0.01$)and maximum oxygen uptake ($r=0.28$, $p<0.01$) at 12 months. Kohl (1992) and colleagues evaluated the relationship of physical fitness to mortality within glucose tolerance strata in an 8.2 years follow-up study of a large cohort of men. Physically fit men had lower age-adjusted all-cause death rates than unfit men at all levels of glucose tolerance After multivariate analysis that controlled for all other major CHD risk factors and length of follow-up interval, the relative risk for all-cause

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9 National Institutes of Health: consensus development conference on diet and exercise in non-insulin dependent diabetes mellitus. *Diabetes Care.* 1987, 10, 639-644.

10 HbA_{1c} : Glycosylated haemoglobin A_{1c}, a measure of glycaemic control (Vanninen et al.1992).

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mortality was 1.92 (CI=0.75-4.90) in the low-fit compared to the high-fit men (Kohl et al.,1992).

Some recent clinical studies have reported positive dynamic changes of parameters relating to metabolism, platelet function, blood coagulation and hemorrheologic situation. (Di GX et al., 1993; Di GX, Fu PY et al., 1993; Ibbotson et al., 1993; Abe & Fujinuma, 1993; Berrish et al., 1993; Nakagawa, 1991; Lampman & Schteingart, 1991). For those who have NIDDM diabetes, it would appear that risk factor modification may be more easily achieved than glycemic control (Sharratt & Sharratt, 1994). While the exercise component of diabetes management is considered to be crucial in some reviews (Canabal,1992; Krug et al.,1991), poor participation and adherence rates are reported. Behaviour modification appears to be essential in exercise intervention for persons with diabetes (Searle & Ready , 1991) and improved activity levels may possibly be achieved via intensive intervention measures (Vanninen et al.,1991).

1.3.4 Physical activity and NIDDM in the elderly

Glucose tolerance decreases with increased age and obesity, and elderly persons with reduced insulin sensitivity are predisposed to the development of NIDDM, which is common in the geriatric population (Katz & Lowenthal, 1994). Exercise has been shown to slow this effect (Fentem et al. 1988, Canabal, 1992). Katz & Lowenthal's (1994) investigations provide presumptive evidence that elderly persons with NIDDM may benefit from exercise training, thus supporting recommendations made by Kelleher (1991), Laws & Reaven (1991), Rogers & Evans (1993) and Raz et al.,(1994). Laws & Reaven had earlier proposed that the transience of beneficial effects of exercise, on insulin sensitivity and glucose tolerance underscores the importance of efforts to promote continuing activity throughout the life cycle (*ibid.*)

Differences, however, have been noted in clinical studies between elderly and young in the management of NIDDM. Abe and Fujinuma (1993) found that in the elderly, levels of blood glucose after exercise were not changed, whereas in middle agged NIDDM there were significant decreases. Studies of Katz & Lowenthal (1994), Staten (1991) and Kelleher (1991) are cautious in exercise prescription, and recommend physician defined intensity of activity for older diabetics.

1.3.5 Physical activity and gestational diabetes (GDM)

Approximately 2% of all pregnant women develop gestational diabetes, usually during the second half of their pregnancy (DA, 1994). Few reports have been presented on the impact of regular exercise during pregnancy and the gestational diabetic condition.. Clinical studies by Bung et al (1993) conclude that exercise can be safely conducted in women with GDM, resulting in normoglycaemia for the mother and thus preventing insulin therapy. Artal (1992) recommends exercise as an alternative and safe therapeutic approach for gestational diabetes, while Horton (1991) suggests that the benefits of exercise could be applied by reversing the insulin resistance associated with GDM, and thus should be considered as a potential approach to the prevention and treatment of GDM. Brudenell (1994) and Carbon (1994) both agree that pregnant women with uncomplicated diabetes should not necessarily be denied exercise.

1.3.6 Physical activity, diabetes and coronary heart disease (CHD)

Diabetes is itself known to be a risk factor for both CHD and stroke. It has been estimated that people with diabetes mellitus have a two to four-fold greater risk of death from CHD and stroke (Health of the Nation,1991). Regular exercise, however, may diminish the risk for atherosclerotic vascular disease in patients with NIDDM and in the general population. The basis for this effect of exercise may be its ability to diminish or prevent hyperinsulinemia, insulin resistance, and /or increases in intra-abdominal adipose mass (Barnard et al., 1992). In a review of diabetes, exercise and atherosclerosis, it is suggested that the high prevalence of hyperinsulinemia and insulin resistance in individuals leading a western lifestyle accounts for the reported benefit of physical activity in preventing CHD in the general population (Ruderman & Schneider,1992). In this context Ruderman & Schneider propose that exercise (and diet) are most likely to be effective when initiated in young individuals, before the onset of irreversible vascular alterations, and when lifestyle changes may be more acceptable.

1.4 Physical activity : Prevention and control of overweight and obesity

There has been no internationally accepted definition of overweight or obesity. The standards traditionally used are those presented by the Metropolitan Life Insurance Company (1960) based on the large Build and Blood Pressure Study, and more recently incorporating data in the 1979 Build Study (Society of Actuaries, 1979). These present weight ranges encompass all frame sizes and are the adopted standards in Irish health studies.

It is accepted that body mass index (BMI)[11] correlates well with other measures of the fat content of the body in adult men and women (National Institutes of Health, 1985; Royal College of Physicians, 1983). The latter report uses BMI indicators to define overweight and obesity:

Obesity is defined as BMI >30 (males) and BMI >28.6 (females)

Overweight is defined as BMI> 25.1 (males) and BMI > 23.9 (females)

Some definitions of 'overweight' limit this category to individuals who weigh 110 to 119 % of these standards, obesity is then defined as a weight of 120% or more of the standard range. 110% of relative weight corresponds in the USA to about 25 per cent and 31 per cent above the 'optimal' weights of men and women respectively (Andres, 1980). The mean BMI adopted as the US standard was 24.0 for males (85th percentile at 28.0, 95th at 32) and BMI for females defined as the ratio of height to weight to the power of three (National Institutes of Health, 1985). Some studies define moderate obesity as 41% to 100% overweight (Brownell, 1988). A statistical WHO report (Gurney & Gorstein,1988) defined BMI of 30 as representative of "a high degree of fatness in both males and females". Diverse standards make comparisons of international data difficult.

[11] BMI or Quetelet index : Wt/Ht^2, where Wt is weight in kg and Ht is height in metres.

1.4.1 Prevalence of overweight and obesity

Obesity is much more prevalent in the United States than in Britain and Ireland, and is reported to have reached epidemic levels in the US population (Miles, 1991; Kuezmarski et al.,1994). In certain ethnic and regional subgroups, 50% of women are clinically obese. The prevalence of clinical obesity in Britain has doubled in the past decade and is continuing to increase (Prentice and Jebb, 1995). Similar trend data for Ireland have not been reported, but the analysis of body weight in Irish population samples allows for the estimation of the extent to which excess body weight may be a public health problem in this country. In the Kilkenny Health Project baseline survey (1985), mean body mass index was found to be high, with a high prevalence of overweight and obesity. The follow-up survey in 1990 showed significant increases in the prevalence of obesity in Kilkenny and the reference county, Offaly (3% and 8.3%), while there was a small decline over time in the prevalence of overweight. In the 1990 Irish National Nutrition Survey, a similarly high prevalence of overweight was observed, but a lower prevalence of obesity [Table 1.3].

In the Happy Heart National Survey, baseline year 1992, there is a much lower prevalence of overweight and obesity, than reported in the three earlier surveys. Just over half (53%) of the Irish adults surveyed in this report were within the acceptable weight category, 37% were overweight and the remainder (10%) were obese (Irish Heart Foundation,1994). The report considers that, to some extent, differences in the survey findings may be accounted for by the higher prevalence of overweight and obesity in rural areas. Data breakdown by region (urban/rural) in the 1994 report however, indicate very similar patterns for both regions with 36.1% of "urban" respondents classified as overweight compared to 37.7% of rural correspondents (Irish Heart Foundation,1994). Hence this does not appear to be a major contributory factor. Self-report error in the Happy Heart National Survey and a higher BMI classification for overweight may have contributed in larger measure to the differential observed. Clear discrepancies between self-report versus controlled measurements in obesity studies have been observed (Forbes, 1993; Lee et al., 1993; Laws, 1993). A self-report tendency to slightly overestimate height and to underestimate weight would give falsely low levels of body mass index. In addition, it is difficult to make comparisons with other studies, when the classification "overweight" is BMI 25.0 - <30 in this survey (Irish Heart Foundation,1994) while in other studies, female BMI > 23.9 is classified as "overweight".

Table 1.3 *Summary of the gender breakdown within 4 surveys of percentages of population classified as overweight and obese*

	Males		Females	
	Overweight %	Obese %	Overweight %	Obese %
Kilkenny 1985 [n=792]	51.1	13.7	44.7	19.2
Kilkenny 1990 [n=802]	53.1	15.7	40.7	22.8
INDI 1990 [n=676]	53.0	10.0	33.0	15.0
IHF 1994 [n=1,751]	45.5	10.3	28.1	9.5

Sources: Kilkenny Health Project, 1985; Kilkenny Health Project, 1990; Irish National Nutrition Survey 1990; Irish Heart Foundation Survey, 1994.

The prevalence of obesity in Ireland is high, when compared with the prevalence in other countries. WHO data, (Gurney & Gorstein, 1988) show negligible obesity in Central American countries, though sample sizes are very small. A prevalence of 8.5% obesity in males is cited for Canada and 12.0% for the United States. In Australia, 9.6% of males aged 55-64 years are classified as obese, compared with 17.6% of males in the same age cohort in Kilkenny. Obesity, a "national epidemic" in the United States, with its associated health risks and diseases, presents a tremendous drain to the economy (Miles, 1991). Risk attached to excess weight, however, as in the US, may have declined in recent decades, as population levels of serum total cholesterol and CHD mortality decline.

1.4.2 Overweight, obesity and health

Health risks can begin in people who are only 20% overweight (Brownell, 1988). Moderate obesity carries considerably higher health burdens, and is associated with an

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increased risk of subsequent mortality independent of other risk factors, such as smoking, elevated blood pressure and elevated cholesterol (Hubert et al.,1983; Barlow et al.,1995). It is mainly through its association with an increased prevalence of raised blood pressure and raised plasma cholesterol, that obesity acts to increase the risk of CHD and stroke (Blair, Habicht et al., 1984). The relationship between body mass index and CHD mortality has been described in the British Regional Heart Study (Shaper & Wannamathee, 1989) and in Eastern Finland (Tuomelitho et al., 1987) as "U" shaped. Those with lowest BMI are shown to be at relatively greater risk than average, and the risk increases proportionately thereafter. Body mass indices greater than 31 $kg.m^{-2}$ in males and 29 $kg.m^{-2}$ in females are illustrated to be a marker of CHD and a predictor of acute myocardial infarction.

In the Harvard Alumni All-Cause Mortality study (Paffenbarger et al.,1986), although the overall trend of association between body-mass index and total mortality was not significant, the two thirds of alumni with indexes between the two extremes had a lower risk. The higher rates for alumni with extremes of physique suggest that overly fat men may succumb to cardiovascular disease, and the very underweight possibly to wasting diseases such as cancer. Of particular interest was the association of mortality with a low net gain in BMI since college, as alumni with the lowest net gain had a 29% higher risk of death than their classmates who gained the most. This trend represented a departure from former findings for coronary heart disease (Paffenbarger et al.,1978; Paffenbarger et al.,1984). In the Harvard alumni follow-up study (Paffenbarger et al.,1993) alumni were classified as having an index of BMI >26, BMI 24-25, or BMI<24. A reversed J-shaped curve for mortality risk was seen for the high and low extremes of the body-mass index as compared with intermediate values. In this cohort of alumni (now 7-10 years older),overweight for height was associated with a 55% increase in risk (CI 15-134%) for coronary heart disease.

While National Institutes of Health studies that link obesity to heart disease and stroke are based on male subjects (Moriarty et al.,1994), a number of large prospective cohort studies of women have also demonstrated direct positive associations between obesity and the risk of coronary heart disease (Lew & Garfinkel, 1979, Hubert et al.,1983;

Manson et al.,1990). In the Nurses' Health Study, involving over 120,000 middle-aged women, the risk of coronary heart disease was over three times higher among women with BMI of 29 or higher than among the lean women (BMI < 21). Even the women who were mildly to moderately overweight (BMI 25-28.9) had nearly twice as high a risk of coronary heart disease as the lean women (Manson et al.,1990). Unfortunately, direct evidence that weight loss reduces the risk of coronary heart disease is not yet available because of the small numbers of subjects able to maintain a reduced level of weight (Rich-Edwards et al.,1995).

There has been controversy as to whether or not obesity is an *independent* risk factor for coronary heart disease (Keys et al.,1972; Keys,1980; Royal College of Physicians, 1983; Shaper &Wannamathee,1989; Lindenstrom et al.,1993). If account is taken of studies with a long-term follow-up, i.e over five years, the role of obesity in CHD is more evident (Lew & Garfinkel, 1979; Garrow, 1981a; Hubert et al.,1983). Studies by Bjorntorp, (1985), Donaghue et al.(1987), Reichley et al.,(1987), Blair et al.,(1984), and Lapidus et al.(1984) suggest that the body distribution of fat deposits may be a better predictor of coronary artery disease than is the degree of obesity. Overweight individuals with centrally deposited body fat (apple shaped ovoid) are known to be more at risk than those with gluteally deposited fat (pear-shaped, gynoid). Data in the OPCS survey (1992) show that women start changing to apple shape in the 45-64 age group, which correspondingly is the age bracket in which increased cardiovascular disease begins to occur. In childhood studies, in contrast, it appears that 'size' or 'fatness' is more associated with risk factors than body fat distribution (Sangi et al.,1992).

Many of the coronary risk factors associated with obesity may themselves be interrelated. In data analysis of Shelley et al.'s study (1991a), after adjustment for age, sex and known risk factors, hypertensive status (i.e. known hypertensive) remained significantly related to obesity in males and females. In females, HDL was independently associated with obesity, and in males low levels of exercise. Analysis of BMI data in the Kilkenny Health survey, other variables controlled, led Shelley and colleagues to conclude that in view of the high levels of serum total cholesterol in the population under study, and the high mortality from CHD in Ireland, it is likely that obesity is at least a marker of CHD risk in Ireland, if not an independent risk factor (Shelley et al.,1991a).

Obesity carries increased risk of an number of other conditions being associated with diabetes mellitus and NIDDM (Bray,1979; Hubert et al., 1983, Kissebah, 1988), osteoarthritis (Silberberg, 1979; Leach et al.,1973), gall bladder disease (Bray, 1979; Rimm et al.,1975; Royal College of Physicians, 1983), and respiratory disorders (Rochester and Arora, 1979; Lasarev and Baranova, 1979). Specific to women are associaions of menstrual irregularities, progressive increase in risk of cancer of the uterus (Lew & Garfinkel,1979), cancers of the reproductive tract (Lampman & Schteingart, 1989), and increased fatality from post-menopausal breast cancer (Royal College of Physicians,1983; Health of the Nation,1992). The American Cancer Society Study (Lew & Garfinkel, 1979) shows that increasing degrees of overweight in men are associated with a statistically increased risk of cancer of the colon, rectum and prostate.

Apart from the known physical health risks, overweight and obesity can present psychological problems for individuals. Socio-cultural theories suggest that Zeitgeist in Western societies is towards a "thin-body cult" (McCarthy, 1990: Slade, 1994) and away from a higher body weight and obesity (Sobal & Stunkard, 1989). In a society, such as Ireland, that values "thinness", there is increasing public health concern at the development of maladaptive diet behaviour, particularly amongst adolescents, which is manifested in the prevalence of such eating disorders as anorexia nervosa, comfort eating, and bulimia (Moore-Groarke & Thompson, 1995).

Writers such as Marano (1991) and Wolf (1991) argue that 20th century 'accepted' weight standards for females are socio-culturally rather than health determined, and adherence to such norms has contributed to inappropriate and unnecessary dieting behaviour. Sociocultural influences associated with the increased prevalence of eating disorders have been indentified by Garner et al., 1983; Garner, 1984; Seid, 1989; Hsu, 1990; Moriarty & Moriarty, 1991 and Moriarty et al.,1994. Further, if anthropometric relationships are closely examined, average adult heights and weights have increased since the start of the '80s (Knight, 1984; Gregory et al., 1990; OPCS, 1991). In the UK, women's average weight has increased from 62.2 kg in 1980 to 66.2 kg in 1991 (OPCS, 1991). The consequent higher average BMI may imply that a revision of the currently accepted height and weight standards is appropriate. Indeed, as early as 1983, such a revision was deemed to be "long overdue" (Royal College of Physicians, 1983; Manson et al., 1987).

1.4.3 Physical activity, overweight and obesity

The basis of overweight and obesity is not dependent on a single factor. Social, psychological, endocrinological and metabolic factors will all contribute to the prevalence of overweight in the community, and several factors may well be involved in the individual with a weight problem (Royal College of Physicians, 1983). A particularly controversial issue in the aetiology of obesity is whether genetic and/or metabolic defects, or alterations in behaviour are the primary cause of weight gain. (Epstein and Wing 1980; Bray,1982; Royal College of Physicians, 1983; Pollock et al.,1984; Brownell,1988; Lampman & Schteingart,1989; Wood et al.,1988; Poehlman, 1989; ACSM, 1990; Wells 1991; Royal College of Physicians, 1991; Drinkwater, 1994). While traditionally considered a disorder primarily of energy intake, viz. intake chronically in excess of energy expenditure, recent evidence indicates that metabolic processes and activity behaviour are potent influences in the pathogenesis of overweight and obesity (King & Tribble, 1991; Poppitt, 1994; Harris, 1990; Wood, 1993; Liebel et al.,1995; Bennett, 1995).

According to Poppitt (1994), the recent rapid changes in obesity that have occurred within a common gene pool suggest that social and behavioural factors predominate, potentially interacting with individual susceptibility. In 1991, findings of the British Health Survey (Secretary of State for Health,1992) show that rates of obesity in the UK doubled between 1980 and 1991 (8% of males and 12% of females being classified as obese), yet food intake had been declining rather than increasing since the 1970s. Therefore, according to Poppitt, physical activity must have been falling more rapidly. Similar findings were reported in a child population study (Gortmaker et al.,1990). In this study, population dietary intake data indicated no statistically significant change and perhaps some decrease in mean energy intake among youth during the same period that obesity was increasing. Poppitt (1994) considers that physical inactivity seems to be a key factor in predisposing to obesity, perhaps because the down-regulation of energy intake in humans, which would be necessary to balance the low levels of activity, is poorly controlled (Poppitt, 1994).

Two recent studies (Tucker & Friedman,1989; Gortmaker et al.,1990) have investigated the association between measures of inactivity and obesity. In the Harvard School of Public Health study, a substantial relationship was reported between television viewing and the prevalence of obesity. Among those reporting one hour or less per day T.V. viewing, the prevalence of obesity was 4.5%; among those reporting three or more hours the prevalence was 19.2% ($p<.0001$). Television viewing was the best single correlate of BMI ($r = .21$). In contrast, there was a statistically insignificant relationship between the physical activity measure (devised by Paffenbarger et al.,1986) and BMI ($r = -.04$), and a modest relationship of the dietary intake measure to BMI ($r = .10$). These cross-sectional data are obviously quite limited in what they say about the causes of obesity - there are limitations in the activity measures (Caspersen et al.,1985). As such, a key competing hypothesis, that obesity leads to television viewing and not vice versa, cannot be tested. Despite these limitations, the lack of an independent relationship between the measure of physical activity and obesity in this sample indicates the importance of distinct measures of *inactivity*.

In the debate on the aetiology and control of overweight and obesity, the set-point theory (Leibel & Hirsch, 1984; Weigle, 1988; Harris, 1990; Leibel, 1990, Weigle, 1994; Bennett, 1995) has received renewed support in a recent study by Liebel and colleagues (Liebel et al.,1995). Evidence in these studies indicates that the body has a complex, highly sophisticated system for regulating its fat stores, controlled by a set-point mechanism, "the adipostat". This exerts a powerful influence on eating and physical activity behaviours, perceived as largely voluntary. Data in Liebel's research project show that, after a 10% or 20% loss in weight, the decline in total energy expenditure reflected similar decreases in both non-resting and resting energy expenditure in both control and obese subjects.[12] This is "the best evidence so far" (Bennett, 1995) of the hypothesis that energy expenditure, adjusted for metabolic mass, increases with a weight gain and decreases with a weight loss, under control of the adipostat. The metabolic variable most affected by weight change in Liebel's experimental study was non-resting energy expenditure. The nature of the changes in this variable cannot be indentified, since it was not measured directly in the study. Liebel and colleagues, however, consider the possibility that changes in skeletal muscle have a role in mediating the alterations that occur with weight loss. This may be the reason, they conclude, why exercise is helpful in maintaining a reduced body weight.

Reviewing the evidence on the set-point theory, Bennett (1995) reaffirms that external factors can reset the adipostat. Three factors appear to be most capable of exerting this influence: drugs, the composition and sensory properties of the usual diet, and the habitual level of physical activity (Wood,1993). People drifting into sedentary patterns of behaviour with age, for example, reset their adipostat upwards... Likewise, the secular trend toward increased body fat in each successive generation may be more easily explained by the availability of motor transport than by the availability of fast food (Bennett, 1995). The responses of the adipostat to environmental conditions, however, are probably determined by several genes, being quite plastic in some individuals, Bennett suggests, and more closely controlled in others, especially the young.

It appears also that overweight, and more specifically obesity, may have implications in limiting the individual's disposition towards physical activity (King et al.,1992), although using quantitative data alone, this is difficult to establish. In the Kilkenny Health Project findings, for example, low levels of activity in males were independently associated with obesity. The authors acknowledge that. it is difficult to know to what extent this lower level of activity may be a reflection of decreased ability to exercise with increasing weight, or alternatively whether lower levels of exercise contributed to the development of obesity (Shelley et al.,1991a).

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12 Non-resting energy expenditure: approximately 30% of total energy expenditure, mainly in the form of physical activity; resting expenditure: 60% of total; thermic effect of feeding: 10%

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A large scale prospective study of 25,389 men by Barlow, Kohl & Blair (1995) has examined the relation of physical fitness to mortality risk across various levels of body composition. Age-adjusted relative risks (RR) for all-cause mortality across low, moderate and high baseline fitness categories were 1.0, 0.49 and 0.34 in men with a BMI < 27.0; 1.0, 0.61 and 0.40 for men with an BMI between 27 and 30; and 1.0, 0.29 (for combined moderate and high fitness) for men with a BMI ≥ 30.0. The authors concluded that moderate and high levels of physical fitness provide comparable benefits in mortality protection across the spectrum of obesity (Barlow, Kohl & Blair, 1995). While it is clear that regular exercise does not make all individuals thin, Barlow et al. (1995) consider that active and fit individuals, even if they are obese, may benefit from an active way of life.

Although exercise alone is generally not an effective treatment for obesity, the importance of physical activity in its prevention and control has been widely acknowledged (Bray, 1990; Segal & Pi-Sunyer, 1989; King & Trimble, 1991). Among the types of exercise-related physiological and behavioural factors most likely to be involved in the development of obesity are reductions in the amount of physical activity actually performed, differences in the effect of physical activity on diet-induced thermogenesis, and modelling of deleterious exercise and dietary patterns on the part of the family and other facets of the environment. Evaluating the accumulating evidence on the role of physical activity, King & Trimble (1991) consider the energy expenditure component to be "significant". In contrast, there is relatively little evidence supporting the common or folk belief that obese individuals have a significantly greater energy intake than the nonobese.

1.4.4 Physical activity and weight control

With respect to weight reduction and control in the already overweight and obese, evidence suggests that physical activity may be particularly important in helping to sustain initial losses through increased total energy output, preservation of lean body mass, and changes in substrate utilisation.. (King, 1991; Forbes, 1993; Saris, 1993; Parizkova, 1993; Masuda et al., 1993; Stefanick, 1993; Birketvedt, 1992; Walberg &

Rankin, 1992; Phinney, 1992a; Safer, 1991; Miles 1991; DiPietro et al.,1993). Results of these studies indicate that a combination of diet and moderate exercise is superior to a single intervention, both in short-term and long-term weight control, although there is concern at the possible erosion of lean body mass if much weight is lost during exercise by people on low-calorie diets. (Donnelly et al., 1991; Forbes, 1992). Long-term preservation of weight loss is strongly influenced by post-diet exercise habits. (Phinney, 1992b). The large-scale study by DiPetro et al.(1993), using BRFSS data, reported that even lower intensity activity, e.g. walking, was associated with decreases in weight in persons aged 40 or older. Psychological benefits may serve as an additional impetus for engaging in physical activities over the long run. In the severely and hyperplastic obese, however, exercise is probably of little benefit (Bray, 1990; Segal & Punyer, 1989; Royal College of Physicians,1991). On the basis of the wide range of health benefits to be derived from regular exercise. Stefanick (1993) states that the emphasis on increased activity for inactive people, particularly obese, sedentary individuals, is justified whether or not ideal body weight or significant weight loss is achieved (Stefanick,1993).

In a similar vein, Leibel and colleagues acknowledge the difficulty imposed by metabolic alterations in lower weight maintenance. Nevertheless, they consider that the beneficial effect of even a modest weight loss on lipid and carbohydrate metabolism in the obese, justifies persistent efforts at weight reduction and maintenance of a reduced body weight (Leibel et al.,1995).

In view of the large number of adults classified in Ireland as overweight or obese, the low activity status, high CHD incidence, and the emergent attendant psychological problems associated with a society where "thinness" is valued, overweight and obesity are considerable health concerns. There is the additional concern for child health, as parental weight has been found to be a critical predictor of obesity in children (Epstein et al.,1990). It must also be recognised that although the risk to health increases progressively with excess weight, there are many mildly overweight individuals who, as a group, constitute a substantial risk in public health terms. Analogous to the argument employed re cholesterol reduction, it may be important to encourage the mildly overweight group of the population to reduce weight by a few kilograms, as well as emphasising to the few the dangers of being substantially obese (Shelley et al.,1991b). Continuity of physical activity throughout the life-cycle is an important factor in effecting such incremental change.

The poor prognosis, however, for successful weight reduction by overweight individuals is widely acknowledged (Brownell & Wadden, 1986, Rich-Edwards et al.,1995), as is the high rate of recidivism among obese people who lose weight (Liebel, 1990; Weigle, 1994). Prevention of obesity is therefore critical. And for future generations of young people, education programmes must endeavour to persuade the young to adopt a lifestyle which combines sensible diet and appropriate physical activity.

1.5 Physical activity and the prevention of osteoporosis

The aetiology of age-related osteoporosis is still unclear, but there is general agreement that three factors acting alone or in combination are pre-eminent in terms of maintenance of bone integrity: endocrine status, nutritional factors and physical activity. Other affective factors include frame size (Hannan et al.,1995), genetic components and smoking behaviour[13]. The relative contribution of each of the main factors has not been established, but physical activity is clearly a dominant player.

1.5.1 Prevalence of osteoporosis

Osteoporosis has been identified as a growing international health care problem. An estimated 110,000 Irish women suffer from this condition, a brittle bone disease which affects half of all women over the age of 50 and two thirds of women over the age of 65 (Dempsey,1995). Although most patients with osteoporosis are women, up to one third of hip fractures occur in men (Need et al.,1995). The rate of decline in bone mass is similar in both middle-aged men and women, except that in women, due to a link with oestrogen deficiency, the rate of loss accelerates for several years after the menopause.

While preventive measures can obviate against or defer the decline in density, eventually the fracture threshold may be reached, resulting in fracture of the forearm, neck, femur or crush fractures of the verterbrae. It is estimated that the cumulative lifetime risks of a 50-year old white woman sustaining a distal radius fracture is 15%, a vertebral fracture 32% and a hip fracture 16% (Cummings et al.,1989). The cost of these fractures, whether measured in terms of consequent morbidity and mortality or cost implications for the health services, is substantial. In Ireland, there are approximately 15,000 hip fractures each year to women over 65 (Dempsey, 1995), and one in four women reaching the age of 90 can be expected to have a hip fracture (Law et al.,1991). Patients with such fractures will often require expensive institutional care.

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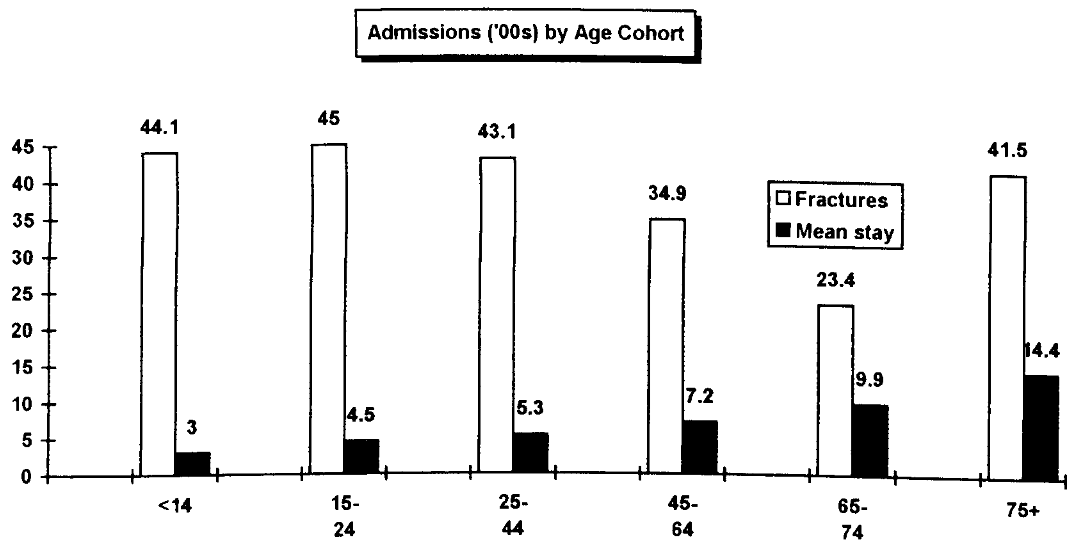
[13] Nicotine is anti-oestrogen and may be locally toxic to bone cells (Hannan et al.,1995).

The number of osteoporotic fractures has increased steadily in most countries over the last 30 years (Obrant et al.,1989), and although incidence rates may be levelling off in some populations (Spector et al.,1990) the number of fracture cases will continue to rise due to the increased numbers of elderly in the population.

The high incidence of fractures in the older age cohorts and the attendant hospitalisation stay is illustrated in Figure 1.6.

Figure 1.6 *Hospital admissions for fractures ('00s) and mean stay by age cohort*



Source: HIPE, 1994

1.5.2 Physical activity and the prevention of osteoporosis

Evidence from the research suggests five ways in which habitual physical activity exerts a positive influence on this condition.

1. Active children and young adults have been shown consistently to have denser bones than their sedentary peers (Meleski et al.,1981; Bailey & McCulloch, 1992; Krall & Dawson-Hughes,1994, Need et al.,1995). Thus greater density at the end of growth extends the period prior to fracture threshold. Mild general exercise, e.g. walking, however does not appear to be effective in enhancing BMD in younger age periods, and vigorous varied weight bearing exercise is more successful (Gutin & Kesper, 1992).

2. Halting or reversal of bone density decline through moderate weight bearing programmes in menopausal women and elderly individuals (Krolner et al.,1983; Ayalonet et al.,1987; Chow et al.,1987; Murphy & Henderson, 1994; Nelson et al., 1994; Krall & Dawson-Hughes, 1994).

3. Higher bone density in active women at all ages from 20 to 80 than in sedentary peers (Nelson et al., 1988; Nelson et al.,1991, Slemenda et al.,1993). Greater bone density in athletes than in age-matched sedentary people (Talmage et al.,1986; Huddleston et al.,1989; Law et al.,1991). Initiation of exercise training by ambulatory adults and the expected production of significant increases in bone mineral density, however, has not been clearly demonstrated (Marcus et al.,1992)

4. While the effects appear to be site specific (Slemenda & Johnston,1993; Need et al.,1995), many years of training may have a systematic effect on bone (Murhphy 1994). Regardless of age, gains in BMD can be seen with exercise (Gutin & Kesper,1992).

5. Physical activity impacts positively on fracture risk, through improved muscle mass, strength and power, and joint flexibility (Tinetti et al., 1988; Nevitt et al., 1989; Frontera et al.,1991; Secretary of State for Health, 1992; Tinetti et al.,1994a; Cummings et al.,1995)

Researchers, however, are not unanimous in their recommendation of physical activity for bone mass optimisation. While several studies have demonstrated an association between habitual physical activity and higher bone and muscle mass (Pocock et al.,1989; Bevier et al.,1989; Michel et al.,1989; Brewer et al., 1983; Need et al.,1995), prospective studies have been less clear (Notelovitz et al., 1991; Pruitt et al.,1992, Gleeson et al.,1990). One non-randomised prospective study showed decreases in lumbar spine BMD in strength trained women (Rockwell et al.,1990). Most of the initial studies examined the effects of aerobic exercise on bone density. Some studies examining aerobic activity and bone density have shown benefits (Dalsky et al.,1988; Chow et al., 1987; Zylstra et al.,1989; Slemenda & Johnston, 1993; Krall & Dawson-Hughes, 1994, Need et al.,1995), while others have shown no benefit (Cavanaugh & Cann, 1989;

Prince et al.,1991). Methodological considerations, such as inappropriate sample size to detect important differences, absence of pre-exercise bone mass measurements, and differences in weight and muscle mass between experimental and control groups have confounded interpretation of study results. Even the more rigorously controlled studies are limited by the methodology used to collect physical activity information.

There is little information about which factors influence bone density in men. Vigorous activity may lead to bone gain, while immobilisation causes bone loss (Seeman et al.,1993; Need et al.,1995). Men who undertake regular outdoor activity have been shown to have a lower prevalence of hip fracture than those who do not (McArdle et al.,1986) and active men have a higher bone density than sedentary men (Snow-Harter et al.,1992). A sedentary lifestyle could therefore, increase the risk of fractures (Wickham et al.,1989).A recent study by Need et al.(1995) examined the relation between physical activity and bone density in 137 normal men. In those aged under 50, physical activity and bone density were significantly related in the spine, femoral neck, Ward's triangle and trochanter. The mean difference in femoral bone density across the range of activities recorded was 12%, equivalent to 18 years of bone loss (Wishart, Need et al.). Activity and bone density were *not* related in men aged 50 and over. Data in this study suggested that any exercise is beneficial to bone and that, within the normal range, the more the better (Need et al.,1995). The observation that bone density was related to physical activity only in those aged up to 50, suggests that exercise may have its major effect on 'peak' bone density.

It is accepted that longitudinal studies alone provide a means of establishing valid relationships between exercise and bone mass accretion (Block et al., 1987) although many of the these studies are also prone to methodological flaws. A longitudinal study by Tylavsky et al.,(1992) investigated the effects of calcium intake and activity behaviour during adolescence on the radial bone mass of female college students, aged 18-22 years. Data analyses showed that long-term physical activity patterns were significantly correlated to distal BMC ($r=0.48$, $p<0.01$) and BMD ($r=0.42$, $p<0.01$) after controlling for BMI and gynaecological age. While the analysis of covariance supported physical activity as having a stronger influence than calcium on the distal radius, the most pronounced benefit to bone mass was evident from the analysis, when at least moderate long-term calcium intake and moderate long-term physical activity existed together. While postulated long-term benefits require verification in a prospective study, the results support the conclusions drawn by Heaney (1987). Both of these studies emphasise the importance of mechanical loading and /or regular physical activity during the formative years as an environmental factor modifying the genetic contribution to peak bone mass.

Indeed it is widely accepted that peak bone mass is highly dependent on physical activity and calcium intake in childhood (Murphy 1994). More active children may emerge from adolescence with 5-10% greater bone mass (Slemada et al 1991b) and data from a longitudinal study of children in Amsterdam found that 20year old males and females with a relatively high amount of weight bearing activity during their youth demonstrated highest BMDs (Kemper et al. 1992). Bailey & McCulloch (1992) reason that. the encouragement of children and adults to increase their level of physical activity would be a more profitable approach than the recommendation of large quantities of marketable calcium, and that greater emphasis should be placed on physical activity as a preventive strategy (Bailey & McCulloch, 1992).

1.5.3 Physical activity as an intervention measure in osteoporosis

Perhaps the most controversial issue concerns the relative merits of intervention measures during bone loss periods, in particular that of Hormone Replacement Therapy (HRT). Bailey et al., (1986) assert that in the absence of weight bearing activity and mechanical stress, no amount of nutritional or endocrine intervention can or will maintain bone density. This accords with Wolff's law which states that bone remodelling is directly dependent on the mechanical load placed on it (Chamay & Tschatz, 1972). Block et al.(1987), however, consider it is unwise to make confident recommendations for the prophylactic use of exercise. A similar conclusion is drawn from a small prospective study of rural women (Sowers et al., 1992), which showed no association between physical activity and BMD level, and an association of lower BMD levels with non-replacement of oestrogen in menopausal women. A study group of the Royal

College of Obstreticians and Gynaecologists reports that much of the bone loss after menopause can be prevented by oestrogen treatment (Drife & Studd, 1990) In the cross-sectional analysis of a large (n=9704) prospective study of older women (65 years +), Bauer et al.(1993) found no association between physical activity, calcium supplements, and bone mass, but muscle strength and weight were important factors. Similar findings have been reported by Shaw (1993).. Drinkwater (1994) sees exercise as having a beneficial effect on bone, but holds that there is no evidence that exercise can substitue for HRT as a means of preventing bone loss in postmenopausal women (Drinkwater, 1994).

This opinion has received some recent British medical support (Stevenson, 1995). Unopposed oestrogen therapy has been shown to reduce subsequent hip fractures by about 50%, and Spector et al. (1992) suggest that to reduce the numbers of such fractures significantly HRT may be necessary for a least 20 years. In a prospective study of 9,516 women 65 years of age or older, Cummings and colleagues analysed the effect of oestrogen in women (with no previous diagnosis of osteoporosis or fracture) on the incidence of hip fracture. In this group, oestrogen therapy appeared to have a strong protective effect, but the confidence limits were wide (Cummings et al.,1995).

There is evidence of health risks associated with HRT intervention. It is a well-recognised cause of endometrial cancer and increases the risk of gallbladder disease, although its possible influence on the development of breast cancer is not yet clear (Belchetz, 1994; Colditz et al.,1995; Davidson, 1995; Rich-Edwards et al.,1995). Aggregate evidence lends some support to the HRT counter argument, and renewed interest in the nutritional and exercise interventions. Fentem (1988, 1990,1992) considers the accumulated evidence to be sufficient to warrant the inclusion of exercise in osteoporosis intervention. Current Irish medical opinion appears to favour a selective use of HRT, viz. to the lowest one third in bone density measured subjects, as not all women will suffer bone loss to the extent that they are at risk of osteoporosis (Milner,1995).

1.5.4 Physical activity and reduction of fracture incidence

The role of physical activity in reducing fracture incidence receives more universal support (Tinetti et al.,1988; Sorock et al.,1988; Nevitt et al., 1989; Fiatarone et al.,1990; Cummings et al.,1993; Tinetti et al., 1993; Fiatarone et al.,1994, Cummings & Nevitt, 1994; Tinetti et al., 1994; Cummings et al.,1995; Cooper & Barker, 1995). The close relationship between bone density and probability of future fracture is strongly supported by cross-sectional, case-control, and prospective studies, (Johnston & Melton, 1993). In Law's review of six observational studies, they estimate that regular exercise would reduce the risk of fracture by as much as half thereby preventing some 20,000 hip fractures in Britain each year (Law et al., 1991). In a study by Cummings et al. (1993), a decrease of 0.11 g/cm^2 in femoral neck BMD was associated with a 2.6 relative risk (RR) of hip fracture in women over 65 years of age, while their most recent study indicates that women with multiple risk factors and low bone density have an especially high risk of hip fracture (Cummings et al.,1995). Findings of this study showed that women who spent four hours or less per day on their feet had a substantially increased risk of hip fracture, whereas walking for exercise reduced the risk (Cummings et al.,1995).

Physical inactivity in a proportion of elderly women may be a consequence of general ill health and therefore not easily modifiable. However, in Cummings' study (1995), the increased risk of hip fracture associated with inactivity remained statistically significant after adjustment for physical frailty and the presence of other chronic diseases. Commenting on the results of this study, Cooper & Barker (1995) suggest that women who are able should be advised to walk for exercise or spend four hours a day on their feet, and if this practice is followed, the incidence of hip fracture in the general population should be reduced (Cooper & Barker, 1995).

While Drinkwater (1994) and Block (1994) are circumspect concerning the role of exercise in osteoporosis intervention, they both agree that physical activity can have an impact on reducing the incidence of fractures, completely aside from its effect on bone mass, vis-à-vis reduction in the likelihood of falls among the elderly through improved co-ordination, balance and muscle strength, and the improved ability to sustain injuries consequent to falls. The importance of maintaining muscle mass into advanced age therefore, cannot be understated (Butler, 1993) Muscle mass is directly related to strength (Frontera et al.,1991) and the risk of falls in the elderly (Nevitt et al.,1989; Tinetti et al., 1994; Tinetti et al.,1988). Commenting on the positive effects of strength training on fracture risk in a study of women aged 50 to 70 years, Nelson (1994) states that no other single intervention has yet been identified that can simultaneously alter an individual's risk for this multifactorial syndrome.

Although weight bearing type activities are unilaterally considered the most appropriate for reducing the risk of osteoporosis, the optimal frequency and intensity of exercise for prevention of osteoporotic fractures have not yet been determined (Smith et al.1990). Opinion is divided on the benefit of walking, for example (Cavanaugh & Cann, 1988; Krall & Dawson-Hughes, 1994; Nelson et al.,1991; Cooper & Barker, 1995). There is the possibility that severe training schedules may actually increase the likelihood of the disease (Harrison & Chow, 1990) and pressure to reduce weight for sporting performance may also put women at risk for premature osteoporosis (Drinkwater et al., 1990).

1.5.5 Change in bone mineral content (BMC) - activity implications

Bone mass in the female population has dropped 1% -2% per decade in one generation (Smith et al.,1990). If this decline continues, this must have an effect on the fracture incidence, particularly since life expectancy has increased. Given that a BMC deviation of 1SD (12%-15% drop from mean value), increases the likelihood of sustaining a fragility fracture by 2-to 3-fold (Johnell et al.,1991), Duppe and colleagues are concerned at the omen for future rates in the next 30-40 years (Duppe et al.,1992). Previous studies of these researchers (Gardsell et al.,1991a; Sernbo et al.,1988) and present data may indicate that differences in lifestyle rather than in genetics, contribute to differences in bone mass in middle-aged women. On the other hand, Duppe and colleagues show that this difference is not quite so obvious when comparing older age groups. Discussing trends of change, they are however, unequivocal in recommending activity in the earlier years (Gardsell et al.,1991b). Accumulated evidence indicates that frequent exercise may be most effective in helping to reduce the risk of osteoporotic fractures by helping to maximise peak bone density during youth rather than by actually increasing bone density in postmenopausal women and older men (Haskell, 1994). When considering the importance of peak bone mass with regard to future fracture risk, it is obvious, therefore, that preventive measures should start early in life.

1.6 Physical activity in the prevention and management of low back pain

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There is little scientific knowledge of the aetiology of low-back pain (LBP) (Nachemson, 1990). There are known anatomic and physiologic etiological factors responsible for LBP (Keim, 1980), and known underlying systemic illnesses (McCowin et al.,1991), however, these causes typically account for only a small proportion of LBP cases. Non-specific low back pain is by no means a homogeneous symptom and may have many causes (Ernst, 1995). Indeed, most cases of acute LBP are idiopathic (Ernst et al.,1993). Some exercise physiologists suggest that backpain is caused in the main, not by sudden trauma, but by soft tissue injuries, resulting from accumulated years of improper sitting, moving and lifting, combined with a sedentary lifestyle and lack of flexibility (McMahon, 1995). The effects of mechanical loading of the spine on back pain causation have been clearly demonstrated in occupational activity (Walsh et al., 1991). Studies have suggested that high training duration predisposes athletes to LBP (Kujala et al., 1992). For example, the back pain problem of elite gymnasts is well known (Frymoyer & Cats-Baril, 1987). Chronic LBP is however increasingly disassociated with any physical cause, and as such, appears to be a self-sustaining condition that is resistant to medical cause or cure (Waddell, 1987).

1.6.1 Prevalence of low back pain

Of the musculo-skeletal system disorders, low-back pain (chronic and low back) has been clearly delineated as the most costly condition from society's point of view (Nachemson, 1990). No evidence exists to show that the prevalence of back pain has risen in recent years, yet in the United Kingdom, as well as in other countries, such as Ireland, with well developed social security systems, the number of people receiving disability payments has risen steadily (Ellis, 1995). The LBP syndrome is in fact high and going higher in all industrial societies in the world, and is the second most common cause of physical disability after cardiovascular disease, increasing at a rate of 10-13% per year (Waddell, 1993).The escalating incidence of disability is attributed in large measure to the advent of specific legal and insurance issues (Hadler,1987) augmented by the general notion in industrialised countries that discomfort should be treated by rest rather than by activity. Backache afflicts four out of five Irish people at some time in their life (McMahon ,1995). Only 10% (approximately) of people with LBP condition seek medical attention, and 90% with acute low back pain are better within one month regardless of treatment (Jenkins & Borenstein, 1994).

1.6.2 Physical activity and the prevention of low back pain

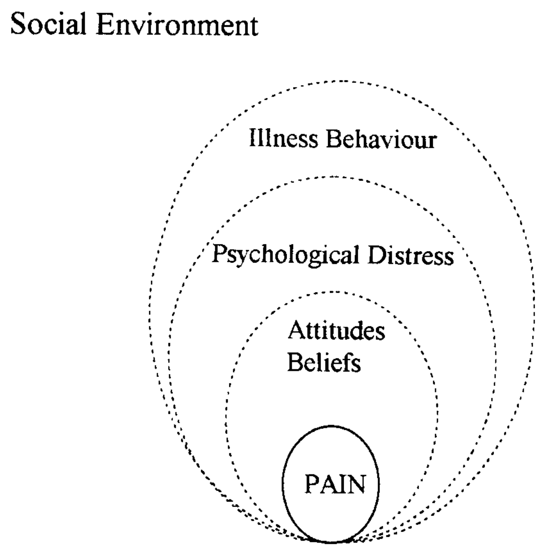
In the healthy system, exercise can increase the strength of muscles, tendons, ligaments and bones, but excessive or inappropriate exercise may cause tissue injury, and repeated injury may result in permanent damage. Rhythmic exercise results in muscle becoming stronger and more resistant to fatigue. In regular activity, ligaments and tendons and their attachments are strengthened, bone becomes stronger and the nutrition of articular cartilage is improved, while inactivity or immobilisation results in atrophy. The stability of joints is also influenced by the state of the surrounding ligaments and musculature. (Royal College of Physicians, 1991). There is therefore ample anatomical logical validity for the importance of the functioning of the trunk and thigh musculature as factors in a healthy back (Plowman, 1992).

There is evidence that a lack of exercise and fitness (i.e., the result of immobilisation) is detrimental (Bortz, 1984) to the musculo-skeletal system, and that tissues become mechanically stronger when exercised (Woo,1988), hence the widespread recommendation of exercise designed to improve muscle strength and flexibility, particularly in the early years (e.g. Patton et al., 1986; Jopling, 1988). The causes of LBP, however, and its relation to proper musculoskeletal development in childhood are not well understood (Lohman, 1992; Salimen et al., 1993). Physical fitness components had been traditionally deemed so important that low back pain and tension was classified as a hypokinetic disease (Kraus & Raab, 1961), and items aimed at evaluating the potential for the onset of LBP were included in the major U.S. health-related physical fitness test batteries used for school aged children and adolescents (AAHPERD, 1980). However, by 1984, it was acknowledged that limited scientific evidence supported the contention that physical exercise is an effective prophylactic and therapeutic modality for low back pain (AAHPERD,1984). In addition, some of these tests have now been shown to have serious anatomical shortcomings (Plowman, 1992), and others, such as the sit-and-reach, deemed to lead to an excessive stretch of the low back (Cailliet, 1988). While the role of low back flexibility may be questioned, and high levels of hip flexor strength and shortening are to be avoided, there is no evidence that high levels of abdominal or back extensor strength/endurance or hamstring flexibility in any way predispose an individual to LBP. There is, in fact, marginal evidence that low levels of strength/endurance and/or flexibility are predictive of recurrent LBP, but no evidence that any particular level of achievement or score is prognostic (Plowman, 1992).

Several studies have attempted to relate the degree of recreational activity to the presence of probability of LBP as opposed to, or in conjunction with, fitness measures (Karvonen et al.,1980; Salimen, 1984; Fairbank et al.,1984; Burton et al.,1989a; Frymoyer & Gordon, 1989). Results of these studies are diverse. In fact, without accurate measures of activity (both intensity *and* frequency) the results are probably meaningless. In a review of epidemiological studies by Nachemson (1990), a weak correlation among less physical fitness, less physical activity at work and leisure, and some increase of incidence, prevalence and absence due to LBP was demonstrated. Nachemson's review concludes that although the prophylactic role of exercise is anatomically and physiologically plausible, there is however little evidence that muscle fitness per se prevents the back pain problem (Nachemson, 1990).

There are however several studies that have demonstrated how increased body awareness, gained in programmes that promote general health and fitness, decreases absenteeism in general, and absenteeism from LBP in particular (Blair et al., 1986; Cady et al, 1985; Cox et al., 1983; Saraste & Hultman, 1986.). Results of pilot studies by Waddell (1992) and Waddell et al., (1993) demonstrate that specific fear-avoidance beliefs about work are strongly related to work loss due to low back pain. Waddell (1992) has incorporated study findings into a biopsychosocial model of the cognitive, affective and behavioural influences in low back pain and disability [Figure 1.7].

Figure 1.7 *Biopsychosocial model of low back pain and disability*



Source: Waddell, 1992.

1.6.3 Efficacy of physical activity in back pain intervention

Much of the positive evidence relating physical activity to back pain reduction emerges in findings of recent intervention studies and clinical trials. Effects of an intervention exercise programme on sick leave due to back pain, for instance, were studied by Kellett et al.(1991) over a period of 18 months, using a comparison control time period. In the exercise group, the number of episodes of back pain and the number of sick leave days attributable to back pain in the intervention period decreased by over 50%. The decrease was not accompanied by any change in cardiovascular fitness. In Leino's prospective study (1993), no associations between physical activity and back disorders were observed at baseline, whilst in the 5-year follow-up findings, mean exercise activity was moderately inversely associated with back symptoms.

In clinical studies, both chronic low back pain and chronic neck pain are associated with weakness of the trunk and neck musculature; however, it is unknown whether weakness is a cause or effect. (Rodriquez et al. 1992). Opinion on the efficacy of exercise in back pain treatment is diverse (Foster & Fulton, 1991; Rodriquez et al.,1992; Manniche,1993; Kryger,1993; Bunch, 1994). Koes (1991) found little evidence favouring any specific type of physiotherapy exercise. Among significant improvements in self-reported pain intensity and frequency, the well-controlled exercise trial of Deyo et al.(1990) noted increased activity in the exercise group, although improvements attained were lost some two months later, when exercise adherence declined. Back schools which involve an educational aspect as well as exercise regimens have been recommended by physicians for LBP improvement and recurrence reduction (Royal College of Physicians,1991), but difficulty is reported in determining which of the factors, including psychological, results in pain improvement. Many clinicians who regularly treat patients with low back pain consider that back-extension exercises, particularly at high intensity, may aggravate the condition in its acute stage and that such "formula" treatments are problematic (Ernst, 1995). Current research indicates that exercise and physical activity assist in both symptomatic and functional recovery in chronic LBP, as well as being integral factors in preventing recurrent injury (Waddell,1993; Jenkins & Borenstein, 1994).

The most recent studies support the activity approach with the emphasis on early return to work (Clinical Standards Advisory Group, 1994; Malmivaara et al.,1995). Findings of Malmivaara's controlled trial suggest that continuing ordinary activies within the limits permitted by the pain leads to more rapid recovery than either bed-rest or back-mobilising exercises. Widespread use of this approach in clinical practice, he posits, would result in "substantial monetary savings" (Malmivaara et al.,1995).

There is an emergent consensus on the role of activity in LBP disability which highlights the need for radical change in medical management and the community health care of low back pain (Nachemson,1990; Waddell,1993; Clinical Standards Advisory Group, 1994; Ellis, 1995). Physicians play a dual role in treating patients with LBP and providing society with the concept and understanding of this condition. It has been proposed that physicians therefore have the responsibility to get not only their patients, but also the society at large active, so that at least partly, the issues of back pain and disability can be resolved (Goldman, 1990; Waddell, 1993).

1.7 Physical activity and mental health

The link between exercise and mental health has been supported, if only anecdotally for centuries. However, only recently have data been accumulated on the complex processes involved. Most people who take regular exercise claim to feel better for it (Stephens, 1988). Psychological assessment suggests that those who regularly exercise feel less depression, tension, fatigue and aggression; they also have better sleep patterns. A sense of achievement (mastery-goal attainment), improved physical appearance and self-esteem, distraction from worries and the presence of companionship and pleasant surroundings may all contribute to this sense of "well- being" (Royal College of Physicians,1991), although this concept is difficult to define and assess. Reduced arousal prior to, during, and after exposure to stressors, quicker autonomic recovery following exposure to a stressor, and attenuated emotional reactions to some stressors are all associated with self-reported habitual activity and/or physical fitness (Bouchard et al.,1990). Such effects of vigorous physical activity could have important primary preventive benefits by making people less susceptible to other factors that might produce mental illness and could also have secondary preventive effects in improving functioning in people with mental illness (Taylor, Sallis & Needle, 1985).

Apart from the agreeable social circumstances of recreational activity, it is likely that a biochemical mechanism is also involved in the antidepressant effect of exercise, incorporating possible changes in levels of endorphins (Markoff, 1982) and the production and metabolism of central monoamines (Chaouloff, 1989), mechanisms which may similarly underlie the euphoric state of *runner's high*. . It is not surprising that the mood elevating effects of regular exercise may be missed when activity is curtailed. Many regular exercisers feel less happy when forced to abandon their exercise (Gauvin, 1989), but very few show the phenomena of exercise dependence in its extreme form (de Coverley Veale,1987a). Although physicians suggest that the average person is in no danger of such a problem, to date the prevalence and significance of exercise dependence in terms of public health are unknown (Biddle & Mutrie, 1991).

Although more than 1,000 articles have been published on the psychological effects of sports and exercise, only a minority are data based (Powell et al.,1989), and while accumulating evidence suggests a positive relationship, this is not yet well substantiated (Morgan, 1989; Fletcher, 1993). Recent reviewers have generally concluded that available data suggest a positive relationship between physical activity or fitness and psychological health and that exercise also holds promise as a primary or adjunctive therapy in several important mental health applications (Wessels, 1985; Martinsen, 1990; Plante & Rodin, 1990; Taylor, Sallis & Needle, 1985; Simons et al.,1985; Morgan & OConnor, 1988; Biddle &Mutrie, 1991; Gauvin,1994 ; McCauley, 1994; Landers & Petruzzello, 1994), and possibly cognitive impairment in older adults (Emery & Blumenthal, 1991). The role of exercise and physical activity in the enhancement of psychological health, with respect to *positive* psychological effects (as opposed to the amelioration of negative symptomology) is also being explored (McAuley, 1994).

The specificity observed for physiologic effects of various types of exercise has not however been clearly demonstrated for mental health effects, and effects of physical activity on mood, cognitive functioning and other psychological-mental health outcomes are still questionable. The most impressive findings to date are in the area of depression (North et al.,1990; Biddle & Mutrie, 1991). Notwithstanding the lack of empirical data, health professionals have acknowledged the importance of this sphere of influence of physical activity, and because of the immediacy of the benefits, it has assumed specific emphasis in health promotion. A Scottish report on prevention of coronary heart disease, for example, concludes that the promotion of regular physical exercise to consumers is most likely to meet with success if the immediate benefits, such as the feeling of well-being, the reduction in tension and depression and the social benefits of interaction with others are emphasised, with information about other beneficial effects also being made available (SHHD, 1990).

Depression is now recognised as a public health menace. It accounts for over 10,000 admissions to Irish psychiatric hospitals per year, and costs the country an estimated £280 million annually (McKeon, 1995). Determining whether regular physical activity can protect against, or serve as a non-pharmacological treatment of depression, stress, and anxiety related disorders, is an investigative area of public health importance.

Whilst it is not within the scope of this study to investigate the psychological aspects of adult physical activity, the reported benefits of physical activity and exercise on psychological health and health behaviour are unreservedly acknowledged.

1.8 Physical activity and health benefits for women

Increased support for the relationship between lifestyle practices and health, and the reality of epidemiological data which reflect the high morbidity for women, denote that women should be included as a target of lifestyle-oriented health-promoting programming and research. The focus on women is important, not alone for the enhancement of women's personal health, but also because women, as parents, play important health-related roles for their children, as models of appropriate behaviour, as gatekeepers to both opportunities and barriers (Gottlieb & Chen, 1985; Sallis et al.,1989; Stucky-Ropp & Lorenzo, 1993) and as the major source of reinforcement in most children's lives (Perry et al.,1988; Rose et al.,1994). In addition, since women comprise the largest (living) segment of the older population, it is extremely important to examine their health behaviour, prior to old age. Years of inactivity in females may be either a major cause or a contributing factor to degenerative changes that are associated with ageing and chronic illness (Gillis & Perry, 1991).

1.8.1 Women's lifestyle activity and health-related behaviour

Despite the lower absolute risk to women from CHD, the mortality rate from CHD is high for Irish women in comparison to most other European countries (Fig.1.1), and from the age of 60 onwards, women are considered to be at high risk for this disease (Rich-Edwards et al.,1995). Poor lifestyle habits (and CHD risk), particularly in relation to physical activity and diet, are evident in the findings of female population studies.

There is almost universal agreement that women take part in regular activity less than men. Most studies have found lower vigorous activity levels among women than men, particularly at younger ages (Sallis et al., 1985; Schoenborn, 1985; Stephens et al.,1985; Tunstall-Pedoe et al.,1989; Change of Heart Baseline Clinical Survey,1990; Armstrong et al.,1990; Ulster Marketing Surveys, 1991; Heartbeat Wales,1992; King & Coles, 1992; Lifestyle Report, 1992; Activity and Health Research, 1992; Mcauley, 1994; Pratt et al., 1995; Lloyd et al.,1995). Among older adults, differences, though somewhat smaller than at younger ages, persist. A descriptive epidemiology of leisure-time physical activity in the U.S. reports that the gender difference diminishes or disappears when light and moderate activies are included in the determination of regular leisure-time physical activity levels (Stephens et al.,1985), but gender differences persist when moderate and vigorous intensity activity levels are combined (Pratt et al.,1995). Gender imbalance is observed in Irish population studies at all levels of exercise intensity.

In the Kilkenny Health Project (1992), the largest proportion of women who were active at leisure spent less than half an hour at the activity per week, whereas the active men spent longer than one hour daily at the pursuit. When work and leisure exercise are combined into a physical activity index (PAI), the differences in levels of activity between the sexes remain. 45.3% of females were sedentary and 49.6% take moderate exercise. Data in the National Survey are records of physical activity levels at leisure only, and these are still very low for women, with 42% *sedentary*, and 49% engaged in *moderate* activity, and a decreased gradient of physical activity with age (Irish Heart Foundation,1994). Findings of an Irish workforce survey show fewer females (27%) than males (35%) to be exercisers, and a much greater proportion of females (45%) as non exercisers than are males (26%) (Hope, 1991). Consistent with the findings of Ford et al.(1991), women in the lower socio-economic groups were identified as being the most inactive in all Irish population studies.

Pender (1987) notes that a sedentary lifestyle often emerges early in females and becomes highly resistant to change. This is confirmed by recent Youth Risk Behaviour Surveillance System data (CDC, 1992) and UK reports (Sports Council & Health Education Authority,1988; Health-Related Physical Activity in the National Curriculum, 1990). These show that up to 91% of young women do not take sufficient exercise to obtain health benefits. This inactivity pattern has also been noted in Northern Irish, Welsh, and Irish female adolescent groups (Riddoch et al., 1991; Welsh Heart Programme, 1986; O Reilly & Shelley, 1991). Riddoch and colleagues report that the decline in physical activity begins after the age of 14 years, and reaches extremely low levels in older Northern Ireland girls. A parallel decline is noted in the Kilkenny adolescent study. 54.5% of 16 -18 year old girls are recorded as least active or inactive compared to 34.8 % of boys in the same age cohort (O Reilly & Shelley,1991). This reduction in exercise during school years is accelerated when pupils leave school (Shelley, Daly & Graham, 1991).

Physical activity is not the only lifestyle variable on which women perform less favourably than men. In the 1990 Kilkenny Health Project survey (1992), only just over one-third of the female population (34.2%) were in the acceptable weight category, 46.5% were overweight and 19.4% were obese. The prevalence of overweight and obesity increases with age [14.4% to 32.6%] as does the incidence of hypertension [27.2% (45-54 years) to 51.5% (55-64 years)]. In the national survey (Irish Heart Foundation,1994), almost two thirds (62.4%) of the women were in the acceptable weight category, 28.1% were overweight and 9.5% were obese. In addition, reductions in obesity by females appear to be very difficult to achieve. While people are more labile in fatness than had been supposed, in an early study by Garn (1985) 40% of obese males were still obese two decades later, while approximately 60% of initially obese adult women were still obese after two decades.

Women are not alone at risk from overweight and obesity, but also from desperate attempts to lose weight which can lead to serious dietary disturbances (Taylor et al.,1985; Wilson & Eldredge, 1992). Various surveys have indicated that between 30% and 40% of the population (varying with different age-sex groups) will claim to be dieting at any one time (Haslett, 1995). Many are women who define overweight and obesity by cultural standards rather than by health standards. As a result, forays into dieting are often met with resistance by their own genetic makeup leading to a continuous battle against their own biological nature (Drinkwater, 1994).

A further problem is that many women who are dieting do not follow the recognised and safest strategy for weight reduction: the combination of regular exercise and suitable diet, finding it a lonely and disappointing battle, and the use of drugs, both on and off prescription, is now widespread. There is increased medical concern at the production of newer drugs which affect the reduction in the absorption of fat, and warnings about possible increases in heart disease and colonic cancer if these drugs become widely distributed have been issued by researchers (Haslett, 1995).

Joffe (1994) reports that women's health begins in paediatrics and raises important issues critical to the well-being of younger female patients, such as the effect of exercise on adolescent menstrual function and bone density; the pathogenesis of atherosclerosis, (aortic plaque development differences between girls and males) and the higher rates of cigarette smoking by teenage girls. His concerns, although addressed in the context of U.S. adolescents, are equally relevant to Irish youth. Irish female adolescent activity levels are known to be extremely low (O'Reilly & Shelley,1991). In earlier research, Grube & Morgan (1986) suggested that more older girls were becoming smokers and this was leading to a change in smoking prevalence between the sexes, a trend apparent in other European countries (Aaro et al., 1986; Welsh Heart Programme, 1986). This is a worrying trend, as studies of smoking behaviour in the US have shown that the cessation ratio in the population is lower among women than men (CDC, 1989; Surveillance for Selected Tobacco-Use Behaviours,1990-1994). In summary, on only one health behaviour parameter, viz.: alcohol consumption, are women more favourably positioned vis-à-vis their male counterparts.

1.8.2 Physical activity and female reproductive system concerns

Data defining the role of physical activity in improving health-related fitness for women is inadequate, particularly relative to the physiologic changes specific to women, such as menstruation, pregnancy and the menopause (Drinkwater, 1994). Until definitive data are available, conclusions drawn from the few studies must be tentative.

Menstruation

Menstrual and ovulatory dysfunction is affected by a number of factors including the degree of previous training, extent of exercise and weight loss. Delayed puberty, amenorrhoea and infertility may occur, but are reversible and are not usually seen with moderate exercise (Royal College of Physicians, 1991). It is postulated that the pattern of reproductive change associated with increased "conditioning" exercise is the same as that related to weight loss, severe physical illness or major psychological stress (Prior, 1987). Such characteristic menstrual cycle changes include decreased pre-menstrual symptoms, luteal phase shortening, anovulation and progression to oligoamenorrhea or rarely amenorrhoea. Problems that may arise in the reproductive system for women whose physical activity is performed at "competitive" level are noted (Royal College of Physicians,1991; Cumming,1987; Cumming, 1990), although recent findings by Choi & Salmon (1994) indicate a possible protection from menstrual problems in women who routinely take high levels of exercise. A return to 'normal' may occur at any point depending on the rapidity of decreased training load and factors of individual susceptibility (Prior, 1987).

Pregnancy

Benefits of moderate exercise during pregnancy have been documented (Lokey et al., 1991) and guidelines for safe exercise prescribed (White, 1992) Theoretic risks to both mother and foetus are also listed (Artal, 1992). There is some evidence that heavy exercise loads and hard physical work throughout pregnancy may adversely affect neonatal outcome (Cummings,1987). Sensible exercise during pregnancy, however, is not contraindicated (Royal College of Physicians,1991)

The current literature includes the following consistent findings:

Women who exercised before pregnancy and continued to do so during pregnancy tended to weigh less, gain less weight, and deliver smaller babies than controls (Cummings, 1990; Artal, 1992; Dewey & McCrory, 1994).

All women, regardless of initial level of physical activity, decrease their activity as pregnancy progresses (Rose et al., 1991; Clissold et al., 1991).

No information is available to assess whether active women have better pregnancy outcome than their sedentary counterparts. No information is available on sedentary women. Physically active women appear to tolerate labour pain better (Artal, 1992).

Exercise can be used as an alternative and safe therapeutic approach for gestational diabetes.(Bung, 1993).

In addition, Mutrie (1994) recommends that moderate physical exercise may be psychologically beneficial to the pregnant woman In the absence of controlled trials in this area however, firm conclusions cannot be drawn.

Menopause

At the pre-and peri-menopausal stages, benefits of physical activity, as earlier discussed, accrue in the prevention and delay of osteoporosis. Since women show an accelerated decline of bone mass following the menopause, there is a strong case for pre-menopausal women taking active measures, such as physical activity, to minimise bone mass loss. The beneficial effect of exercise becomes apparent particularly when the overriding influence of oestrogen is removed (Drinkwater, 1994). In addition, the psychological effects of exercise during this life-stage are important. In general population studies, benefits of physical activity for mental health were most evident in women, and in particular for those aged 40 or over (Stephens,1988). Studies of the psychological benefits of physical activity have been comprehensively reviewed (Mutrie,1994).

Combined physical and psychological effects of physical activity therefore, appear to be particularly health enhancing during female reproductive life-stages. Mutrie suggests that in menstruation, pregnancy and the menopause, sport and exercise are ways in which the unity of mind and body can be reinforced and help women to feel in control of the functions which others have suggested control women (Mutrie, 1994).

1.8.3 Physical activity in women's health promotion

Women's health is recently beginning to take a place of prominence on the national health agenda. Ireland is the first EU state to produce a strategy document (Department of Health, 1995). Issues such as re-organisation of cervical cancer screening, and appropriate indications for oestrogen replacement in post menopausal women are discussed in this document, as are important health risk areas, such as gender-based violence. Life expectancy and risk concerns however, should not define the entirety of the women's health domain. Gillis & Perry (1991) have highlighted the need to explore

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the role of physical activity as a health promoting, rather than a disease-preventing lifestyle behaviour for women. Women's health policies therefore should also address the "active living" concept, wherein the experience is as important as the outcome, and "being active" provides not alone the opportunity for health, but also happiness and personal fulfilment (Makosky, 1994; Edwards,1994). This concept is not necessarily incompatible with reasonable recommendations concerning volume and intensity of regular physical activity (Bouchard, 1994).

Irish women have been shown to be more willing to seek out health information than Irish men (Shelley, Drynan et al.,1991; Collins et al.,1993). Although studies using the health belief model and other models of attitude, suggest that knowledge will contribute only small amounts of behavioural variance (Godin & Shephard, 1986b; Oaks et al.,1987; Steptoe & Wardle, 1992), the demonstrated interest in health matters is a positive finding, and as such, cannot be discounted .

Women's health behaviour is an important issue in public health planning, not alone for improving women's personal health, but also for the role women, as parents, play in facilitating children's health behaviour and in the modelling of health habits. Adoption of, and adherence to positive health behaviours by women, including physical activity, is therefore critical in the education of children for lifetime health.

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1. 9 Physical activity and health benefits for older adults

Advances in medical treatment of elderly people have certainly contributed to extended life expectancy. Much of the research efforts by the medical community however are focused on prolonging life, rather than preserving the quality of life (Dargie & Grant, 1991; Astrand, 1994). The association of health behaviour with extending active life for people with non fatal diseases of ageing however, has only recently entered the investigative domain.

From 1981 to 1993 there was an increase in the absolute number of people in the 75+ and 45-64 years old population categories throughout Ireland by 28% and 11% respectively (NNSC, 1995). According to 1991 census data, 11.4 % of the Irish population is 65 or over, a total of 402, 924 people (Kenny, 1994). Population projections expect the number of persons aged over 65 to grow by 40% in the next 25 years (Eurostat, 1993). Given such a proportion of the population to be old or very old, and the high prevalence of disability among the elderly, improving quality of life in the later years, is an important issue in public health research and planning. Integral and crucial to improved life quality is the empowerment component, which initially appears to be only indirectly related to health outcomes, but which has significant physiologic and psychological implications, viz.: the ability to look after oneself through movement independence. The maintenance of quality of life and movement independence is positively related to maintenance of an active lifestyle, yet two-thirds of all adults age 65 or older are either irregularly active or completely sedentary (Rooney, 1993).

Functional capacity decline with age is universal, progressive, irreversible, and unique(Orban,1994). Reported studies provide evidence of the decrease in cardiovascular and respiratory functional efficiency (de Vries et al., 1989; Shephard 1990) and decreases in functions such as glucose tolerance, aerobic capacity, nerve conduction velocity and creatinine clearance have also been demonstrated. There is an approximate 30% decline in muscle strength and a 40% reduction in muscle area between the second and seventh decades of life (Rogers & Evans, 1993). Orban's model (1994) shows that the rate of functional decline (age class), although less than 0.25%

per year in the 4th decade, increases to about 1% per year in the 7th decade and to more than 2% per year in the 10th decade. Being old or growing old, however, should not necessarily mean being disabled or progressively incapacitated, as stereotypical attitude may sometimes suggest (Kenny, 1994). The time has come for a shift towards ameliorating the quality of life for the ageing population (Olshansky et al.1990).

Although Holloszy (1993) has counter-argued that physical activity slows ageing and confers long-term health benefits, most of the recent evidence supports a positive effect of physical activity on specific and general functions of the organism (Astrand, 1986,1991). Shephard & Montelpare (1988) argue that habitual physical activity enhances and extends 'age-specific' functional and energy capacity and that the benefits are limited only by dosage, but acknowledge that there is little evidence to support the argument. Orban (1994) supports this tenet, but considers that the analysis of the effect of physical activity on functional capacity decline to be extremely difficult, if not impossible, due to the lack of adequate physical activity indicators in the data. Vigorous endurance exercise training, however, has been shown to elicit a proliferation of muscle capillaries, and increase in oxidative enzyme activity, and a significant improvement in VO_{2max} (Rogers & Evans, 1993). Since older people adapt to resistive and endurance exercise in a similar fashion to young people, the decline in the muscle's metabolic and force-producing capacity can no longer be considered as an inevitable consequence of the ageing process.

It is agreed that increased capacity certainly enables one to fulfil and extend quality of life (Fentem, 1992; Orban, 1994). The enhancement and preservation of physical work capacity not only prevents a deterioration in the quality of life, but can promote improvement in that quality. In an arbitrary calculation of quality adjusted years, Shephard (1994) compares the total advantage of the active person over a sedentary person to be 8.7 quality-adjusted years (QAY). There are as yet, unfortunately, no reliable data on the average "quality" that people assign to various states of health, and hence quantification of QAY needs more careful investigation. Shephard's observations, however, indicate the potential importance of physical activity in conferring improved life quality in advancing age.

Muir-Gray (1987) has addressed the contribution "fitness" can make to attenuating age-related diminution of functional capacity. He believes that loss of fitness (through inactivity or illness) at this time of life, leads to the development of a "fitness-gap" - a widening disparity between best possible levels of physical performance and actual levels of physical performance.("Performance" meaning perhaps the simple mobility tasks of stair climbing, flexibility tasks of shoelace tying etc.) If allowed to progress unchecked, Muir-Gray believes that the disparity reaches a critical point at which individuals may not have sufficient psychological reserve to permit them to undertake simple physical tasks. Astrand (1994) also asserts that exercise training can readily produce a profound improvement of functions essential for physical fitness in old age, and thus effectively postpone physical deterioration for some 10 to 20 years. In the elderly, motor neurone depletion combined with disuse cause the loss of muscle bulk and power. Appropriate exercise can increase muscle bulk and strength by 10-20% in men in their early seventies (Royal College of Physicians,1991). Even up to the age of 96 years, men and women can respond to resistance training with a substantial (greater than 200%) increase in strength and muscle size (Evans, 1992). The adaptations in ageing skeletal muscle to exercise training may also prevent sarcopenia, enhance the ease of carrying out activities of daily living, and exert a beneficial effect on age-associated diseases.

The loss of movement capacity as a consequence of declining fitness may lead into what Young (1987) terms the "disuse-disability" spiral, where loss of fitness leads to reduction in movement capacity, probable aggravation of symptoms of chronic disease, which in turn will probably lead to a reduction of habitual physical activity, which in turn leads to further losses in fitness and so on.

In a study by Lacroix et al. (1993) several health behaviours were investigated in relation to maintaining mobility during a 4 year follow-up of adults aged 65 years and older. The 6,981 adults had intact mobility at baseline. After adjustment for age and all of the health behaviours, risk of losing mobility was significantly associated with current smoking, not consuming alcohol compared with consuming small to moderate alcohol amounts, high (>80th percentile) compared with moderate (21-80th percentiles) body mass index, and low physical activity levels in both men and women. These findings suggest that positive health behaviours, including maintenance of moderate activity levels, can not only extend longevity but also reduce the risk of losing mobility and independence in later life. Rooney (1993) reports adequate aerobic exercise to be associated with a 1- to 2- year increase in life expectancy, as well as increased functional independence.

A serious public health problem among elderly people, because of its frequency, the associated morbidity, and the cost of the necessary health care is that of falling (Sattin, 1992; Berg & Casssells, 1990; DHHS, 1990). From 20% to 30% of community-living persons over the age of 65 years fall each year, and half of these persons experience multiple falls (Tinetti et al.,1993). In 1993, there were 5,814 Irish hospital admissions for fractures among people aged 65 and over, incurring an average hospital stay of between 10 and 14 days (HIPE, 1993), almost twice the period for younger admissions. Many such fractures are resultant from falls. Studies of the elderly have shown that although the majority of falls result in no serious morbidity, possible sequelae include death, physical trauma ranging from minor soft tissue injuries to fractures, and activity restriction because of fear (Blake et al.,1988; Tinetti et al.,1988; Vellas et al.,1987).

The risk of falling increases with the number of risk factors present, suggesting that a multifactorial strategy of risk-factor abatement may reduce the risk of falling.(Tinetti et al., 1988; Blake et al.,1988; Campbell et al.,1989; Nevitt et al., 1989). While obvious environmental hazards are contributing factors in up to a third of falls (Cummings & Nevitt ,1994), muscle weakness, impairment in balance, and use of medications have been identified as potentially modifiable risk factors (Tinetti et al.,1994a). Resistance training can improve strength, even among the oldest and most frail, and it may improve gait and balance (Fiatarone et al.,1994; Judge et al.,1993). Whether intervention that prevents falls will also prevent major injuries or hip fractures is not clear, as falls that cause hip fractures may be qualitatively different from others (Nevitt & Cummings, 1993). Studies by Cooper at al.(1988) and Lau et al.(1988) have shown physical activity to be protective against hip fracture in men and women. Tinetti's intervention trial (1994) also reported a reduction in incidence of falls and associated medical care, but Cummings & Nevitt (1994) consider the study to be too small to answer this question.

However, an important outcome of such intervention strategies is improved function which results from, not only incidence of falls, but also increase in subjects' confidence in performing daily activities - an important independent determinant of daily functioning (Tinetti et al.,1994b). Maintaining the ability to continue self care and enjoy leisure-time pursuits has also been shown to enhance psychological status, including less depression and anxiety (Bortz, 1980; Haskell et al.,1985)

Decline in energy capacity with age, as noted, is a normal phenomenon; abstinence from physical activity is not. Evidence suggests that regular periodic energy stimulation throughout the day is increasingly important for the older adult. But to fully impact on the quality of living, Orban (1994) suggests that optimal active living ought to include vigorous physical activity not only of an optimal supplemental dosage, but of an increased intensity in daily living as well. He defends ACSM (1994) guidelines, and asserts that most people can achieve 60% to 70% heart rate reserve in a very short time, instancing a training programme with 70 year-olds, who started at 40% to 50% of maximum heart rate and within a few weeks were at 70%. Target models however he adds, may greatly underestimate the threshold for a more fit older adult, and deprive him or her of the optimal active living benefits (Orban,1994). Linsted (1991) and colleagues' findings on the contrary suggest moderate activity levels for all ages, rather than higher activity levels, and the moderate intensity threshold is generally agreed. Concerns about the safety of exercising for older people at any intensity can be assuaged by the observations of Vuori et al.(1982), which show that the relative risk of exercising is less at an age of 50 to 69 years than at 40 to 49 years.

Rowe & Kahn (1987) addressed the need for a change in social health provision of "direct assistance treatment", which promotes learning helplessness in older people, and accelerates the rate of functional impairment and reduced physical fitness. This is the type of treatment of the elderly to which Muir-Gray (1987) refers, when he argues that, too often. provision of a social response, a prosthetic response is given to what is essentially a correctable physical problem He therefore, clearly, unequivocally and emphatically states the case for the promotion of exercise, and to grant to old people the right to be active, even if that means that they have to struggle and be at risk.

Advancing age and elapsed time after initial adoption of an activity are among the most reliable predictors of inactivity. Analysis of physical activity surveys that provide sociodemographic data has shown consistent agreement on the decline of physical activity with advancing age (Stephens et al.,1985). It seems likely that past activity environments and experiences are strong influences on present and future participation (Dishman & Sallis, 1994). This confirms the need for regular activity in the early years to be enjoyable and diverse in form, and for the formation of positive attitudes to exercise as a lifetime activity.

1.10 Physical activity and health benefits in youth

As stated at the outset of this study, current understanding of the health effects of physical activity suggests that, while active children experience some improvements in mental and physical health, health benefits in youth are transitory. Therefore one of the major rationales for promoting physical activity in children is to establish patterns of regular activity that can be maintained throughout life.

An overview of the lifetime activity - health relationship however would be incomplete without reference to childhood. Regular physical activity has no apparent effect on statural growth and on commonly used indices of biological maturation (skeletal age, age at menarche, and age at peak height velocity). In well-nourished children and youth, these variables are primarily regulated by genetic factors (Bouchard, Shephard & Stephens, 1993). Inferences about the effects of physical activity, e.g. later menarche in female athletes, are based on specialised groups of children training for specific sports, and have limited relevance to the general population of children. Regular physical activity however is an important factor in the regulation of body mass, and is generally associated with greater skeletal mineralization.[14] Recent reports investigating developmental changes in skeletal mass of adolescent girls and young women under different experimental or ecological conditions support the contention that modification of environmental factors, especially dietary calcium and physical activity, can favourably modulate bone mass and bone density compared to controls (Anderson & Metz, 1993).. The peripubertal period, starting as early as 10 years of age, seems to be most responsive to modification of environmental/lifestyle factors, whereas potential gains of bone mass during late adolescence and early adulthood, although smaller, may be more readily achieved through improved dietary calcium intakes and regular exercise programmes. Studies tracking the effects of activity on indicators of growth during childhood and adolescence are reviewed by Malina (1990, 1994) and Beunen et al.(1992).

This section of the overview confines its reference to three important and ongoing lines

14 The relationship of physical activity to growth, maturation, and fitness. In: Bouchard, Shephard & Stephens, 1993. *Physical activity, fitness and health: Consensus statement*, 85-90.

of investigation of the health effects of physical activity in youth. These are the relation between physical activity and obesity, the relation between physical activity in children and cardiovascular disease risk factors, and intervention trials to assess the therapeutic effects of physical activity in children. Brief reference is also made to the relationship between children's physical activity and psychosocial health.

1.10.1 Physical activity and obesity in children and adolescents

The accepted diagnostic criterion for obesity is the 85th percentile of triceps skinfolds (Must, Dallal & Dietz, 1991). Obese children are defined as those with triceps skinfolds greater than or equal to the 85th percentile of all children in the NHES cycle in 2 or 3 samples of children of the same age and sex (Gortmaker et al., 1987). A substantial increase in the prevalence of this disorder has been indicated in studies of western populations, an increase that has occurred despite a cultural standard that encourages thinness. Data from surveys of the US population estimate the prevalence of obesity for 12-17 year olds at 18% for males, and 26% for females.[15] Trends in weight-for-height and triceps skinfold thickness for English and Scottish children suggest that obesity is increasing in the child population in Britain (Prentice & Jebb, 1995; Chinn, 1994). Obesity in childhood is not considered to be of similar magnitude in this country[16], although the increase is likely to parallel that observed for Great Britain. In a study of 707 British adolescents, Armstrong & McManus (1994) using age, height, body mass criteria of the Royal College of Physicians, report that 13.4% of the boys and 9.7% of the girls in the sample could be classified as "overweight". While clinical growth standards for Irish children have been published (Hoey, Tanner and Cox, 1987), no data are available on the prevalence of overweight or obesity. One small study of 11-12 year-olds (n = 100) found that, although 40% of the children wanted to be lighter, only 6 children could be described as clinically overweight. (Gallagher and Flynn, 1994). A large-scale study (n=1163) of Irish primary school children (Watson,1993) reports the mean weight per age group only, and absence of percentile data precludes identification of cases as 'overweight' status.

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15 *Healthy Youth 2000.* Chicago, Ill: Department of Adolescent health, American Medical Association. 1990. AA75; 90-302, 10M.

16 Personal communication, Dr.M.Flynn, Dept. of Biological Sciences, DIT, Dublin.14/9/1996

Increases in the prevalence of obesity among children and adolescents poses negative implications, not only for long-term health risks, but for immediate, physiological and psychological well being. Obese children are a greater risk for hypertension, psychosocial dysfunction, respiratory disease, diabetes and several orthopaedic conditions (Gortmaker et al., 1987). While chronic disease outcomes related to obesity are not manifest until adulthood, behaviours that predispose individuals to obesity often are established during adolescence. Obesity carries a social stigma in affluent societies and overweight children in particular can suffer, as they tend to be disliked more than disabled or disfigured children. This has been observed in several surveys of children's attitudes to each other (Richardson et al.,1961; De Jong, 1980). By adolescence many overweight children have feelings of personal shame and rejection (Tobias & Gordon, 1980), and may also be at a disadvantage in choosing a mate (Weiss, 1980). Disadvantages in the economic consequences of overweight in adolescent and young adulthood have been cited (Gortmaker et al., 1993; Sobal, 1991). A large British cohort study (n = 12,537) for example, recently demonstrated an inverse relationship between obesity in adolescent girls and earnings in their twenties (Sargent and Blanchflower,1994).

Childhood obesity has been described as "one of the most complex and least understood clinical syndromes in paediatric medicine".[17] Convention suggests obesity results from overeating and inadequate physical activity. In the UK, however, studies of children and adolescents suggest that over quite short periods of time there has been a fall in energy consumption consistent with a fall in physical activity, and this reduced intake has not always been sufficient to prevent an increase in body fat (Royal College of Physicians, 1983). In a recent survey of paediatricians, excessive calorie consumption was cited most frequently as a major cause of this disorder (Price et al., 1989). The basis of overweight and obesity is not dependent on one or two single factors. '..Social, psychological, endocrinological and metabolic factors all contribute to the prevalence of overweight in the community',[18] and a combination of factors, sometimes genetic and behavioural, may well be involved in the individual with a weight problem

17 Korsch, B. Editor's column: Childhood obesity. *Journal of Pediatrics.* 1986,7, p.299.

18 Obesity : A report of the Royal College of Physicians. *Journal of the Royal College of Physicians of London.* 1983, 17 (1), p.43.

Studies of children and adolescents have documented associations between physical activity and obesity, but such a relationship is not consistently found (Corbin & Fletcher, 1968; Epstein & Wing, 1980; Shapiro et al., 1984; Epstein et al.,1985; Huttunen et al.,1986; Gortmaker et al.,1987; Vara, 1989; Epstein, Koeske & Wing, 1984; Cooper et al.,1990; Epstein et al.,1990; Gortmaker, 1990; Epstein et al., 1991; Cohen et al.,1991; Crepaldi et al.,1991; Taylor & Baranowski, 1991; Blaak et al.,1992; Muecke et al.,1992; Sallis, McKenzie & Alcaraz,1993; Esposito-del Puente, 1993; Gazzaniga & Burns, 1993; Raitakari et al.,1994; Bernard et al., 1995). All studies were conducted after the subjects had become obese and, thus, could not address whether hypoactivity is part of the aetiology of obesity or simply reflects less activity induced by more weight. Another problem in determining the relationship between physical activity and obesity is that some authors approach physical activity as a behavioural phenomenon, while others measure energy expenditure, the physiologic corollary of physical activity (Bar-Or & Baranowski, 1994). Because body mass is a primary determinant of energy expenditure, an obese adolescent, with an observed low physical activity, can have a higher total energy expenditure (EE) than a leaner (lighter) somewhat more active peer.

In determining its relationship to adiposity therefore, Bar-Or and Baranowski, (1994) recommend that physical activity be expressed as body movement not as energy expenditure. Alternatively, if data on EE are available, differences in body mass should be taken into account.

In a commentary on the analysis of data in their study, Sallis, McKenzie & Alcaraz (1993) note that it is difficult to interpret the non-significant correlation between skin-fold measurements and physical activity observed among girls in his study. Two potential explanations suggested are that dietary factors are more important in the development of obesity in girls, and that obese girls may be engaging in increased levels of physical activity as a form of weight control. In the longitudinal study of Finnish youth (Raitakari et al.,1994), constantly active young women had thinner subscapular skinfolds compared with constantly sedentary young women. Differences in obesity indices however among active and sedentary individuals were only seen in subscapular skinfold index, but not in body mass index. Thus, physical activity seems to induce a preferential loss of body fat also accompanied by an increase of lean tissue. This finding, according to the authors, also implies that body mass index is probably a poor measure of obesity during growth.

Studies of the aetiology of obesity have indicated that the distinct measure of inactivity seems to be a key factor in predisposing to obesity (Walberg & Ward, 1985; Tucker, 1986; Shah & Jeffrey, 1991; Moore-Groarke & Thompson, 1995). Data from large scale surveys of adolescents (Dietz & Gortmaker, 1985; Pate & Ross, 1987; Bernard et al., 1995) suggest a significant relationship between the prevalence of obesity and the extent of television viewing. Other studies (Tucker, 1986; Robinson et al.,1993) did not confirm such a relationship. Robinson et al., (1993) noted that the relationship between television viewing and subsequent changes in BMI or adiposity over a 2-year period was not significant in adolescent girls.

The relationship between physical activity and childhood obesity has been reviewed by several authors: Dietz (1991), Bar-Or (1993), Gutin & Manos (1993) and Bar-Or and Baranowski (1994). While all reviews note the inconsistency in study findings, a lifestyle association is cited as a common factor in analysis commentary. Data showing relationships between obesity and measures of both activity and inactivity, coupled with those linking television viewing to greater consumption of so-called "snack foods" lend credence and support to the importance of lifestyle factors as contributors to childhood and adolescent obesity.

1.10.2 Physical activity and cardiovascular disease risk factors in children

The prevalence of cardiovascular disease risk factors in child populations is reported in early studies such as the Muscatine study (Lauer et al.,1975), Gilliam et al.(1977), and Orchard et al.(1980). In the past decade, the Bogalusa heart study of multiracial youth (Newman et al.,1986), the Oslo Youth Study (Tell & Vellar, 1988), the studies of British children by Armstrong and colleagues (1990, 1992), the Irish adolescent study (O' Reilly & Shelley, 1991), the study of Belfast schoolchildren (Primrose et al., 1993), and the Cardiovascular Risk in Young Finns study (Raitakari et al.,1994) have investigated the presence of disease risk factors in youth. The accumulated evidence has led researchers to explore the relationships between children's health behaviours: in particular smoking, diet, physical activity, and cardiovascular disease risk.

The literature on the relationship of physical activity to cardiovascular disease risk factors among children has been reviewed several times in past decade (Vacarro & Mahon, 1989; Despres et al.,1990; Baranowski et al.,1992). The literature is not extensive, and some of the generalizations are not thoroughly supported by well-designed research (Baranowski et al., 1992). The relationship of physical activity to blood lipids, blood pressure and body composition has been examined in both cross-sectional and controlled training studies. The training studies provide a test of what characteristics of physical activity affect risk factors because the intensity, duration, and frequency of activity are controlled, but the cross-sectional studies provide a test of whether *usual* levels of activity are so related.

Physical activity and lipid profile

A high lipoproten (a)(Lp(a)) level is an independent and predominantly genetically determined risk factor for coronary heart disease and other vascular diseases. In cross-sectional research, physical activity or fitness has been associated with lower triglyceride and higher HDL-cholesterol levels (Thorland & Gilliam, 1981; Sallis et al.,1988; Tell & Vellar, 1988; Suter & Hawes, 1992; Raitakari et al., 1994; Taimela et al.,1994), although the relationship was not apparent in the 5th grade schoolchildren studied by Miyanishi et al.(1993) and was significant only for girls in the small-scale study of Suter & Hawes (1993). The onset of puberty seems to enhance the effect of exercise, but lipid levels (total cholesterol, LDLc) at these ages are generally lower than during childhood (Wanne et al.,1984). Taimela and colleagues' study (1994) of a large cohort of Finnish youth found high levels of Lp(a) (>25 mg/dl) to be less frequent in the physically most active subjects. Levels of Lp(a) were not related to age, gender, or other behavioural variables (risk factors) studied. In the same study, Raaitakari and colleagues (1994) studied whether the 6-year change of physical activity level would contribute to the changes in lipoprotein and insulin levels independently of changes in diet, obesity, or smoking habits. Multiple regression analyses showed that physical activity had an independent inverse effect on serum insulin and triglycerides among boys only. The authors conclude that this finding "..provides an additional reason for the promotion of physical activity in primary prevention of these diseases".[19] In the Child and Adolescent Trial for Cardiovascular Health (CATCH) (Luepker et al.,1996), a three-year large scale intervention study, increased activity levels were recorded both for in-school and out of school activity, lower food energy intake and total fat intake were also recorded, but the intervention did not accomplish the blood cholesterol reductions it set out to achieve. The controlled training literature also provides an unclear picture of risk relationships (e.g. Badruddin et al.,1993; Berg et al.,1994). Nonetheless, researchers have concluded that children showing risk factors such as hypercholesterolaemia or obesity will benefit from early intervention programmes when changing dietary and exercise behaviours.

Physical activity and blood pressure

Much of the cross-sectional and training literature does not provide support for the idea that aerobic physical activity is related to blood pressure in children with blood pressures in the normal range (Klesges et al., 1990; Ferrara et al.,1991; Pearl et al.,1991; Jenner et al., 1992). Al-Hazzaa and colleagues (1994) found physical activity to be significantly associated with lower blood pressure in their study of 91 preadolescent boys. Lower blood pressure levels in active children were also observed by Sallis and colleagues (1988) and Tell & Vellar (1988). In the large-scale study of Australian children conducted by Jenner and colleagues (1992), compared with weight and body mass index, dietary energy intake and the chosen measures of physical activity and physical fitness were poor predictors of blood pressure

Physical activity and adiposity

The findings in relation to the effect of physical activity on body composition are equivocal. In some cross-sectional studies no statistically significant differences in adiposity were found between active and inactive children (Klesges et al.,1990; Pearl et al.,1991; Beunen et al.,1992; al-Hazza et al.,1994). For example, Pearl et al. (1991) note that differences between active and inactive children (n=295) were not statistically

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[19] Raitakari, O.T., V.K.Kimmo, S.Taimela, R.Telama et al., 1994. Effects of persistent physical activity and inactivity on coronary risk factors in children and young adults. *American Journal of Epidemiology.* 1994, 140 (3), 203.

significant (p >0.1), whether boys and girls were analysed separately or when combined. In others (e.g. Janz et al., 1992; Fontvieille et al.,1993; Miyanishi et al.,1993; Sallis et al.,1988; Bernard et al.,1995) significant effects of activity on BMI were observed. al-Hazzaa et al.(1994) found that while physical activity was not significantly associated with BMI, differences across fitness categories were observed The converse is reported in the study by Sallis and colleagues (1988). After adjustment for body mass index, fitness-risk factors were no longer significant, but the activity rating was significantly correlated with body mass index in all subgroups analysed. In the CATCH intervention trial (Luepker et al.,1996), reductions in body mass index did not correlate with both increases in physical activity and reduced energy intake. The authors explain the absence of association in terms of the developmental period of the children sampled, with the onset of puberty occurring for many during the study. Thus the "...effects of exercise and diet may be obscured by these more substantial developmental changes".[20] In another commentary on the results, Garrison (1996) suggests that "...whatever effect 0.46MJ/d (sic.) might have on relative weight seems likely to be overwhelmed by the potentially higher activity levels and increased muscle mass of more active children." [21] As to the explanation for no influence on skinfold thickness, "...perhaps imbalance in energy is not severe enough and is not present in a large enough proportion of preadolescent children to enable detection of significant relationships" (*ibid.*).

Results from training studies are also inconsistent. For example, there was no significant decrease in skinfolds of 8- to 9- year old children following an 8-week skipping programme, wherein children spent an average of 69.2 ± 5.6% of the 4 x 15 min. skipping periods with heart rates exceeding 150 beats min^{-1} (Stratton & Waggett, 1995). Despres and colleagues (1990) concur that there is inconsistency in the relation between body composition and physical activity. In their review, they suggest that aerobic exercise might reduce risk factors for coronary heart disease independent of any effect on adipose tissue mass.

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[20] Luepker, R.V., C.P. Perry, S.M. McKinlay et al., 1996. Outcomes of a field trial to improve children's dietary patterns and physical activity. *Journal of the American Medical Association*. 1996, 275 (10), 773.

[21] Garrison, R.J.,1996. Improving dietary patterns and physical activity levels among children and adolescents. [Letter]. *Journal of the American Medical Association*. 1996, 276 (3), 195.

Discussion of the activity-health relationship often elicits the concern that fitness levels of children may be suffering by an increasingly sedentary contemporary lifestyle. No information is available to indicate the quantitative influence of a sedentary lifestyle on aerobic fitness in children (Rowland, 1994). It has been proposed that high spontaneous daily habits of children serve to maximise aerobic function and thereby reduce their ability to improve VO_{2max} with exercise training. The limited duration of sustained heart rates during daily activity (Armstrong et al.,1990; Armstrong & Bray, 1991; Biddle et al.,1992; Atkins et al.,1995)[22] and the failure to document a firm relationship between levels of regular physical activity and VO_2 max in the paediatric age group (Rowland, 1990) have weakened this argument. Evidence does exist that aerobic fitness may decline when physical education stops in the summer (Knuttgen & Steendahl, 1963), and as well when Alaskan children developed contemporary lifestyles of television watching (Rode & Shephard, 1971). Data however in the recent study by Rowland (1994) suggest an average fall in peak aerobic power of only 13% in children aged 7-11 years after approximately nine weeks of bed rest. These findings further imply that daily activities of children do not profoundly affect aerobic function.

The evidence relating physical activity to cardiovascular disease risk factors in childhood is not consistent. Physical activity has little influence upon the risk of acute illness; however, by controlling the evolution of certain risk factors, exercise may protect against future disease. Biologic risk factors, such as serum lipids, are shown to track reasonably well from childhood to adulthood (Raitakari et al.,1994). Data suggest that as many as 70% of overweight adolescents become overweight adults (Garn, 1985), and adults obese as adolescents constitute a majority of the heaviest adults (Rimm & Rimm, 1976). Studies tracking physical activity behaviour are few (Kuh & Cooper, 1992; Lee et al.,1992; Kelder et al.,1994; Raitakari et al.,1994) but the evidence suggests that early adaptation to sedentary lifestyle seems to have stronger modifying effect on later activity patterns compared with adaptation to high levels of physical activity. The persistence in rankings of physical activity behaviour from 6th to 12th grade noted by Kelder et al.(1994) suggests that consolidation of health behaviour may begin prior to 6th grade.

[22] Illustrated further in this study: see Table 2.1b and relevant text

Certainly the observation that groups maintain relative ranking indicates that there are subgroups of students who remain at higher risk than their peers.

Life-style patterns adopted in childhood may persist into adulthood, and the evidence from the few previous studies are in favour of this assumption. Perhaps Cunnane's commentary on the results of studies on cardiovascular disease risk best reflects and summarises the viewpoint held by many researchers. "..... The most important consideration in the debate on childhood and cardiovascular disease risk, is that research over the past 40 years clearly points to childhood as a critical period when dietary and lifestyle patterns are initiated which have long term implications for coronary heart disease in adult life."[23]

1.10.3 Therapeutic effects of physical activity in children

The therapeutic effects of physical activity have been studied both in controlled trials and intervention studies. Continuing trials on the management of obesity indicate that physical activity makes important contributions to obesity control (Epstein, Koeske & Wing, 1985; Epstein et al., 1987, 1990; Cohen et al.,1991; Blaak et al.,1992; Racette et al.,1993; Foger et al.,1993; Maffeis et al.,1993; Berg et al., 1994).

Experience from intervention programmes has shown that the combination of intensive dietary and physical activity programmes improves body composition, physical fitness, as well as lipid metabolism in obese children in the short-term. In some cases, the combined programme is effective even without insisting on caloric reduction (Foger et al.,1993). Although training by itself has a beneficial effect, the resulting changes in adiposity are small (1 - 3% reduction in body fat) (Bar-Or & Baranowski,1994). Some evidence suggests that behaviour modification of the parents and of the child/adolescent, in separate groups, must be incorporated to achieve long-range effects (Brownell et al., 1983; Epstein et al., 1987; Epstein et al.,1990).

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[23] Cunnane, S.C.,1993. Childhood origins of lifestyle-related risk factors for coronary heart disease in adulthood. *Nutrition and Health.* 1993, 9, 107-115, p.107.

The relationship between physical activity and body fatness may in part be explained by the fact that routine exercise training seems to stimulate an increase in total daily, non-resting EE beyond that produced by the exercise sessions *per se* (Blaak et al., 1992; Racette et al.,1993). Research on obese adolescent males indicates that moderate, routine exercise increased daily EE by 12%, but only 6% of the increase could be attributed to the formal exercise (Blaak et al., 1992). In a study of energy expenditure in adolescents during low intensity, leisure activities, Horswill, Kien and Zipf (1995) reported that walking at 40% of peak $VO_{2\ max}$ elicited an increase in metabolic rate of 235% compared with that of television viewing, whereas in fact, the mild exercise of walking at 40% of $VO_{2\ max}$ would not be considered a stimulus for increasing peak oxygen uptake (ACSM, 1978). Thus the benefits of low intensity exercise suggest that, in some cases, the simple encouragement to be less sedentary might be more effective in weight control than motivating children to exercise more (Epstein et al.,1990). Maffeis et al. (1993) are in broad agreement with this argument, but add that the prescription of light physical exercise that is simple to perform and also has a high gravitational component, such as walking and running, is a useful tool (in addition to dieting), to achieve fat loss in obese children. Bar-Or and Baranowski (1994) concur that lifestyle activities (e.g. walking to and from school) appear to have a more lasting effect than regimented activities (e.g.calisthenics or jogging).

Some recent investigations into the role of physical activity as adjunctive therapy demonstrate positive outcomes for children with such conditions as spina bifida (Andrade et al.,1991), Prader-Willi syndrome (Davies & Joughin, 1993), insulin-dependent diabetes mellitus (Kriska et al.,1991), Down syndrome (Sharav & Bowman, 1992), and cystic fibrosis (Loutzenhiser & Clark, 1993). Normal levels of physical activity are recommended for children with congenital cardiopathy (Drago et al.,1991), and physical activity is demonstrated to be a means of enhancing the social skills of children with learning disabilities (Bluechardt & Shephard, 1995). The psychological and medical benefits of exercise in other diseases seen in children such as asthma, renal disorders, muscular dystrophy and epilepsy have been comprehensively reviewed in a report by the Royal College of Physicians (1991). In the absence of knowledge on the clinical manifestations, symptoms and aetiology of these conditions, commentary on the results is inappropriate. Suffice it to conclude with an extract from the summary report of the Royal College of Physicians (1991): "... In few [of the conditions cited] .. is there an absolute contraindication, while the habit of regular exercise is most beneficial when acquired young."[24]

1.10.4 Physical activity and psychosocial health

High positive health is sometimes referred to as "wellness" or high-level well-being. Such wellness in the child is characterised by positive emotional and social well-being as well as somatically manifest physical health. The psychological and social benefits of physical activity for children and adolescents, have not been disputed, but receive less attention in the literature. This is primarily because the term "wellness", while difficult to define, is equally difficult to measure.

Physical education literature frequently refers to the role of physical activity in increasing children's self confidence and self esteem. The links between self-efficacy, performance estimates and perceptions of mastery or competence therein become self-evident. In Gruber's (1986) meta-analytic review of the literature on self-esteem and exercise in children, self-esteem scores in studies where children experienced physical activity intervention were nearly one-half of a standard deviation above those for children in the control groups, who did not exercise. Studies have linked increased activity to children's physical self-perception, and its corollary, more positive physical self-perception profile to activity participation, has also been observed.[25] Links between physical activity, social integration, and socialisation through activity have been established. Further understanding of the connections between social integration and health has led to the development of what one might call a 'socio-somatic' theory. Eder (1990) has cogently argued that functioning patterns of interaction with significant others are a basic prerequisite for psychosocial health. Empirical evidence is provided in the analysis of data on the interrelations between social integration, happiness and health of children

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24 Medical aspects of exercise: Benefits and risks. Summary of a report of the Royal College of Physicians. *Journal of the Royal College of Physicians of London*. 1991, 25 (3), p.195.

25 Further discussion in section 3.2.1 of this study

aged 11-15 years in 9 European countries (Eder, 1988; 1989a; 1990). A socio-medical study by Danish researchers Holstein, Ito and Due(1990) lends additional support to this thesis.

In the large cohort study (n=5,061) of British adolescents (Steptoe & Butler, 1996), emotional well-being was found to be positively associated with extent of participation in sport and vigorous recreational activity among adolescents. The associations were significant for the psychological symptom subscale of the malaise inventory (regression coefficient - 0.024, 95% CI -0.036 to -0.011, $p<0.001$) and the General Health Questionnaire (odds ratio of emotional distress per unit increase in vigorous physical activity 0.992, 95% CI 0.985-0.998, $p<0.01$). This was a longitudinal study of a 1970 cohort of British children, but results were taken from cross-sectional analyses of the 1986 data. Although causal associations cannot be assumed in cross-sectional analysis, the authors interpret their results as being consistent with experimental evidence that vigorous exercise has favourable effects on emotional state.

In the present study, socio-somatic theory is explored in relation to 11 -12 year old Irish children. It is anticipated that data may provide new evidence of the relationship between children's physical activity, health, and well-being.

The social and psychological effects of physical activity in childhood are less transitory than physiological effects. In terms of benefit for lifetime health therefore, the social and psychological outcomes may be the more important. It is essential that these outcomes be recognised in children's health promotion agenda.

1.11 Physical activity and other health-related behaviours

The full impact of physical activity on health and disease can be appreciated only when both the direct and indirect effects are considered and possible causal mechanisms described.(Blair et al., 1985) It is important therefore in epidemiological research, health education and health promotion planning, to examine how physical activity indirectly influences health by acting through other behaviours. The relationships among health behaviours are, however, not well understood. The few existing data, based largely on adult samples, have tended to support a multidimensional view of health behaviours, with different practices typically clustering in statistically orthogonal domains (Blair et al.,1985; Kirscht, 1983). However, no stable structure or consistent number of clusters has surfaced regularly (Langlie,1979; Tapp & Goldenthal, 1982; Kannas, 1982; Millar, 1991; Hulshof et al.,1992; Sobal et al.,1992; Uitenbroek, 1993).

It is well established that clustering of cardiovascular risk factors occurs (Criqui, 1980; Meimanaliev et al.,1991;Bosma et al.,1994) and this has been demonstrated across the life-span (Criqui et al., 1980; Kuller et al.,1980; Khoury et al., 1980; Clarke et al.,1986; Smoak et al., 1987). Some of this clustering or commonality of risk factors could be due to a grouping of health behaviours known to be associated with risk factors. Conversely, demographic or other factors may play a more powerful role. Clustering of risk factors, although often associated with population-specific health behaviours, is not consistently demonstrated. In a recent Canadian community survey little clustering of high or low risk levels was observed in any particular locale (Mao et al.,1990). King & Dowd (1990) advert to the clustering of risk factors in the diabetic sub-population, but refer to the independence of cardiovascular risk factors in the general population in both the USA and Finland (the latter suffering a particularly high incidence of cardiovascular disease). In Scotland, where CHD mortality differs between local districts by more than a factor of two to one, there are considerable variations in risk factors and lifestyle across districts, but clustering is not evident (Tunstall-Pedoe et al., 1989). In England, regional variation in CHD mortality rates are considerable, but surprisingly there are very few distinct regional differences in physical activity behaviours (Cavill, 1995).

Although it is intuitively plausible to suggest that adoption of a positive health behaviour such as physical activity, automatically predisposes the individual to adoption of other positive health behaviours, the accumulating evidence indicates to the contrary. There is some evidence that a higher than expected proportion of those who adopt leisure-time physical activity subsequently stop smoking (Shephard, 1989; Marti et al., 1988) but physical activity has not correlated consistently with other health behaviours (Blair,1985; Norman,1986; Steptoe & Wardle, 1992; Dishman & Sallis,1994). Pair-wise comparisons between a variety of health habits have shown relationships between health behaviours to be weak. At best, such comparisons have yielded modest associations (Terre et al., 1990). Studies examining an array of health-habit pairs have only infrequently demonstrated substantial links (i.e., correlation greater than 0.30) between individual health practices (Williams & Wechsler, 1972; Langlie, 1979; Mechanic & Cleary, 1980; Blair, Goodyear et al.,1984).

A notable exception is the more systematic covariation of substance use behaviours (tobacco, alcohol, and other drug use). A rather robust relationship is indicated between tobacco and alcohol use in both adult and adolescent samples (Carmody et al.,1985; Dent et al.,1987; Istvan & Marazzo, 1984; Marsden et al., 1985). Similar associations have been observed in behavioural studies of Irish adolescents (O Rourke et al., 1974; O Connor & Daly, 1985). Intervention-induced changes in specific health habits however have not been typically associated with beneficial shifts in non targeted behaviours. (Tell, 1984; Blair, 1984; Pomerleau, 1987; Millstein et al.,1993). While three large-scale multifactorial interventions for adolescents produced favourable changes in diet, physical activity and smoking behaviour, changes were generally modest and long-term maintenance was not demonstrated (Perry et al., 1987; Tell & Vellar, 1987; Killen et al., 1988).

Although there may be correlation between physical activity and other health behaviours when variability within an individual is considered, it does not appear that variations between individuals in most health behaviours can be explained by variations in physical activity. The limited documented evidence suggests that the links between positive health behaviours are tenuous, with the possible exception of physical activity and weight control.

The most comprehensive review to-date of the relationship of physical activity with other health behaviours is that published by Blair and colleagues in 1985. Researchers examined more than 40 studies to determine if data relating exercise of physical activity to smoking, alcohol intake, substance abuse, diet, weight control, stress management, risk taking behaviour and preventive health examinations were presented. In addition to surveying existing research, new data analyses were performed using BRFSS and NSPHPC[26] data, derived from large and representative population samples.Results of this study indicate that health behaviour tends to be multidimensional, and association between behaviours tend to be small, statistically insignificant or both. Except for diet, there is relatively little overlap between physical activity and other health behaviours (Blair et al.,1985).

Among the conclusions drawn from data in this study were:

- Habitual physical activity is positively associated with better weight control
- High levels of activity are associated with high caloric intake
- Smoking may be inversely associated with leisure-time activity
- Occupational physical activity is positively associated with smoking habit

In a study of the determinants of vigorous exercise in a community sample by Sallis and colleagues (Sallis et al.,1989), among the distal/indirect variables, diet was found to be significantly correlated to exercise, supporting Blair's assumption that both of these health behaviours may have synergistic effects. Smoking habits were inversely related to exercise frequency, but only for men. In a follow-up analysis of activity determinants by Sallis, Hovell & Hofstetter (1992) smoking was an inverse predictor of adoption of activity for both women and men. Smoking behaviour, however, was inconsistently related to vigorous exercise in both analyses and alcohol use was unrelated.

As part of the 1990 Behavioural Risk Factor Surveillance system, the relationship between leisure-time physical activity and dietary fat was examined in a population-

[26] Behaviour Risk Factor Surveillance System (BRFSS) and National Survey of Personal Health Practices and Consequences (NSPHPC)

based probability sample of 29, 672 adults (Simoes et al.,1995). Dietary fat and physical activity were strongly and inversely associated, independently of nine other demographic and behavioural risk factors. The relationship between dietary fat and leisure-time physical activity was linear, and the odds ratio of being in the highest quartile for fat intake was 0.6 for men and women who were physically active compared with those who were inactive.

Vigorous exercise and smoking appear to be incompatible behaviours, but investigations suggest that the relationship is relatively modest (Tell et al.,1984; Dishman, Sallis & Orenstein, 1985; Blair et al.,1985; King et al.,1991), or in some cases, negative (Gibbons et al.,1983; Leon et al.,1981; LaPorte et al.,1985; Pomerleau et al.,1987). Three studies have examined the contribution of physical exercise to smoking cessation, using exercises regimens (Hill, 1985; Russell et al.,1988; Taylor et al.,1988). All researchers found that exercise training did not prevent smoking relapse. Marcus et al.(1991) found exercise training, in combination with smoking cessation treatment, to positively effect 24-hour cessation rates in women, but as typically reported in the literature, none of the subjects maintained abstinence (CDC,1989). Heavy smokers (>25 per day) are more likely to be dependent on nicotine and therefore less likely to cease successfully.

In 1990, data from the population survey of the Swiss MONICA project were collated by Dai and colleagues to examine cross-sectionally the interrelationships between different lifestyle factors. Men and women training twice or more times per week exhibited consistently and highly significantly more favourable health habits, regarding diet, non-smoking and weight control. Those who occasionally exercised had in turn more favourable health habits than their sedentary counterparts (Dai et al.,1990). This association between exercise and weight maintenance is supported by Bouchard, Shephard & Stephens (1993), who suggest that persons who exercise are most successful in making permanent lifestyle changes (e.g., modifying diet).

Data in the 1991 Health Report for Canada (Millar,1991), however, showed that while Canadians were exercising more, smoking and drinking less than in the previous years, the association between exercise and smoking was not positive in the case of women, and particularly negative in the case of younger women. Also, despite increased physical activity, the percentage of people who are overweight has increased.

In 1992, Sobal and colleagues examined patterns of interrelations among health-promotion behaviours in a national (U.S.) sample of over three thousand adults. Consistent with the findings of Blair et al., correlations between health behaviours were weak, with an absolute value averaging r =.07, ranging from r = .00 to r = .71(Sobal et al.,1992). These findings suggest that engaging in one health behaviour is not necessarily associated with practising others.

Uitenbroek's study (1993) of leisure-time physical activity and other behaviours collated data from a 5,000 adult Scottish population sample. Respondents who reported frequent exercise also reported frequent alcohol consumption and weight losing behaviour. Significantly less often these respondents reported smoking and adding salt to their food, compared to the respondents who exercised less often. No significant relation was found between physical activity and other preventive health behaviours.

In the longitudinal study of Finnish youth (Raitakari et al.,1994), dietary and smoking habits between sedentary and physically active subjects were compared. Subjects leading a sedentary lifestyle began to smoke more often compared with young people in the cohort as a whole. In contrast, those remaining physically active hardly ever started to smoke during the follow-up. Furthermore, the diet of sedentary young men was characterised by higher intake of saturated fat and lower P/S ratio compared with that of active men. The authors conclude that the clustering of risk-related behaviour in adolescents is related to physical activity levels during transition from adolescence to adulthood.

Some surveys have accumulated data on population health practices and it may be possible to identify links between these practices. However, interpretation is limited by absence of measures of association, and the inclusion in some studies of the physical dimension of weight, which is not synonymous with diet, the behavioural variable.

In the recent report on health behaviour in Ireland (Irish Heart Foundation,1994) for example, no measurements of association have been used in data analysis. Sectional analysis, however, shows that women in the manual social classes smoke more and exercise less than women or men in professional and managerial classes. On the positive side, nearly one quarter of the total survey population who had been smokers one year prior to survey reported that they had stopped during the year. The recorded decline in smoking may be attributed in larger measure to the introduction of environmental regulatory controls, and increased responsiveness to the stop-smoking message, rather than to increased activity levels per se. The decline, however achieved, is to be welcomed, for while the adverse consequences of smoking are well known, the less apparent effect of smoking on the healthy lifestyle habit of physical activity has been underscored alarmingly in analyses of CHD studies (Rodriguez et al., 1994; Abbott et al., 1994).

Many studies of adolescent health practices indicate quite disparate associations between health behaviours (Terre et al.,1990; Mendoza et al.,1991; Nutbeam et al.,1991; Riddoch et al., 1991; O Reilly & Shelley, 1992; Felts et al.,1992; USDHHS, 1992). In Felts' study (1992) adolescents who reported themselves as "too fat" (75% of whom were females and trying to lose weight) reported fewer days of strenuous activity and fewer hours of strenuous exercise in PE classes and more hours TV. viewing. The Irish adolescent population study (OReilly & Shelley, 1992) reported that activity levels were lowest for older girls (16 - 18 years) but smoking was twice as prevalent for older boys who took greater amounts of exercise than girls. Moreover, while health-related knowledge levels were high, behaviour was not related to knowledge score. In the Northern Ireland survey, activity levels for older girls declined significantly, but positive smoking behaviours were observed, with only one in every ten girls smoking (Riddoch et al.,1991).

Assessing the 'lifestyle' concept in health education with young people, Nutbeam and colleagues (1991) analysed data from a WHO international survey of youth in 11 countries. Analyses on individual health behaviours for 15 year-olds clusterea into two groups, viz. health enhancing behaviours and health-compromising behaviours. A relatively modest proportion of the variance of the original variables was explained by these two lifestyle factors, ranging from 41.1% (Norway) to 30.3% (Israel). Physical activity was included with three other health enhancing behaviours, consumption of healthy foods, good oral hygiene and use of vitamins. Among the 36 factor loadings, the authors report only two discrepancies, physical activity loading as highly on the first factor as the second for Belgium, and for Israel, physical activity did not load on any of the factors. The factor loading coefficients however for physical activity in all of the countries studied were low to moderate (0.26 to 0.48) and much lower than the other three factor loadings. The authors interpret the data as supporting a more integrated approach to health education based on the promotion of healthy lifestyles, rather than individual health behaviours. Such inference however might be better understood, and the suggested approach might be better pursued in the context of the two clusters identified, rather than in a 'global' lifestyle approach.

In studies examining health behaviour relationships in adolescents and children, there has been an effort to draw in measures other than smoking, drinking and diet. These include not only socio-economic status, but also mental health, relationships with peers and parents and adjustment in school (e.g.Eder ,1990). In Terre et al.'s study patterns of interrelationships varied at different developmental levels. For example, an early pattern of substance use behaviours changes at subsequent developmental levels to distinct smoking and drinking clusters. Alcohol use clusters with dislike for leisure-time physical activity in grades 7-8, and then shifts to an association with aggressive behaviour in the high-school cohort (Terre et al.,1990). Commonalities among health-risk behaviours across countries were found by Mendoza and his Spanish research team (Mendoza et al.,1991) in the analysis of WHO 1986 survey data (Aaro et al.,1986). They found that frequent consumption of tobacco, alcohol and unhealthy food is linked to physical inactivity, as well as to patterns of school and family alienation. This pattern was particularly common among boys of lower class backgrounds, and overall, the relationships between these factors were stronger among boys than girls.

Accumulated data over the last ten years clearly indicate that associations between physical activity and other positive health behaviours are weak. The evidence to suggest otherwise may be anecdotal rather than documented. Dargie & Grant (1991) advert to physical activity acting as a "catalyst" to other health behaviours, and the catalytic effect may indeed explain some of the associations seen, although, there are numerous problems with existing studies, and few have been designed specifically to investigate the relationship between health behaviours. Blair (1988) rejects the assumption that exercise should, of its nature, be instrumental in promoting other behaviours. Synergistic effects, he reasons, are not expected from most other health-promoting activities.

The process of health behaviour change is exceedingly complex. Perhaps it is unrealistic, therefore, to expect that exercise can have a powerful influence as a preventive health practice in such a complex process. In terms of behavioural intervention, however, independence of health behaviours has considerable implications for the targeting and delivery of health services. Adult behaviour change might be best effected if public health efforts were multifaceted and behaviour specific There is, however, a current perspective on exercise and nutrition which supports a duality of benefit in these two health components, nutrition having a compensatory role in providing antioxidant nutrients against the potentially harmful effects of exercise. Singh (1992) suggests that both components should be included in any regimen of optimal health promotion. Analysts of the BRFSS (1990) data on physical activity and dietary fat caution researchers on the potentially confounding effects of diet and physical activity on each other (Simoes et al., 1995). [27] In this study, they suggest that creators of public health messages that target one behaviour should consider including the other.

An additional consideration in promoting behaviour change is the potential for preoccupation with behavioural adaptation. Preoccupation with health (e.g. cholesterol-reduced diet anxiety) may adversely result in behavioural change becoming a source of stress. Perhaps the most important target measure, often unrealistically estimated, should be an incremental behaviour change. Small changes in one or more health behaviours are much more likely to achieve adherence success (Dishman, 1988) In the case of physical

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27 Behavioural Risk Factor Surveillance System, 1990.

activity, an incremental change, such as that proposed in the most recent Irish health strategy document (Department of Health, 1994) has realistic achievement potential, although measures for achieving same are not discussed.

Findings of studies in child and adolescent health behaviour add to the doubts about the notion of a globally healthy or risky 'lifestyle', and tentatively suggest that, despite its popularity, a lifestyle view of children's health behaviours may not be empirically tenable. Cumulative evidence appears to suggest that health behaviour patterns for children might be best effected if health strategies are multifaceted and behaviour specific.

2

CHILDREN'S PHYSICAL ACTIVITY BEHAVIOUR PATTERNS AND TRENDS

2.0 Introduction

Given that regular participation in physical activity is an acknowledged component of a healthy lifestyle, it is vitally important to have accurate information on the epidemiology of physical activity in youth. It is also a responsibility of both public and private agencies to periodically monitor the prevalence of health behaviours over time, to assess whether the behaviours they seek to effect, are consequently increasing, decreasing or remaining the same (Kolbe, 1989b; Kolbe,1990). Outcomes of curriculum programmes which are designed to effect changes in behaviour therefore must similarly be evaluated.

Much of the previous health research and policy interest has focused on quantitative physiological parameters of children's physical fitness. The emphasis in this investigation is on physical activity behaviour, reflecting the current consensus that children are consistently found to have the highest levels of aerobic fitness of any age group, and that fitness is mediated by activity. Although the concerns about the physical activity habits of adolescent youth are long-standing, there are surprisingly few published studies describing physical activity behaviour in youth. Little is known about the distribution or patterns of physical activity of boys and girls of different ethnic and socioeconomic backgrounds, and of changes in activity patterns over time. Absence of data on children's activity makes comparisons across populations difficult. The under-13 age cohort has not been studied in the recent Irish and British national health surveys (Irish Heart Foundation, 1994; SCHEA, 1993; Cospoir, 1996), while data for 11-12 year-olds' activity have been recorded in Northern Ireland and in ten selected European countries and Canada (Riddoch, 1990; King & Coles, 1992). Nevertheless, the natural course of habitual activity during the paediatric years has been described reasonably well in the small number of studies located.

A genre of popular opinion, oft quoted, is that 'children are neither as active nor as fit now as they used to be' and the passivity of young people arouses media concerns on occasions. While aspects of today's lifestyle such as watching television and means of transportation have been cited as contributory factors, declining levels of activity have not been reliably substantiated. Only one longitudinal study of physical activity patterns includes the 12 year-old and younger age cohorts in the sample. This study of young Finns (Telama et al.,1994) reported that there has not been any major change in physical activity among adolescents in the period 1981-1989, and a positive observation of the longitudinal data was the marked increase in the participation in organised sport of young women. Comprehensive research on youth activity has been conducted by Sallis and colleagues. In 1993, Sallis noted that while time trends in the physical activity of youth are of specific interest, no reliable data on trends in physical activity have been identified (Sallis,1993).

The oft-publicised beliefs that children's aerobic fitness is low and that fitness levels of children have declined over the years similarly have not been substantiated. Netherlands researcher, Saris (1986) used historical comparisons of studies conducted in the thirties and forties to examine changes in aerobic power in children. He reported that data of this period do not differ essentially from the early measurements of Robinson (1938) and Astrand (1952), and therefore it is indicated that the level of aerobic power had not changed substantially in the last 40 years. This review suggested that the level of daily exercise in children is still sufficient to maintain a certain level of physical fitness (Saris, 1986).

Armstrong & Welsman (1994) compared recent UK physical fitness data with earlier studies of similar groups of children (Thomason & Hardman, 1977; Bar-Or, 1983; Krahenbuhl et al.,1985; Armstrong, 1987; Armstrong, 1989; Armstrong et al.,1990a; Armstrong et al.,1991b). The authors concluded that there is no scientific evidence to support the premise that the cardiorespiratory fitness of children has deteriorated over time, and that children are indeed the most fit segment of society. Comparing data in the Northern Ireland Fitness Survey (Riddoch, 1990) with the criteria earlier proposed by Klissouras (1973), Riddoch and his research colleagues similarly conclude that there is no evidence that children are any less fit now than they were in past generations (Riddoch et al.,1991). No comparative study of Irish children's physical fitness (as measured by peak VO_2) can be located.

In comparisons of children's fitness with other population groups, research findings are extremely positive. Sallis (1993) reports that, in U.S. age cohort comparisons, all available data support the conclusion that children are the most active and most fit segment of the population. Children are consistently found to have the highest levels of aerobic fitness of any age group, so increasing childhood fitness is not usually considered a major health goal in itself. (Sallis, McKenzie & Alcaraz, 1993). Canadian researcher, Bar-Or (1987) agrees that children are more active than older age groups, but considers that their fitness, in its broad sense, is lower than in young adults. This can partly be explained by the observation that children demonstrate smaller $VO_{2\ max}$ increments (average rise 10%: range 1.3-20.5) than do young adults following periods of aerobic training (Pate & Ward, 1990). Some international comparisons of children's fitness also allay popular concerns. Northern Irish children, for example, were found to be similar in stature, body composition and physical fitness to their age matched peers in other western industrialised countries: Australia, New Zealand, Canada and the USA (Riddoch,1990). An aerobic endurance test administered in the 1989-'90 study of Irish primary school children found that children's scores averaged about 80% of 1985 international norms (Watson,1993). In conclusion therefore, although there is growing concern that fitness levels of children may be suffering by an increasingly sedentary contemporary lifestyle, no information is available to indicate the quantitative influence of a sedentary lifestyle on aerobic fitness in children (Rowland, 1994).

Somewhat divergent viewpoints, however, have been expressed concerning the status of physical activity behaviour in youth. Some have taken the position that today's youth are not as active as is required for good health and fitness (Simons-Morton et al.,1987; Cureton, 1987; Bar-Or 1987; Seefeldt & Vogel, 1987; Armstrong, 1989) and that emphasis should be given to increasing habitual activity in youth Others have concluded that youth, at least by comparison with older age groups, are quite physically active, and consequently, activity programs for youth should focus on the long-term goal of promoting adult physical activity (Sallis & McKenzie, 1991). Consensus of opinion among Irish and some British educationists suggests that both objectives can be simultaneously pursued through appropriate primary PE curriculum design (Armstrong, 1990; Leigh Doyle, 1992 ; NCCA, 1995).

2.1 The assessment of children's habitual physical activity

Valid, practical and affordable objective measures of physical activity are a necessary precondition for improved epidemiological studies as well as the development of a data-based, health-related physical activity standard for youth. In relation to such a standard, the physical activity behaviour of specific population groups may be more meaningfully compared.

Measuring habitual daily activity is one of the most difficult tasks for the physiologist and epidemiologist because activity has to be assessed in terms of type, intensity and duration (Lange Anderssen, 1978). Physical activity is a complex behaviour for which there is no standard measurement (Caspersen et al.,1985; LaPorte et al.,1985; Wilson et al., 1986; Mundal et al.,1987). It is not readily dichotomised, such as smoking versus non-smoking, nor does it conform to a readily measured continuum, such as cholesterol or blood pressure. Obtaining this information from children is even more complex than from adults, due to the fluctuating activity patterns which characterise children's activity and the cognitive demands of some reporting instruments. Difficulties in defining or assessing physical activity levels in diverse international settings also confounds comparisons within or among international groups.

The difficulties encountered in monitoring children's habitual physical activity however, and the relative merits of objective, observational and self-report measurement methods have been well-documented in the past decennium (Baranowski et al.,1984; Baranowski, 1985; Saris, 1985; Wallace et al.,1985; Godin & Shephard, 1985; Godin et al.,1986; Saris, 1986; Bar-Or, 1987; Cureton, 1987; Simons-Morton et al.,1987; Baranowski, 1988; Freedson, 1989; Noland, 1990; Sallis et al., 1990; Gross et al.,1990; Freedson, 1991; McKenzie et al.,1991; Sallis, 1991; Baranowski & Simons-Morton, 1991; Armstrong & Bray,1991; Baranowski et al.,1992; Jacobs et al.,1993; Sallis et al.,1993a; Sallis et al.,1993b; Stratton,1995).

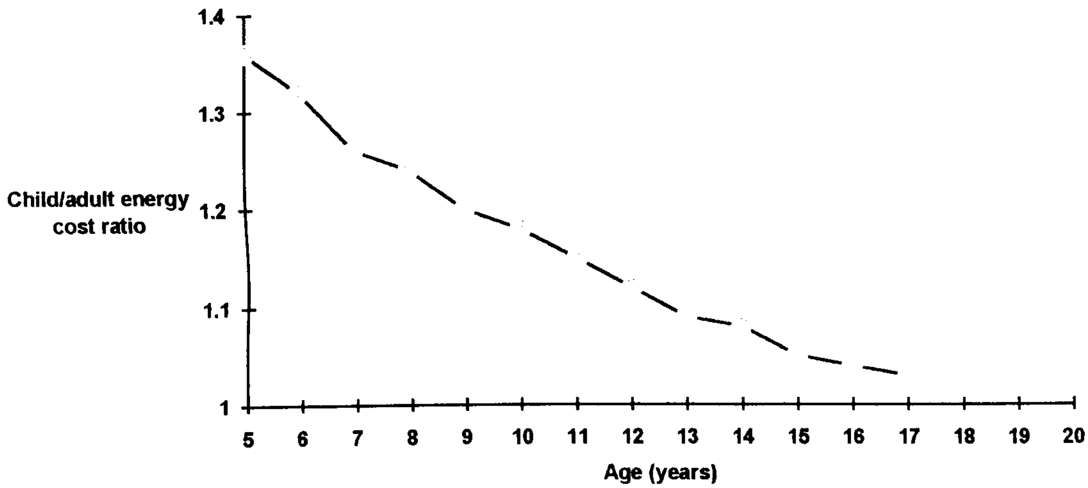
More than 30 different methods have been used to assess physical activity. Methods which have been used with children can be grouped into six major categories:

calorimetry, survey procedures, physiological markers, behavioural observation, mechanical and electronic monitors, and dietary measures. No single instrument fulfils the criteria of being valid, reliable, and practical while not affecting behaviour (LaPorte et al.,1985). The instruments that are very precise tend to be impractical on a population basis. Large-scale studies need a method which is simple, low-cost, and not time-consuming so that large representative samples can be measured. Retrospective activity questionnaires therefore are the most popular in large-scale epidemiological studies.

Following the collection of data on time spent in activity, energy expenditure can be estimated using the following procedure. Each activity is assigned an intensity level that corresponds to the rate of energy expenditure, MET values being commonly used to denote intensity level. 'MET' is the exercise metabolic rate divided by the resting metabolic rate, and MET values can be expressed as either calorie or oxygen use per unit time per unit body weight [One MET is estimated to be 3.5ml of oxygen/kg/min in adults] The time in each activity is multiplied by body weight, and absolute oxygen consumption (VO_2) from physical activity is derived. The product of VO_2 (L/min) and 5.0 kcal /L VO_2 provides an estimate of energy expenditure in kcal (Nieman, 1990). In large-scale studies the activity measure is generally derived from the product of activity frequency and intensity of activity (or activity category), denoted by its MET value.

Of central importance to child health researchers is that tabled MET values are based on calorie cost studies in adults. Several studies have indicated that adult energy cost (e.g. MET) values should not be used for children, and the use of adult values creates substantial bias in the estimation of children's energy expenditure (Åstrand, 1952; Daniels et al.,1978; Montoye, 1982; Skinner et al., 1971; Spurrr, 1984). The physiological data indicate that energy expenditure in children is systematically underestimated when adult cost values are used, although the effect is seen with weight-bearing activities only. The bias is almost 40% in young children (Sallis, Buono & Freedson, 1991). Child/adult ratios of energy cost by age derived from the available data are shown in Figure 2.1.

Figure 2.1 *Child / adult ratios of energy cost by age (smoothed curve)*



Source: Sallis, Buono & Freedson, 1991

The adoption of these age-adjusted energy cost values would clearly facilitate comparisons across studies and across ages, and should allow more accurate recommendations to be developed regarding physical activity for health promotion in children at various ages.

2.1.1 Measurement methods - objective vs. self-report

In objective measurement techniques, the researcher is cognisant of the desirability of recording the daily movements of a child with equipment which measures a number of body functions, while at the same time ensuring that the child's normal daily activities are not hindered. Such unobtrusive measurement techniques are expensive and difficult to apply to large samples. Objective measures include oxygen uptake, energy intake, heart rate recording, doubly labelled water technique and movement counters. Heart rate recording is one of the easiest to register with the least encumbrance to the subject, and is the most preferred technique for larger groups. Heart-rate monitors are frequently used and accepted as validating standards for self-reports (e.g.Janz, 1992; Sallis et al.,1993b). Combination of a heart-rate measure with an observational technique has also been explored for measuring activity in PE lessons (Stratton, 1995). The efficacy of the latter however is shown to be difficult to support, as provision of contrasting results compounds the errors in each method.

All electronic or mechanical methods are imperfect measures, and none is accepted as gold standard (method with almost no error) (Baranowski, 1988). For example, there is no theoretically specified unit of measurement associated with a large-scale integrated sensor (LSI) or caltrac (McGowan et al., 1984); the heart rate monitor detects emotion as well as activity (Taylor et al., 1982;) heart rate response to intensity of activity varies by cardiovascular fitness, medication, environmental conditions (heat, crowding), and fatigue (Taylor et al.,1984); genes determine cardiovascular fitness levels as well as physical activity (Bouchard & Malina, 1983). Thus there are limits to any measure of activity.

Direct behavioural observation methods have been devised both as data collection instruments, such as the FATS[1] and BEACHES[2] systems, and as validating instruments for self-report measures (McKenzie et al.,1991; Wallace et al.,1985; Baranowski et al.,1987). Observation of children however may induce a change in their usual performance of activity, and in the validation process, observation may result in children artificially increasing accuracy of the self-report measures. Behavioural observation methods also require large numbers of trained observers, and time costs are considerable.

The relatively low cost, and feasibility of testing large numbers of children has led epidemiological and health promotion investigators to rely heavily on physical activity self-reports, and 18 distinct self-report (both interviewer and self-administered), diary or proxy report measures have been identified. The attractive aspect of using self-report measures is that a variety of variables (e.g., physiological types of activity, activity phenotypes, frequency and location of activity) are available from one source. Specific advantage to physical activity reporting is that absence or low frequency of leisure time exercise are not "unacceptable" behaviours (Godin et al., 1986) and therefore less subject to falsification. However, some Hawthorne effects can be expected, consistent with the contention of Mechanic and Hansell (1987) that adolescents' self-assessments of health and actual health behaviours are influenced by competence in age-relevant areas of importance. Any behavioural self-report by children involves substantial cognitive

1 The Fargo Activity Time-sampling Survey (FATS) (Klesges et al., 1984)
2 Behaviours of Eating and Activity for Child Health Evaluation System (BEACHES) (McKenzie et al., 1991)

demands, and it has been shown that self-reported physical activity correlates only moderately with objective activity measures. Correlations are found to be rarely greater than r = 0.80 (Sallis, 1991). Even adults have been observed to be only moderately accurate in recall of physical activity levels (r = 0.62), and have overestimated aerobic activities by over 300% (Klesges et al.,1990).

A comparison was made by Biddle, Mitchell & Armstrong (1992) between measures of physical activity using continuous heart-rate, interviewer administered and self-administered 7-day recall, and a leisure-time questionnaire. Only modest correlates were found between heart rate and some of the recall measures. Of particular interest was an extreme groups analysis, conducted to see if subjects classified as "highly active" and "inactive" by the heart rate criteria were also different on self-report scores. None of the analyses reached statistical significance ($p > 0.05$), suggesting that the self-report measures could not differentiate between children at the extremes of the range of physical activity (as assessed by heart rate), in spite of group differences which were often, but not always, in the expected direction.

Evaluating the reliability and validity of four self-report measures with 4th Grade children, Sallis and colleagues reported the highest Pearson correlation between self-reports and caltrac activity counts as r (55) = .40 ($p<.01$) (Sallis et al.,1993a). The correlation measures therefore for either of the four instruments cannot be considered high The 7-Day Tally did not correlate significantly with the mean Caltrac at either of two administrations. Both reliability and validity data however, provided some support for using the Weekly Activity Checklist and Yesterday Activity Checklist. Validity data for both of these instruments however are not strong, shown by coefficients of variation which ranged from $r^2 = .05$ to $r^2 = .11$. The 7-Day Tally and Weekly Activity Sum perform more poorly.

In a study which evaluated self-reports with older age cohorts (5th, 8th and 11th Grades), there was an age-related increase in validity coefficients. Correlations between the PAR (hours of very hard activities) and heart rate monitoring (minutes in intervals with HR > 139 bpm) ranged from r = 0.33 for 5th Grade children to r = 0.57 for 11th Grade children (Sallis et al.,1993b). In the determination of reliability of recall, reliability decreased from r = 0.79 after a 2-3day interval to r = 0.45 after a 4-6 d interval. The implication is that repeated 24-h activity recalls would provide the most reliable reports from children.

In this study, the Godin-Shephard Physical Activity Survey[3] (a simple quantitative weekly activity self-report) was designated as "a very promising self-report measure" (Sallis et al.1993b). Correlations of Godin-Shephard measures with PAR data were significant in all age groups and in the 0.60 range for the 5th- and 8th- grade samples, providing some evidence of construct validity. Reliability results for this survey indicated that children were able to use this scale very effectively. Coefficients for 8th- and 11th-grade groups met adult standards. A 2 week test-retest reliability coefficient of 0.84 was reported in an earlier study with children in grades 7 to 9 (Godin & Shephard, 1986).

Evaluating the test results of the study, the authors acknowledge that reliability of .80 or greater however, is only expected when assessing what have traditionally been viewed as stable characteristics (e.g., personality). Physical activity, like diet behaviour, varies daily and is therefore not a stable behaviour in the traditional sense. This suggests self-report measures of physical activity should be judged differently than personality measures (Sallis et al.,1993b). All reviewers of self-report instruments agree that the capacity of children to accurately report physical activity is age-related. Physical activity scales developed to measure just one physical activity dimension in 4-to 8- year-old children were found in validation tests to have inadequate psychometric properties (Calfas et al.,1991). Children younger than age 10 are in the main not expected to provide usable recalls of their physical activity. There is also consensus that methods with shorter latencies between the activity and the recall can be expected to be more reliable that 7-day recalls.

Although validation studies indicate that some instruments are clearly better than others, none has the psychometric characteristics desired in self-report measures Durnin (1990) has described self-report methods as providing a mixture of rather "rough and vague

[3] Godin, G. and R.J. Shephard, 1985. A simple method to assess exercise behaviour in the community. *Canadian Journal of Applied Sports Science*. 1985, 10, 141-146.

information". Observers of national studies' data however note that, even if the reliability of self-report data relating to physical activity is somewhat weak at the level of individuals, large sets of data that do not depend on each other give rather consistent results of, for instance, the level of activity among age-gender groups (Telama et al., 1985; Telama, Laakso & Yang, 1994). UK researchers Biddle, Mitchell & Armstrong (1992) agree that, if administered properly, self-report measures have the potential to provide information, particularly on the nature of activities undertaken

2.1.2 Physical activity standards

Assessment of children's habitual physical activity, using a variety of instruments discussed above, has been conducted internationally although the number of such studies is small [Tables 2.2, 2.3, 2.4, 2.5]. To make valid comparisons between activity levels of different population groups, accepted standards of physical activity must be applied. Although criteria for cardiorespiratory fitness have been established and widely studied, there is regrettably no consensus on a standard for youth physical activity, Criteria for health-related physical activity in youth have been proposed by Haskell (1985), Simons-Morton et al.(1987,1988); Blair, Clark et al.(1989); Konsensusrapport (1989); and Government of Canada (1989). In the latter report, "regular participation" for children and youth is described as daily involvement of at least 30 minutes in one or more sessions. Participation may be either structured or playful, and participation goals may range from the subjective pursuit of joy and pleasure through movement to such objective and focused outcomes as skill acquisition, physical fitness, or the satisfaction of psycho-social and bio-physical needs (Government of Canada, 1989). In 1993, this guideline was modified by the International Consensus Conference on Physical Activity Guidelines for 11 to 21 year-olds, which issued two recommendations.

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

2. In addition to daily lifestyle activities, three or more sessions per week of activities lasting 20 minutes or more that require moderate to vigorous levels of exertion are recommended (Sallis & Patrick,1994).

The consensus conference recommendations are the most informed guidelines that can be developed at the present time, although the latter guideline is based primarily on associations of activity with health outcomes in adulthood. Because there is still controversy on this standard and because physical activity is inherently a continuous measure, Sallis (1993) concludes that it is not possible to resolve the issue of how many youth are *active*. The extent to which children comply with these guidelines however gives the best available quantitative assessment of children's physical activity.

Results of the most recent studies of European children have suggested that children have surprisingly low levels of habitual physical activity and that many children seldom experience the intensity and duration of physical activity associated with health-related outcomes (Armstrong, 1994). No comparative data are available on the activity patterns of Irish school children. It is likely that participation trends may be similar to those reported for British and Northern Ireland school children. Factors that may contribute to increased levels of participation in Ireland are the multicultural nature of Ireland's educational system, and the socio-cultural influences on sport and recreation. In this multicultural context, Gaelic games and Irish dancing are provided for many children alongside multicultural sports such as soccer and rugby. Hence the child's selection of activities in many instances is enhanced. Given the more traditional emphasis on male participation in Gaelic games however, activity provision historically has not been as comprehensive for girls. A major barrier to activity participation in school is the absence of adequate school PE facilities in many Irish primary schools. Consequent to this physical factor, and / or to the teacher's perceived expertise factor, there is a focus on one or two elements of the PE curriculum. For particular population groups therefore, the introduction to a range of physical activities in the primary years may be impoverished.

2.2 Participation in daily physical activity
[Consensus Recommendation 1]

To assess whether children satisfy the recommendation of daily physical activity, it is necessary to examine studies in which children report their activities both within and outside school hours. Both sets of data are not reported in many of the studies, hence the assumption is made that if statutory school PE periods are aggregated with exercise frequency of 'at least four times per week', the guideline of daily physical activity may be fulfilled.

Results from U.S. national studies and several small sample studies suggest that the average adolescent[4] in the U.S. spends approximately 60 minutes (study means range between 30 min and 120 min) per day doing some type of physical activity, broadly defined (Sallis & Patrick, 1994). The authors conclude that although it is difficult to quantify, the majority of adolescents appear to meet the first recommendation of daily or nearly daily physical activity. This pattern is not replicated in the data reported for European children.

In the study of Northern Irish schoolchildren (Riddoch, 1990), only 5 out of 10 boys (11-18 yrs) and 3 out of 10 girls exercise at least 4 times per week. Thus many of both sexes do not meet the daily activity recommendation. In contrast, 2 out of ten boys and 1 out of ten girls exercise seven or more times per week. On the extremely negative side, 22.7% of 11-12 year-old boys, and 18.3 % of 11-12 year-old girls took no exercise apart from PE and Games during the preceding week of the survey. Data interpretation in this study however is confounded by the non-normal distributions. Hence it is also difficult to compare these results with mean values reported in other studies.

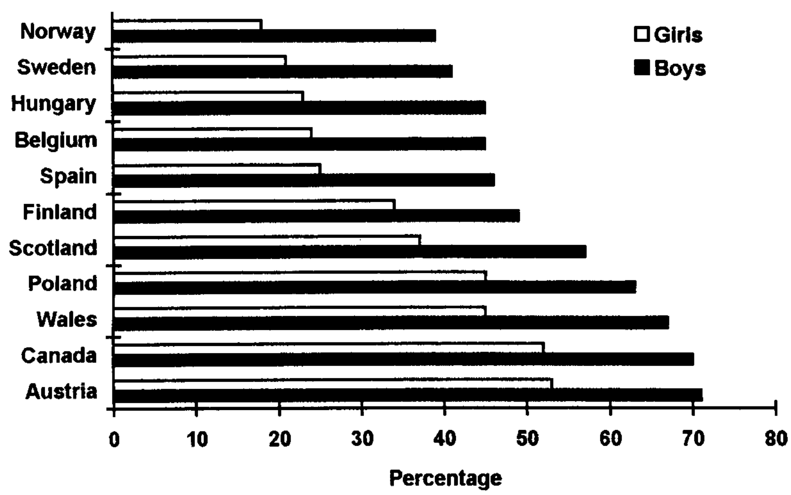
A specific inquiry in the Danish study of 1,671 children aged 11 to 15 years (Holstein et al., 1990), was the evaluation of children's outdoor activity patterns. The proportion of 11-year old boys and girls practising outdoor activities at least three times a week was 63 %. When curriculum PE and outdoor activities are aggregated therefore, almost two-thirds of the Danish children interviewed meet the daily activity recommendation.

[4] The term *adolescent* is operationally defined in many U.S. studies as persons of 11-21 years

Daily physical activity outside school hours was measured by self-report in the Young Finns study (Telama et al.,1994). Only 36 % of 12-year old boys and 21% of girls of similar age report daily sessions of physical activity of half an hour or more duration.

A study carried out on behalf of the World Health Organisation (King & Coles,1992) examined physical activity patterns in each of 10 European countries, and compared these data with results of a Canadian population survey. Three age groups were targeted to simulate a longitudinal study and median ages set at 11, 13 and 15 years. The percentage of 11 year old boys and girls who exercise[5] at least 4 times per week out of school are illustrated by participating country in Figure 2.2.

Figure 2.2 *Percentage of 11-year old boys and girls who exercise at least four times per week out of school - 10 European countries and Canada* [6]



Source: King & Coles, 1992

As illustrated in Figure 2.2, approximately 50% of all 11-year boys and 30 % of girls interviewed are 'very active' outside school hours. Boys are therefore much more active than girls. Activity data from only one of the European countries, viz. Austria, were similar to activity data recorded for Canadian youth. The 11- and 13-year old children in other European countries surveyed appear to be less active than Canadians of similar age.

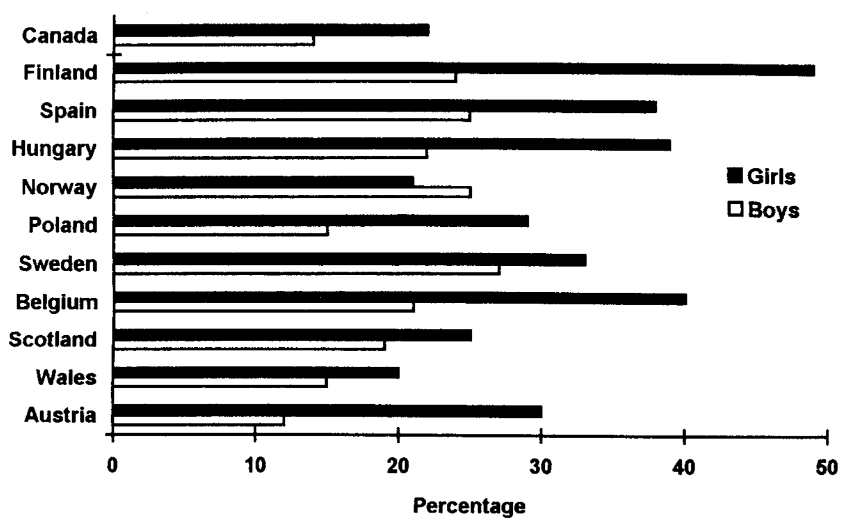
[5] Exercise outside school hours to the point where children get out of breath or sweat

[6] Percentages are based on responses to 'Every day' and '4-6 times per week'

If self-reported exercise frequency and PE frequency are summed, approximately 52% of boys and 32% of girls fulfil the recommendation of daily physical activity. These findings are similar to frequency data reported in the Northern Ireland Survey (Riddoch, 1990). Defining frequency data as a 'total' measure of children's activity in both of these studies however may be misleading. In questionnaire design, exercise definition referred to activity performed 'to the point where you get out of breath or sweat'. This implies moderate to vigorous intensity activity. Thus recreational, play and transportation activities may have been excluded from children's responses. In the recommendation for daily physical activity, such activities are inclusive. The frequency of daily physical activity may, in reality, be much higher.

At the other end of the activity spectrum, a large number of prepubertal children perform little or no activity outside school hours [Figure 2.3]. For many of these children, PE and games within school represent their only participation in physical activity.

Figure 2.3 *Percentage of 11-year old boys and girls who exercise once a week or less out of school - 10 European countries and Canada* [7]



Source: King & Coles, 1992

In nine of the ten countries surveyed, the gender differential in activity participation is substantial. Girls inactivity is much greater than that of boys of comparative age.

[7] Percentages are based on responses to 'Once a week', 'Once a month', 'Less than once a month' 'Never'

Eleven year old girls in Austria are three times less active than boys. In Finland, Hungary and Belgium, girls are twice as inactive as boys of similar age. In our closest neighbouring countries, Scotland and Wales, the gender difference is not as marked, but 25 % and 20 % of eleven year old girls respectively exercise only once a week or less outside school hours.

Representative data in the studies cited indicate that more than half of all senior class boys and one third of all senior class girls have an activity period daily or almost daily. However, there are substantial numbers of children of both sexes who fail to satisfy Recommendation 1 of the International Consensus conference.

2.3 Participation in moderate to vigorous physical activity [Consensus Recommendation 2]

The second recommendation of three or more sessions per week of moderate to vigorous activity represents a more structured definition of physical activity. Moderate intensity activity has been arbitrarily defined as activities requiring an energy expenditure in the range of 3-5 metabolic equivalents (METs), or HR $\geq$ 50 % VO_{2max} (Sallis et al.,1985). Vigorous activities are those requiring an estimated 6 METS or above, or in heart-rate measurement terms as HR $\geq$ 75% VO_{2max} (Verschuur & Kemper, 1985).

The extent to which 9-12 year old children meet the recommendation of moderate to vigorous physical activity (MVPA) is reviewed in studies of the period 1985-1995 which have employed (i) objective measures and (ii) self-report measures of children's activity.

2.3.1 Participation in moderate to vigorous physical activity (MVPA) [objective measures]

In the period 1985-1995, ten studies which used objective heart-rate monitoring [Tables 2.1a, 2.1b, 2.3] and two studies which used direct observational methods have been identified. All of these studies had, in relative terms, small sample sizes, in part due to the expense of collecting and monitoring the data. These studies are of particular interest in that their results can be used in examining, in an indirect manner, the "validity" of the data derived in the population surveys.

Data in the observational studies are limited in scope. Parcel et al.(1987) observed children's physical activity during PE classes (n = 409). They reported that of the total teaching time available, only 6.1% were in activities that were potentially "aerobic", and 11.4% of the time was spent in other fitness activities (not specified). During recess, the average longest episode of continuous movement was 1.2 minutes. The authors concluded that the amount of vigorous activity observed in these activity periods was substantially less than recommended. The data however do not accurately reflect the amount of MVPA in which children engaged, as it is possible that skill practices, games and free play (which contributed to 41% of PE time) may have been of moderate intensity. In the observational study by Baranowski and colleagues, the authors determined that while only half of the 3rd to 6th grade children under study engaged in aerobic activity on any one day, those who did participated in substantial amounts of such activity (Baranowski et al.,1987). This pattern of some children being highly active is replicated in most studies.

More detailed analysis of children's MVPA is presented in studies which use heart rate monitoring as the measurement method. In an early study by Verschuur and Kemper (1985), heart rate monitoring of 12-13 year-olds showed that the mean time per day spent in moderate intensity activity by these children was 1.3 hours for boys and 1.2 hours for girls, while 12 minutes per day was recorded as vigorous intensity, although the period of time in MVPA was greatly reduced for the older age-cohorts studied.

Armstrong and colleagues (1990) recorded a mean activity time per day of 1.13 hours for boys and 0.98 hours for girls at moderate intensity, when heart rate > 139 bpm^{-1} is used as the criterion measure [Table 2.1a]. Two further studies use similar activity measures (Biddle et al.,1992; Sallis et al.,1993b). Lower mean values for daily MVPA are reported in these.

Table 2.1a *Studies of children's daily MVPA measured by heart rate monitoring [Criterion measure HR > 139 bpm^{-1}]#*

Study Population	**N**	**Age in years**	**Measurement instrument**	**Duration of monitor**	**% time h-rate > 139 bpm^{-1} per week-day**
Armstrong et al.(1990) British youth	103 m 163 f	11-16	Sport Tester 3000	3-day	9.8 % m 8.2 % f
Biddle, Mitchell & Armstrong (1992) UK	47 m 46 f	12	Sport Tester 3000	3-day	6.7% m/f
Sallis et al. (1993b) U.S. youth	50 m 52 f	10-16	UNIQ Heart Watch	1-day (16 hr.)	5.2 % m 4.5 % f

140 bpm^{-1} corresponds to 70% of maximum: equivalent to brisk walking

In the study of British youth aged 11 to 16 years, Armstrong and colleagues (1990) report that only 14 year old females fell below a mean of 20 min/d activity with elevated heart rate. Few children, however, recorded sustained 20-minute periods at this intensity. Similar patterns are observed in the analysis of data by Armstrong & Bray (1991), Biddle et al. (1992), and more recently by Atkins et al.(1995). Results of these four studies are presented in Table 2.1b. Cumulative data suggest that the recommendation of three sustained 20-min periods of MVPA [measured as HR > 139 bpm^{-1}] is not consistent with the activity patterns of children in the 9-12 year age group.

Table 2.1b *Periods of sustained MVPA measured by heart rate monitoring [Criterion measure HR > 139 bpm^{-1}]*

Study	**N**	**Age in years**	**One 20-min period**	**Two or more 20-min periods**	
Armstrong et al. (1990)	103 m 163 f	11-16	14.6 10.4	8.9 1.8	m f
Armstrong & Bray (1991)	67 m 65 f	10	18 22	20 13	m f
Biddle et al. (1992)	47 m 46 f	12	27.0 11.4	2.7 0	m f
Atkins et al. (1995)	19 23	10	31.5 30.4	0 0	m f

Table 2.1b shows that no subject achieved more than one period of activity with their heart rates above the recommended threshold (>139 bpm^{-1}) in the three-day monitoring period by Atkins and colleagues (1995), and none of the girls in the study by Biddle and colleagues (1992) recorded more than one period. In the monitoring of 11-16 year olds by Armstrong (1990), very few children (4.3 % boys, 0.7 % girls) spent daily periods of 20 minutes or longer at the recommended threshold over a three day period.

In a further analysis of 10 minute periods, Armstrong and colleagues(1990) showed that over one third of the boys and over half of the girls failed to experience a single 10 minute period with their heart rate above 140 beats/min. During Saturday monitoring over 90% of the girls and 75% of the boys failed to sustain a single 10-min period with their heart rate at or above 140 bpm^{-1}. Biddle and colleagues (1992) report that 34.3% of girls and 46% of the boys failed to experience a single 10-minute period at this intensity in their three-day assessment. In the U.S. study, only 20% of subjects reported at least

15 minutes of very hard (vigorous) activity on the day of the monitoring (Sallis et al.1993). In the largest of these studies, it was concluded that, if moderate to vigorous levels of exertion is defined as equivalent to jogging, only 2% of the boys and none of the girls satisfied Recommendation 2 of the International consensus conference (Armstrong et al.,1990).

Results indicate that sustained periods of physical activity for this length of time are not features of children's habitual physical activity. This is not an unexpected finding, as rapid change in activities is typical for young children, and prolonged exercise is not part of the natural activity behaviour (Saris, 1986).

2.3.2 Participation in moderate to vigorous physical activity (MVPA) [self-report measures]

A more varied pattern, and more extensive participation in MVPA is observed in the data of studies which use self-report measurement. These studies however are more difficult to interpret due to differences in subjects, methods, analyses and definitions of MVPA, and not all studies included the 11-12 year old age cohort.

In the National Children and Youth Fitness Study II (Ross & Gilbert,1985) a U.S. national survey, 56.1% of fifth and sixth grade boys and 49.1% of girls reported engaging in potentially aerobic physical actives for at least 20 minutes three or more times per week, year round. This study does not report the frequency of children's participation in vigorous physical activity. In a review of the health implications of MVPA however, Blair et al.(1989) indicated that 90% or more of these children were active at the level required for health benefits.

In the sociomedical study of Danish school children (Holstein et al.,1990), 40% of 5th Class boys and 31% of 5th class girls report being involved in leisure time exercise "sufficient to make them breathless or sweat" at least four times a week. The majority of these children fulfilled the recommended amount of MVPA, with 87% of boys and 84% of girls (11-yrs old) taking at lest one hour of MVPA weekly. 7% of the children had no

MVPA outside school hours.

In the Northern Ireland National survey (Riddoch, 1990), weekly vigorous exercise[8] taken by children was recorded as a separate item in the 7-day PAR. Five out of ten boys (11-18 yrs.) and seven out of ten girls were involved in vigorous exercise for less than 1-hour in the preceding seven days. The involvement of 11-14 yr.old girls was low in comparison to boys, with 24% more girls than boys taking such exercise. Boys involvement was generally maintained throughout the age range, lending support to the author's hypothesis that the quality exercise taken by these children may be maintained at an adequate level as they get older (Riddoch, 1990). As data in this study were not normally distributed, mean values are not accepted as representative, and comparison of data with that recorded in other national studies is not possible. A disturbing finding of the study was that 11% of 11-12 year old boys and 9% of girls of this age took no moderate to vigorous exercise during the previous week, and this was inclusive of time spent in Physical Education lessons.

A study of a smaller sample of children (Simons-Morton et al.1990) focused specifically on assessing participation in moderate to vigorous physical activity among third and fourth grade children. Similar to the Northern Ireland survey, 12.3% of boys and 13.3% of girls surveyed by Simons-Morton and colleagues reported no moderate to vigorous activity over a three-day period.

In King & Coles (1992) study of activity patterns in Canada and ten European countries, students reported the number of hours they exercise (moderate to vigorous intensity) per week outside school [Figure 2.4a] Significant differences in participation rates between countries is noted. The differences may, in part, be accounted for by the difference in community activities participation. This was recorded as a separate item in questionnaire data. More Canadian boys participate at all ages in community sports than their counterparts in other countries. The data for girls tended to reflect the more limited opportunities, at least in Canada, for girls to be a part of a community team. Half of the

[8] Vigorous exercise described as that which causes *'considerable breathlessness'*

11-year old Canadian girls belong to a community team, although by age 15 this has declined to 30%. Very few Polish girls at any age were involved in this way. Data for UK regions, Wales and Scotland, indicate that a quarter of all 11 year old boys interviewed are very active, exercising four or more hours per week out of school. Their Austrian counterparts however, report a 50% participation rate in this level of activity.

The numbers of children who exercise for one hour or more for each of the participating countries is illustrated in Figure 2.4a Data are derived from children's cumulative responses to exercise for 'About 1 hour', ' About 2-3 hours' and 'About 4-6 hours', '7 hours or more'. In the ten European countries sample, 82% of boys and 73% of girls aged 11 years meet the weekly recommendation of 60 minutes moderate to vigorous activity Whether this is achieved in one, or in the recommended 'three or more' activity sessions is unclear. Percentages of children who report no vigorous exercise at all outside school range from 2% of boys in Hungary to 22% of girls in Spain. In all countries, more 11 year old girls than boys report no participation in vigorous exercise outside school hours [Figure 2.4b]

In the Young Finns study (Telama et al.,1994), the authors note qualitative changes in physical activity which are quite similar to those reported by Riddoch (1990) for Northern Ireland schoolchildren. Those boys and girls who are engaged in physical activity do it even more intensively up to the age of 18, thereafter a certain kind of polarisation occurs, in that the number of those who are passive also increases.

Recent information from the Youth Risk Behavioural Survey (YRBS,1993) (Pate et al.,1994) showed that 62-70 % of adolescent males and 38-51 % of adolescent females participate in moderate to vigorous activity at least three times per week. These data however, pertain only to adolescents between 9th and 12th Grades. MVPA in this survey was not recorded for the younger age cohorts. Available data also indicate that, in general, physical education does not provide adequate amounts of physical activity to meet the second guideline (Sallis & Patrick, 1994). The data compiled from studies summarised in Table 2.2 and Figure 2.4 suggest that substantial numbers of adolescents fail to meet the MVPA recommendation. In Pate and colleagues' descriptive epidemiology, the authors suggest that although the percentage of adolescents meeting this recommendation varies with age and gender, about 50% of the overall population meets this guideline (Pate et al.,1994).

Figure 2.4a *Percentage of 11-year old children who exercise at moderate to vigorous intensity for more than 1 hour weekly outside of school - 10 European countries*

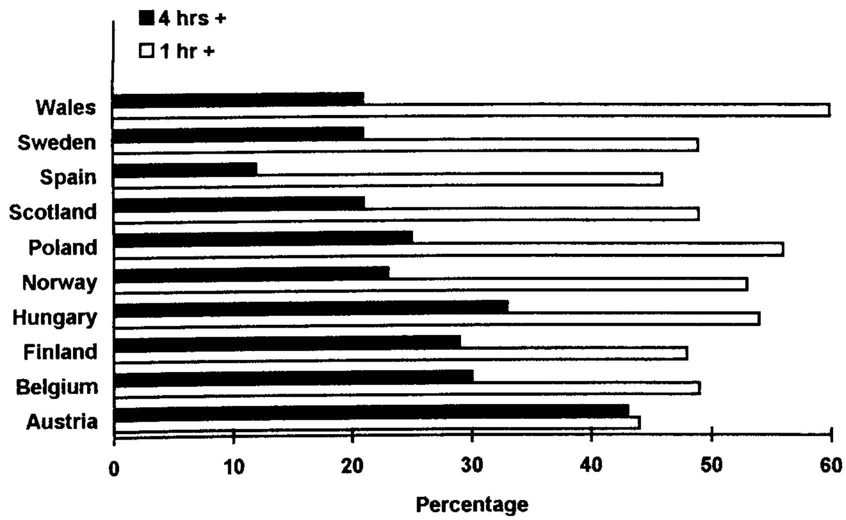
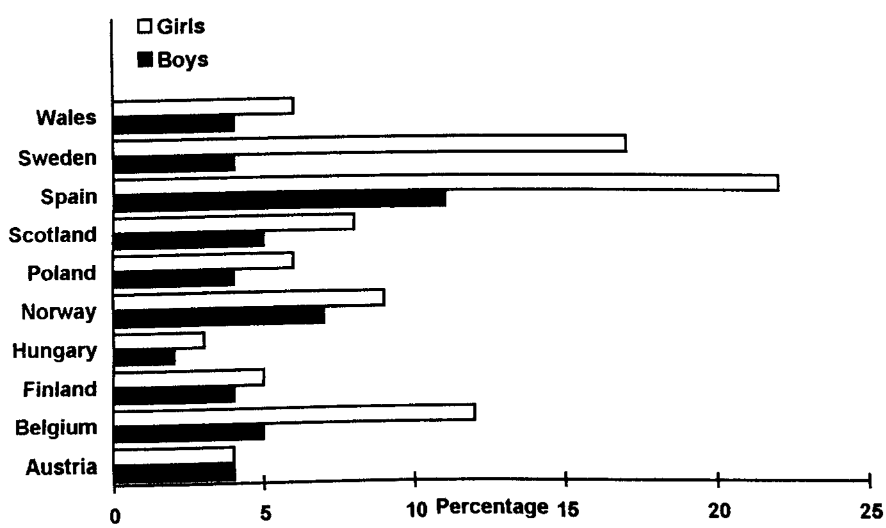


Figure 2.4b *Percentage of 11 year old boys and girls who do not participate in MVPA outside school hours - 10 European countries*



Source: King & Coles (1992)

Table 2.2 *Summary of youth studies (self-report measures): percentages of populations non-participant in moderate-to-vigorous physical activity*

Study pop	**N**	**Measure**	**MVPA**	**Non-participant in MVPA %**
Simons - Morton et al. (1990) U.S.	422 m 390 f	3 day PAR	per day mean m 14 min f 17 min	12.3 m 13.3 f
Holstein et al.,(1990) Denmark	258 m 267 f	7 day PAR	per week > 2 hours 75% m 67% f	8 m 6 f
Riddoch (1990) N Ireland	432 m 455 f	7 day PAR	mean not # reported	11 m 9 f
Boreham et al. (1993) N Ireland	251 m 258 f	7 day PAR	mean not reported	26 m ## 30 f
Telama et al (1994) Finland	2736 m / f	7 day PAR	weekly session high intensity 35% m 19% f	5-10 m φ 5-15 f

\# Data not normally distributed, hence mean values for age-groups not reported

\## Percentage represents number of children in lowest of 4 activity groups

φ Subjects range in age from 9 - 27 years. Sample sizes per cohort not reported

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As illustrated in Figure 2.4b and Tables 2.1a, 2.1b, studies show a wide variation in amounts of MVPA taken by children. Some children spend a much greater amount of time than that specified in the MVPA guideline, and many achieve the recommended weekly total, but in shorter time intervals. As suggested by Bar-Or (1983), the preference for short, high-intensity activities may be explained by psychological factors such as shorter attention span and a lower socially induced motivation for prolonged exercise. Consensus authors themselves advert to the fact that it is not known whether more frequent, shorter sessions of physical activity would provide some of the same health benefits (Sallis & Patrick, 1994).

The disturbing finding in many of the studies is the high percentage of 10-12 year old children who take part in no moderate to vigorous physical activity. In reports of activity inclusive of school periods, this finding raises questions about the content of primary school physical education, since children of this age should participate in at least one hour of curricular PE The public health goal must be to ensure that all children take part in MVPA. Clearly, some of this 'quality exercise' should be achieved within the PE lesson.

The rationale for Guideline 2 in the physical activity consensus statement is the evidence that regular participation in continuous moderate to vigorous physical activity during adolescence enhances psychological health, increases HDL-cholesterol, and increases cardiorespiratory fitness (Sallis & Patrick, 1994). Non-significant increases in cardiorespiratory fitness however have been reported in intervention programmes, designed to provide regular moderate-to-vigorous exercise for schoolchildren. Benedict (1985) and co-workers, for example, found that a daily skipping programme did not increase maximal oxygen uptake or decrease skinfolds significantly. More recently, Stratton & Waggett (1995) found that the overall effect of an 8-week skipping programme on the cardiorespiratory fitness of 8- to 9- year old children was not significant.

The recommendation of 20 to 30 min/d of moderate to vigorous intensity activity, is similar to the adult activity recommendation for cardiovascular health and it has been estimated to be the amount of training required to increase aerobic power in youth (Simons-Morton et al.,1987). More research however is required into the effects of relatively short period of intense physical activity in the cardiopulmonary system of young children Results of a study with adults revealed that multiple short bouts of moderate-intensity exercise training significantly increase peak oxygen uptake (DeBusk et al.,1990). Moreover, improvements in strength, muscle endurance, body composition, flexibility, self image and longevity, can result from levels of exercise well below those recommended for improving cardiovascular fitness (ACSM, 1990), and 'active' children appear to engage is a sufficient variety of activities to enhance multiple components of health-related fitness. This is confirmed in the study of 4th grade children by Sallis, McKenzie and Alcaraz (1993). In this study, an index of physical activity was significantly associated with all five fitness components measured, and a canonical correlation of .29 observed. Welsman & Armstrong (1992) however found that daily physical activity levels in 11-16 year old children did not stress aerobic matabolism sufficiently to influence aerobic fitness.

Thus the recommendation to increase all activities, light, moderate, and vigorous (objectives 1.3 and 1.4) appears to be appropriate, because higher overall levels of activity will impact on several health-related fitness components. The recommendation to specifically engage in activities that enhance and maintain muscular strength, endurance, and flexibility (objective 1.6) may not be necessary for children of this age, according to Sallis, McKenzie and Alcaraz (1993), as increasing overall activity may also increase activities that have specific effects on muscular strength, endurance, and flexibility. Hence standards based on adult data must be examined more closely, as these may not be applicable for youth.

The varied patterns of activity noted within the 11 to 18 year age cohort indicates also that standards of activity proposed for 16-18 year old youth may not be the most appropriate for children in the final years of Primary School. Given the relatively high level of participation in the 11-12 year age group, and the marked decline in activity as children progress through school, the standard for 5th and 6th class children should be one which optimises participation in a variety of activities, rather than specified periods and intensity of activity to improve cardiovascular health. The frequency of four exercise periods per week for this age group as recommended by the Danish Konsensusrapport (1989), may be a more appropriate standard, and, inclusive of at least one hour of school PE is a realistic target. Such a standard would reflect the growing consensus of opinion that regularity of exercise is more important than its intensity.

2. 4 Physical activity behaviour: Patterns by age and gender

Two major findings which consistently emerge from studies of children's physical activity are (i) the gender differential in physical activity participation and (ii) the decline in physical activity from age 6 onwards which is precipitated in the female population. These trends have been observed in studies which used objective, self-report and observational measures of physical activity. In all studies using objective measures of physical activity, boys were more active than girls [Table 2.3]. On average, the gender difference was 22%, with a range of 12% to 30%. Most studies showed declines in physical activity with age for males and females, decline being most marked between 15 and 18 years. Objectively measured, the mean decline for males was 2.7% per year (range1.6 to 3.8 %) and for females 7.4% (range 2.5 to 17%).

Self-report measures used in the studies cited in Tables 2.4 and 2.5 include both self-administered and interviewer-administered surveys. No two studies used the same instrument, and levels of physical activity cannot be compared across studies. The same overall patterns however are found in studies which used self-reported physical activity measures. Ten such studies conducted in the period 1985-1995 have been located [Tables 2.4, 2.5]. Ages of subjects range from 8 to 18 years, and approximately 129,350 children were studied. Five studies are large representative national surveys from Canada, the U.S., Denmark and Northern Ireland, and the World Health Organisation study represents national survey data from Canada and ten European countries.

In the WHO study (King & Coles,1992) one constant observed across most of the European countries is the decrease in participation by age 15, especially for girls. Sweden and Norway are exceptions, where numbers remain stable or increase slightly. However, in many of the countries, students who decrease the time spent exercising from four or more times per week, tend to exercise two or three times per week rather than eliminate exercise altogether. In this study, frequency of weekly exercise reported in response to 'How many times' was not consistent with frequency of 'hours exercise per week' [Table 2.5]. Some countries, e.g., Canada, show an increase in the percentage of children who exercise for four or more hours per week at age 15. Increased participation from age 11 to age 15 in hours of exercise taken is replicated in the Danish national study (Holstein et al.,1990). In the Northern Ireland national study, Riddoch (1990) reports that 17-18 year old Northern Irish boys and girls are approximately 50% less active than 11-14 year olds. The only available data for the Republic of Ireland is a relatively small-scale study (n=425) of post-primary schoolchildren (O Reilly & Shelley, 1991). In this sample, the decline in girls' activity between 13- and 17- years was much greater than that of the boys' interviewed. Daily participation in sports fell by 9% in boys and by 19% in girls in the 4-year period. An encouraging finding in the WHO study was the increased participation levels of Canadian children relative to levels observed in the 1985 study (King et al.1985). The increased participation has been reported also for youth and young adults (Millar, 1991).

Reasons cited for an age-related decline in activity levels include a declining interest in exercise, a change of priorities, or time constraints due to factors such as examinations. Alternatively, as suggested by Riddoch (1990), the decline may reflect the change-over from one exercise pattern to another. There is also the possibility that although the exercise is quantitatively less, it may be of a higher quality and therefore of significant benefit to their health. The maintenance of such 'quality' exercise however has been shown to be more prevalent among boys than girls. Those who increase activity, as reported in King & Coles' study (1992), may be more aware of the benefits of exercise and /or enjoying the social aspects of sports activity.

Table 2.3 *Summary of descriptive studies of physical activity in children (objective measures) 1985-1995*

Study	**N**	**Gender m > f % difference**	**Years**	**Decline in boys %**	**Decline in girls pop. %**
Atomi et al (1986) Japan	11 m	--	10.4	---	---
Sunnegardh et al. (1985) Sweden	63 m 69 f	16	8 to13	8	13
Vershuur & Kemper (1985)m/f U.S.	233	12	12 to 17	17	23
Saris et al. (1986) Netherlands	217 m 189 f	26	6 to 12	23	15
Armstrong et al.(1990) U.K.	103 m 163 f	30	11 to 16	8	50
Sallis et al. (1993b) U.S.	50 m 52 f	30	10 to 16	11	63
Sallis, Mc Kenzie & Alcaraz (1993) U.S.	274 m 254 f	16	10.45	---	---
Atkins et al. (1995) UK	19 m 23 f	---	10.5 ± 1 yr	----	---
Summary		**22 %**		**2.7% per year**	**7.4% per year**

Table 2.4 *Summary of descriptive studies of physical activity in children (self-report measures) 1985-1990*

Study	**N**	**Gender m > f % difference**	**Years**	**Decline boys %**	**Decline girls %**
Ross et al. (1985) U.S.	4,539 m 4,261 f	11	10 to 16	9	+ 2
King et al. (1985) Canada	Over 33,000	---	9 to 15	33	33
Sunnegardh et al.(1985) Sweden	63 m 69 f	12.5	8 to 13	10	6
Shephard (1986) Canada	11,300 m 11,800 f	4	10 to 16	8	8
Fuchs et al. (1988) Germany	236 m 172 f	30	13 to 15	5	10
Summary		**22 %**		**1.8 % per year**	**2.6 % per year**

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Table 2.5 *Summary of descriptive studies of physical activity in children (self-report measures) 1990-1995*

Study pop.	**N**	**Gender m > f % difference**	**Years**	**Decline boys %**	**Decline girls %**
Holstein et al.(1990) Denmark	809 m 862 f	16	11 to 15	+ 8	+ 7 *
Riddoch (1990) N Ireland	1540 m 1671 f	**	11 to 18	30	48 #
O Reilly & Shelley (1991) Ireland	223m 222f	28 ¶	13 to 17	9	19
Sallis, Mc Kenzie & Alcaraz (1993) U.S.	274 m 254 f	3	10 to 11	N/A	N/A
King & Coles (1992)					
Spain	3372 m/f	25	11 to 15	13	25 ♣
Canada	2782 m/f	12		3	19 ♣
Boreham et al.(1993) N Ireland	503 m 512 f	9	12 and 15	+ 2	+ 2 ##

* Percentage change in those taking two hours or more MVPA per week

\# Decline in activity causing 'slight and considerable breathlessness'

** Mean values of activity not included in report (data not normally distributed)

¶ Percentage difference in participation in sports *'at least 4-times a week'*

\## Activity score inclusive of everyday activities (transportation to school etc.)

♣ Percentage decline in numbers who exercise twice per week or more

The accumulated epidemiological data clearly indicate that some children are inactive, many children seldom experience the intensity and duration of physical activity associated with health-related outcomes, gender differences are significant, and there is a marked downward gradient in activity levels of adolescents as they progress through school. Regardless of measure used, boys are more active than girls, although the gender difference is higher when objective measures are used. In the analysis of intensity of activity of 9 - 12 year old children (objectively measured), no significant differences have been observed in moderate activity (equivalent to brisk walking) of boys and girls, but boys experience more short intense periods of physical activity than girls (Armstrong et al.,1990; Armstrong & Bray, 1991). In relation to amount of exercise, boys between the ages of 6 and 17 appear to be about 15 to 25 % more physically active than females, and at ages 11 and 12 years, the gender difference is already very marked. This pattern however has changed in Finland, where girls have "caught up" with boys (Telama et al., 1994) and similar developments have been noted in Sweden (Engstrom, 1990). In many other European countries, significant gender differences persist. Factors which influence habitual physical activity therefore require comprehensive investigation in the context of sex differences at such an early age.

There is strong evidence that physical activity declines throughout the school years, and the rate of decline in activity with age is almost twice as steep when assessed with objective measures. During childhood and adolescence, females reduce their physical activity levels more than males: the rate of decline, when objectively measured, being about 2.5 times greater in females than males. Although the decline in activity appears to have no effect on fitness levels in boys, downward trends have been observed in both activity and fitness in females, the latter experiencing a decline in relative fitness of about 2.2 % per year (Sallis,1993). Because girls are less active, even at early ages, and because females decline in their activity levels faster than do males, the gender gap appears to widen with age. Thus, whatever level of physical activity is found to be important for optimal health, the probability of meeting that standard decreases with each year of age from 6 to 17 years.

Standards of activity for 11 to 12 year olds therefore should be designed to achieve participation in several sessions of structured physical activity as well as free play periods. Children who participate in several periods of structured activity are likely to be involved in a range of sport / recreation areas, and hence have greater opportunity to internalise positive health behaviour and also to build a wider repertoire of motor skills. In this process of skill acquisition, children are more likely to achieve success and to feel confident enough in their own abilities to want to pursue more active lifestyles. Moreover, if participation during the teenage years is reduced or eliminated altogether, the early mastery of motor skill will greatly facilitate adoption or renewal of leisure-time physical activity in adulthood.

From the health-related perspective, it is important at this point to make a distinction between the effects of overall level of physical activity and the effects of structured exercise. It is a basic principle of exercise physiology that specific training activities will have specific training effects (American College of Sports Medicine, 1991). However, in general, children do not exercise; they engage in a variety of physical activities, including walking, running, bicycling, and a variety of games and sports. If children increase their physical activity, they are likely to increase the frequency, duration, and / or intensity of several types of activity, not just one. These activities are likely to have effects on multiple components of health-related fitness.

Clearly there are many 11-12 year-old children who currently follow the optimal activity pattern. Conversely, there are many boys and an even greater number of girls whose physical activity experience is unacceptably low in the final years of Primary School. Why so many are active in these formative years, and some so inactive, must be the focus of careful inquiry. Only then can intervention measures be meaningfully considered.

3

INFLUENCES ON PHYSICAL ACTIVITY IN YOUTH

3.0 Introduction

Lifestyle of an individual is defined by Wenzel (1982) as the entirety of normative orientations and behaviour patterns which are developed through processes of socialisation. This means that lifestyle is not only behaviour, but also includes the attitudes and values of the individual. It also means that these aspects of the individual must be more or less interrelated and must be understood within a social context.

The physical activity component of a child's lifestyle is influenced therefore by a variety of inter-related factors. Some factors may also be interactive. Influences extend from diffuse macroscopic sources such as the mass media to the more specific influences assignable to actual people known and interacting with children. Some influences have been shown to be particularly important at different developmental periods, and it is suggested that certain variables may have greater relevance for specific population sub-groups, although this has received little attention in the literature. No one variable or category of variables is anticipated to account for most of the variance in children's physical activity. Primary socialisation in the family unit is one of the major influences on health behaviour patterns formed early in childhood. It is accepted however that the primary responsibility for engaging children in opportunities to be physically active and to learn physical skills rests with school physical education (McKenzie et al.,1993). The primary school therefore has a vital role to play in the socialisation of children into active lifestyles at the important developmental stage of preadolescence.

In activity behaviour research with adults and youth, psychological models that emphasise the role of knowledge, beliefs, attitudes, motivations, and emotions have been dominant. These models include the Theory of Planned Behaviour (Godin & Shephard, 1990), the Intrinsic Motivation Model (Whitehead, 1993), the Health Belief Model (Rosenstock, 1974; Becker, 1977), the Theory of Reasoned Action (Ajzen & Fishbein, 1980), the Health Promotion Model (Pender, 1987), and theories derived from behavioural analysis of choice (Allison, 1983; Rachlin, 1989). Although the Health Promotion Model is widely used, and includes 'modifying factors' as well as 'cognitive-perceptual' influences on behaviour, it is not all-inclusive of the variables that determine participation in a health-promoting lifestyle. Many questions have also been raised about

the applicability of some of these models to the behaviour of children (Iverson & Portnoy, 1977; Kirscht, 1988; Godin & Shephard, 1986; Godin & Shepherd, 1990). The only available model designed specifically for youth physical activity patterns is the Physical Activity Model (Sonstroem, 1978). Although some cross-sectional evidence supports this model's validity for spontaneous exercise in children, the model has not been experimentally tested. More extensive evidence supports the validity of Social Cognitive Theory (Bandura, 1986), and variables in this model are shown to be equally relevant to the study of exercise determinants both with adults and children (Sallis & Hovell, 1990; Dishman & Sallis, 1994; Stucky-Ropp & Lorenzo, 1993). Social-cognitive theory (SCT) posits that behaviour is a function of personal and environmental factors. It is therefore an appropriate theoretical framework in which lifestyle behaviour can be studied. Four domains of influence which apply to youth activity behaviour are derived from this theory:

1. Biological and developmental factors, 2. Psychological factors, 3. Physical environmental factors, and 4. Social environmental factors

The influence of any one social factor on lifestyle behaviour therefore must be understood, not only in the context of a wider social matrix, but also in relation to the totality of influences in the social cognitive paradigm. A model of such influences is proposed [Figure 3.1]. This model uses both observed and expected variables from the four domains as constructs, and includes the hypothesised relationship between primary PE, recreational activity and health.

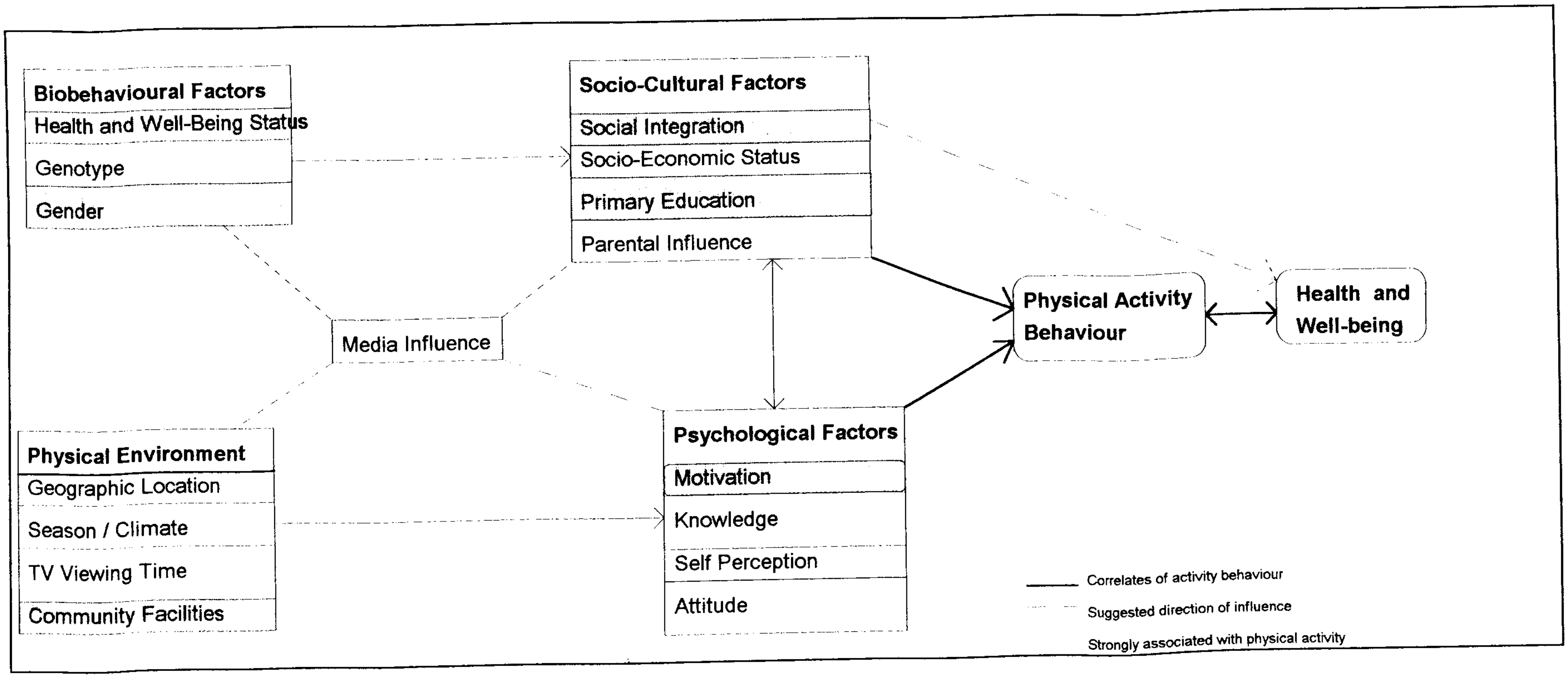

Figure 3.1 *Hypothesised relationship between personal and social variables, physical activity, and health*

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Eleven year old girls in Austria are three times less active than boys. In Finland, Hungary and Belgium, girls are twice as inactive as boys of similar age. In our closest neighbouring countries, Scotland and Wales, the gender difference is not as marked, but 25 % and 20 % of eleven year old girls respectively exercise only once a week or less outside school hours.

Representative data in the studies cited indicate that more than half of all senior class boys and one third of all senior class girls have an activity period daily or almost daily. However, there are substantial numbers of children of both sexes who fail to satisfy Recommendation 1 of the International Consensus conference.

2.3 Participation in moderate to vigorous physical activity [Consensus Recommendation 2]

The second recommendation of three or more sessions per week of moderate to vigorous activity represents a more structured definition of physical activity. Moderate intensity activity has been arbitrarily defined as activities requiring an energy expenditure in the range of 3-5 metabolic equivalents (METs), or HR $\geq$ 50 % VO_{2max} (Sallis et al.,1985). Vigorous activities are those requiring an estimated 6 METS or above, or in heart-rate measurement terms as HR $\geq$ 75% VO_{2max} (Verschuur & Kemper, 1985).

The extent to which 9-12 year old children meet the recommendation of moderate to vigorous physical activity (MVPA) is reviewed in studies of the period 1985-1995 which have employed (i) objective measures and (ii) self-report measures of children's activity.

2.3.1 Participation in moderate to vigorous physical activity (MVPA) [objective measures]

In the period 1985-1995, ten studies which used objective heart-rate monitoring [Tables 2.1a, 2.1b, 2.3] and two studies which used direct observational methods have been identified. All of these studies had, in relative terms, small sample sizes, in part due to the expense of collecting and monitoring the data. These studies are of particular interest in that their results can be used in examining, in an indirect manner, the "validity" of the data derived in the population surveys.

Data in the observational studies are limited in scope. Parcel et al.(1987) observed children's physical activity during PE classes (n = 409). They reported that of the total teaching time available, only 6.1% were in activities that were potentially "aerobic", and 11.4% of the time was spent in other fitness activities (not specified). During recess, the average longest episode of continuous movement was 1.2 minutes. The authors concluded that the amount of vigorous activity observed in these activity periods was substantially less than recommended. The data however do not accurately reflect the amount of MVPA in which children engaged, as it is possible that skill practices, games and free play (which contributed to 41% of PE time) may have been of moderate intensity. In the observational study by Baranowski and colleagues, the authors determined that while only half of the 3rd to 6th grade children under study engaged in aerobic activity on any one day, those who did participated in substantial amounts of such activity (Baranowski et al.,1987). This pattern of some children being highly active is replicated in most studies.

More detailed analysis of children's MVPA is presented in studies which use heart rate monitoring as the measurement method. In an early study by Verschuur and Kemper (1985), heart rate monitoring of 12-13 year-olds showed that the mean time per day spent in moderate intensity activity by these children was 1.3 hours for boys and 1.2 hours for girls, while 12 minutes per day was recorded as vigorous intensity, although the period of time in MVPA was greatly reduced for the older age-cohorts studied.

Armstrong and colleagues (1990) recorded a mean activity time per day of 1.13 hours for boys and 0.98 hours for girls at moderate intensity, when heart rate > 139 bpm^{-1} is used as the criterion measure [Table 2.1a]. Two further studies use similar activity measures (Biddle et al.,1992; Sallis et al.,1993b). Lower mean values for daily MVPA are reported in these.

Table 2.1a *Studies of children's daily MVPA measured by heart rate monitoring [Criterion measure HR > 139 bpm⁻¹]#*

Study Population	**N**	**Age in years**	**Measurement instrument**	**Duration of monitor**	**% time h-rate > 139 bpm^{-1} per week-day**
Armstrong et al.(1990) British youth	103 m 163 f	11-16	Sport Tester 3000	3-day	9.8 % m 8.2 % f
Biddle, Mitchell & Armstrong (1992) UK	47 m 46 f	12	Sport Tester 3000	3-day	6.7% m/f
Sallis et al. (1993b) U.S. youth	50 m 52 f	10-16	UNIQ Heart Watch	1-day (16 hr.)	5.2 % m 4.5 % f

140 bpm^{-1} corresponds to 70% of maximum: equivalent to brisk walking

In the study of British youth aged 11 to 16 years, Armstrong and colleagues (1990) report that only 14 year old females fell below a mean of 20 min/d activity with elevated heart rate. Few children, however, recorded sustained 20-minute periods at this intensity. Similar patterns are observed in the analysis of data by Armstrong & Bray (1991), Biddle et al. (1992), and more recently by Atkins et al.(1995). Results of these four studies are presented in Table 2.1b. Cumulative data suggest that the recommendation of three sustained 20-min periods of MVPA [measured as HR > 139 bpm^{-1}] is not consistent with the activity patterns of children in the 9-12 year age group.

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Table 2.1b *Periods of sustained MVPA measured by heart rate monitoring [Criterion measure HR > 139 bpm⁻¹]*

Study	**N**	**Age in years**	**One 20-min period**	**Two or more 20-min periods**	
Armstrong et al. (1990)	103 m 163 f	11-16	14.6 10.4	8.9 1.8	m f
Armstrong & Bray (1991)	67 m 65 f	10	18 22	20 13	m f
Biddle et al. (1992)	47 m 46 f	12	27.0 11.4	2.7 0	m f
Atkins et al. (1995)	19 23	10	31.5 30.4	0 0	m f

Table 2.1b shows that no subject achieved more than one period of activity with their heart rates above the recommended threshold (>139 bpm^{-1}) in the three-day monitoring period by Atkins and colleagues (1995), and none of the girls in the study by Biddle and colleagues (1992) recorded more than one period. In the monitoring of 11-16 year olds by Armstrong (1990), very few children (4.3 % boys, 0.7 % girls) spent daily periods of 20 minutes or longer at the recommended threshold over a three day period.

In a further analysis of 10 minute periods, Armstrong and colleagues(1990) showed that over one third of the boys and over half of the girls failed to experience a single 10 minute period with their heart rate above 140 beats/min. During Saturday monitoring over 90% of the girls and 75% of the boys failed to sustain a single 10-min period with their heart rate at or above 140 bpm^{-1}. Biddle and colleagues (1992) report that 34.3% of girls and 46% of the boys failed to experience a single 10-minute period at this intensity in their three-day assessment. In the U.S. study, only 20% of subjects reported at least

15 minutes of very hard (vigorous) activity on the day of the monitoring (Sallis et al.1993). In the largest of these studies, it was concluded that, if moderate to vigorous levels of exertion is defined as equivalent to jogging, only 2% of the boys and none of the girls satisfied Recommendation 2 of the International consensus conference (Armstrong et al.,1990).

Results indicate that sustained periods of physical activity for this length of time are not features of children's habitual physical activity. This is not an unexpected finding, as rapid change in activities is typical for young children, and prolonged exercise is not part of the natural activity behaviour (Saris, 1986).

2.3.2 Participation in moderate to vigorous physical activity (MVPA) [self-report measures]

A more varied pattern, and more extensive participation in MVPA is observed in the data of studies which use self-report measurement. These studies however are more difficult to interpret due to differences in subjects, methods, analyses and definitions of MVPA, and not all studies included the 11-12 year old age cohort.

In the National Children and Youth Fitness Study II (Ross & Gilbert,1985) a U.S. national survey, 56.1% of fifth and sixth grade boys and 49.1% of girls reported engaging in potentially aerobic physical actives for at least 20 minutes three or more times per week, year round. This study does not report the frequency of children's participation in vigorous physical activity. In a review of the health implications of MVPA however, Blair et al.(1989) indicated that 90% or more of these children were active at the level required for health benefits.

In the sociomedical study of Danish school children (Holstein et al.,1990), 40% of 5th Class boys and 31% of 5th class girls report being involved in leisure time exercise "sufficient to make them breathless or sweat" at least four times a week. The majority of these children fulfilled the recommended amount of MVPA, with 87% of boys and 84% of girls (11-yrs old) taking at lest one hour of MVPA weekly. 7% of the children had no

MVPA outside school hours.

In the Northern Ireland National survey (Riddoch, 1990), weekly vigorous exercise[8] taken by children was recorded as a separate item in the 7-day PAR. Five out of ten boys (11-18 yrs.) and seven out of ten girls were involved in vigorous exercise for less than 1-hour in the preceding seven days. The involvement of 11-14 yr.old girls was low in comparison to boys, with 24% more girls than boys taking such exercise. Boys involvement was generally maintained throughout the age range, lending support to the author's hypothesis that the quality exercise taken by these children may be maintained at an adequate level as they get older (Riddoch, 1990). As data in this study were not normally distributed, mean values are not accepted as representative, and comparison of data with that recorded in other national studies is not possible. A disturbing finding of the study was that 11% of 11-12 year old boys and 9% of girls of this age took no moderate to vigorous exercise during the previous week, and this was inclusive of time spent in Physical Education lessons.

A study of a smaller sample of children (Simons-Morton et al.1990) focused specifically on assessing participation in moderate to vigorous physical activity among third and fourth grade children. Similar to the Northern Ireland survey, 12.3% of boys and 13.3% of girls surveyed by Simons-Morton and colleagues reported no moderate to vigorous activity over a three-day period.

In King & Coles (1992) study of activity patterns in Canada and ten European countries, students reported the number of hours they exercise (moderate to vigorous intensity) per week outside school [Figure 2.4a] Significant differences in participation rates between countries is noted. The differences may, in part, be accounted for by the difference in community activities participation. This was recorded as a separate item in questionnaire data. More Canadian boys participate at all ages in community sports than their counterparts in other countries. The data for girls tended to reflect the more limited opportunities, at least in Canada, for girls to be a part of a community team. Half of the

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[8] Vigorous exercise described as that which causes *'considerable breathlessness'*

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11-year old Canadian girls belong to a community team, although by age 15 this has declined to 30%. Very few Polish girls at any age were involved in this way. Data for UK regions, Wales and Scotland, indicate that a quarter of all 11 year old boys interviewed are very active, exercising four or more hours per week out of school. Their Austrian counterparts however, report a 50% participation rate in this level of activity.

The numbers of children who exercise for one hour or more for each of the participating countries is illustrated in Figure 2.4a Data are derived from children's cumulative responses to exercise for 'About 1 hour', ' About 2-3 hours' and 'About 4-6 hours', '7 hours or more'. In the ten European countries sample, 82% of boys and 73% of girls aged 11 years meet the weekly recommendation of 60 minutes moderate to vigorous activity Whether this is achieved in one, or in the recommended 'three or more' activity sessions is unclear. Percentages of children who report no vigorous exercise at all outside school range from 2% of boys in Hungary to 22% of girls in Spain. In all countries, more 11 year old girls than boys report no participation in vigorous exercise outside school hours [Figure 2.4b]

In the Young Finns study (Telama et al.,1994), the authors note qualitative changes in physical activity which are quite similar to those reported by Riddoch (1990) for Northern Ireland schoolchildren. Those boys and girls who are engaged in physical activity do it even more intensively up to the age of 18, thereafter a certain kind of polarisation occurs, in that the number of those who are passive also increases.

Recent information from the Youth Risk Behavioural Survey (YRBS,1993) (Pate et al.,1994) showed that 62-70 % of adolescent males and 38-51 % of adolescent females participate in moderate to vigorous activity at least three times per week. These data however, pertain only to adolescents between 9th and 12th Grades. MVPA in this survey was not recorded for the younger age cohorts. Available data also indicate that, in general, physical education does not provide adequate amounts of physical activity to meet the second guideline (Sallis & Patrick, 1994). The data compiled from studies summarised in Table 2.2 and Figure 2.4 suggest that substantial numbers of adolescents fail to meet the MVPA recommendation. In Pate and colleagues' descriptive epidemiology, the authors suggest that although the percentage of adolescents meeting this recommendation varies with age and gender, about 50% of the overall population meets this guideline (Pate et al.,1994).

Figure 2.4a *Percentage of 11-year old children who exercise at moderate to vigorous intensity for more than 1 hour weekly outside of school - 10 European countries*

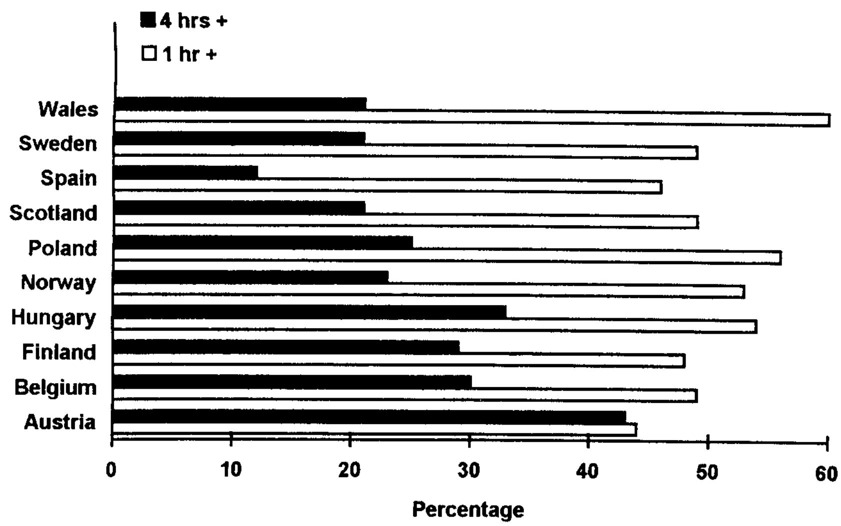
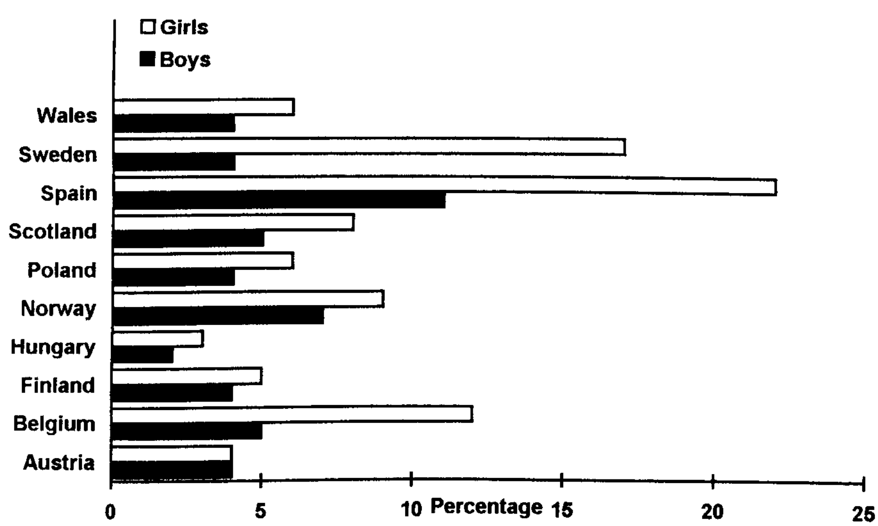


Figure 2.4b *Percentage of 11 year old boys and girls who do not participate in MVPA outside school hours - 10 European countries*



Source: King & Coles (1992)

Table 2.2 *Summary of youth studies (self-report measures): percentages of populations non-participant in moderate-to-vigorous physical activity*

Study pop	N	Measure	MVPA	Non-participant in MVPA %
Simons - Morton et al. (1990) U.S.	422 m 390 f	3 day PAR	per day mean m 14 min f 17 min	12.3 m 13.3 f
Holstein et al.,(1990) Denmark	258 m 267 f	7 day PAR	per week > 2 hours 75% m 67% f	8 m 6 f
Riddoch (1990) N Ireland	432 m 455 f	7 day PAR	mean not # reported	11 m 9 f
Boreham et al. (1993) N Ireland	251 m 258 f	7 day PAR	mean not reported	26 m ## 30 f
Telama et al (1994) Finland	2736 m / f	7 day PAR	weekly session high intensity 35% m 19% f	5-10 m φ 5-15 f

\# Data not normally distributed, hence mean values for age-groups not reported

\#\# Percentage represents number of children in lowest of 4 activity groups

φ Subjects range in age from 9 - 27 years. Sample sizes per cohort not reported

As illustrated in Figure 2.4b and Tables 2.1a, 2.1b, studies show a wide variation in amounts of MVPA taken by children. Some children spend a much greater amount of time than that specified in the MVPA guideline, and many achieve the recommended weekly total, but in shorter time intervals. As suggested by Bar-Or (1983), the preference for short, high-intensity activities may be explained by psychological factors such as shorter attention span and a lower socially induced motivation for prolonged exercise. Consensus authors themselves advert to the fact that it is not known whether more frequent, shorter sessions of physical activity would provide some of the same health benefits (Sallis & Patrick, 1994).

The disturbing finding in many of the studies is the high percentage of 10-12 year old children who take part in no moderate to vigorous physical activity. In reports of activity inclusive of school periods, this finding raises questions about the content of primary school physical education, since children of this age should participate in at least one hour of curricular PE The public health goal must be to ensure that all children take part in MVPA. Clearly, some of this 'quality exercise' should be achieved within the PE lesson.

The rationale for Guideline 2 in the physical activity consensus statement is the evidence that regular participation in continuous moderate to vigorous physical activity during adolescence enhances psychological health, increases HDL-cholesterol, and increases cardiorespiratory fitness (Sallis & Patrick, 1994). Non-significant increases in cardiorespiratory fitness however have been reported in intervention programmes, designed to provide regular moderate-to-vigorous exercise for schoolchildren. Benedict (1985) and co-workers, for example, found that a daily skipping programme did not increase maximal oxygen uptake or decrease skinfolds significantly. More recently, Stratton & Waggett (1995) found that the overall effect of an 8-week skipping programme on the cardiorespiratory fitness of 8- to 9- year old children was not significant.

The recommendation of 20 to 30 min/d of moderate to vigorous intensity activity, is similar to the adult activity recommendation for cardiovascular health and it has been estimated to be the amount of training required to increase aerobic power in youth (Simons-Morton et al.,1987). More research however is required into the effects of relatively short period of intense physical activity in the cardiopulmonary system of young children Results of a study with adults revealed that multiple short bouts of moderate-intensity exercise training significantly increase peak oxygen uptake (DeBusk et al.,1990). Moreover, improvements in strength, muscle endurance, body composition, flexibility, self image and longevity, can result from levels of exercise well below those recommended for improving cardiovascular fitness (ACSM, 1990), and 'active' children appear to engage is a sufficient variety of activities to enhance multiple components of health-related fitness. This is confirmed in the study of 4th grade children by Sallis, McKenzie and Alcaraz (1993). In this study, an index of physical activity was significantly associated with all five fitness components measured, and a canonical correlation of .29 observed. Welsman & Armstrong (1992) however found that daily physical activity levels in 11-16 year old children did not stress aerobic matabolism sufficiently to influence aerobic fitness.

Thus the recommendation to increase all activities, light, moderate, and vigorous (objectives 1.3 and 1.4) appears to be appropriate, because higher overall levels of activity will impact on several health-related fitness components. The recommendation to specifically engage in activities that enhance and maintain muscular strength, endurance, and flexibility (objective 1.6) may not be necessary for children of this age, according to Sallis, McKenzie and Alcaraz (1993), as increasing overall activity may also increase activities that have specific effects on muscular strength, endurance, and flexibility. Hence standards based on adult data must be examined more closely, as these may not be applicable for youth.

The varied patterns of activity noted within the 11 to 18 year age cohort indicates also that standards of activity proposed for 16-18 year old youth may not be the most appropriate for children in the final years of Primary School. Given the relatively high level of participation in the 11-12 year age group, and the marked decline in activity as children progress through school, the standard for 5th and 6th class children should be one which optimises participation in a variety of activities, rather than specified periods and intensity of activity to improve cardiovascular health. The frequency of four exercise periods per week for this age group as recommended by the Danish Konsensusrapport (1989), may be a more appropriate standard, and, inclusive of at least one hour of school PE is a realistic target. Such a standard would reflect the growing consensus of opinion that regularity of exercise is more important than its intensity.

2. 4 Physical activity behaviour: Patterns by age and gender

Two major findings which consistently emerge from studies of children's physical activity are (i) the gender differential in physical activity participation and (ii) the decline in physical activity from age 6 onwards which is precipitated in the female population. These trends have been observed in studies which used objective, self-report and observational measures of physical activity. In all studies using objective measures of physical activity, boys were more active than girls [Table 2.3]. On average, the gender difference was 22%, with a range of 12% to 30%. Most studies showed declines in physical activity with age for males and females, decline being most marked between 15 and 18 years. Objectively measured, the mean decline for males was 2.7% per year (range1.6 to 3.8 %) and for females 7.4% (range 2.5 to 17%).

Self-report measures used in the studies cited in Tables 2.4 and 2.5 include both self-administered and interviewer-administered surveys. No two studies used the same instrument, and levels of physical activity cannot be compared across studies. The same overall patterns however are found in studies which used self-reported physical activity measures. Ten such studies conducted in the period 1985-1995 have been located [Tables 2.4, 2.5]. Ages of subjects range from 8 to 18 years, and approximately 129,350 children were studied. Five studies are large representative national surveys from Canada, the U.S., Denmark and Northern Ireland, and the World Health Organisation study represents national survey data from Canada and ten European countries.

In the WHO study (King & Coles,1992) one constant observed across most of the European countries is the decrease in participation by age 15, especially for girls. Sweden and Norway are exceptions, where numbers remain stable or increase slightly. However, in many of the countries, students who decrease the time spent exercising from four or more times per week, tend to exercise two or three times per week rather than eliminate exercise altogether. In this study, frequency of weekly exercise reported in response to 'How many times' was not consistent with frequency of 'hours exercise per week' [Table 2.5]. Some countries, e.g., Canada, show an increase in the percentage of children who exercise for four or more hours per week at age 15. Increased participation from age 11 to age 15 in hours of exercise taken is replicated in the Danish national study (Holstein et al.,1990). In the Northern Ireland national study, Riddoch (1990) reports that 17-18 year old Northern Irish boys and girls are approximately 50% less active than 11-14 year olds. The only available data for the Republic of Ireland is a relatively small-scale study (n=425) of post-primary schoolchildren (O Reilly & Shelley, 1991). In this sample, the decline in girls' activity between 13- and 17- years was much greater than that of the boys' interviewed. Daily participation in sports fell by 9% in boys and by 19% in girls in the 4-year period. An encouraging finding in the WHO study was the increased participation levels of Canadian children relative to levels observed in the 1985 study (King et al.1985). The increased participation has been reported also for youth and young adults (Millar, 1991).

Reasons cited for an age-related decline in activity levels include a declining interest in exercise, a change of priorities, or time constraints due to factors such as examinations. Alternatively, as suggested by Riddoch (1990), the decline may reflect the change-over from one exercise pattern to another. There is also the possibility that although the exercise is quantitatively less, it may be of a higher quality and therefore of significant benefit to their health. The maintenance of such 'quality' exercise however has been shown to be more prevalent among boys than girls. Those who increase activity, as reported in King & Coles' study (1992), may be more aware of the benefits of exercise and /or enjoying the social aspects of sports activity.

Table 2.3 *Summary of descriptive studies of physical activity in children (objective measures) 1985-1995*

Study	N	Gender m > f % difference	Years	Decline in boys %	Decline in girls pop. %
Atomi et al (1986) Japan	11 m	--	10.4	---	---
Sunnegardh et al. (1985) Sweden	63 m 69 f	16	8 to13	8	13
Vershuur & Kemper (1985)m/f U.S.	233	12	12 to 17	17	23
Saris et al. (1986) Netherlands	217 m 189 f	26	6 to 12	23	15
Armstrong et al.(1990) U.K.	103 m 163 f	30	11 to 16	8	50
Sallis et al. (1993b) U.S.	50 m 52 f	30	10 to 16	11	63
Sallis, Mc Kenzie & Alcaraz (1993) U.S.	274 m 254 f	16	10.45	---	---
Atkins et al. (1995) UK	19 m 23 f	---	10.5 ± 1 yr	----	---
Summary		**22 %**		**2.7% per year**	**7.4% per year**

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Table 2.4 *Summary of descriptive studies of physical activity in children (self-report measures) 1985-1990*

Study	**N**	**Gender m > f % difference**	**Years**	**Decline boys %**	**Decline girls %**
Ross et al. (1985) U.S.	4,539 m 4,261 f	11	10 to 16	9	+ 2
King et al. (1985) Canada	Over 33,000	---	9 to 15	33	33
Sunnegardh et al.(1985) Sweden	63 m 69 f	12.5	8 to 13	10	6
Shephard (1986) Canada	11,300 m 11,800 f	4	10 to 16	8	8
Fuchs et al. (1988) Germany	236 m 172 f	30	13 to 15	5	10
Summary		**22 %**		**1.8 % per year**	**2.6 % per year**

Table 2.5 *Summary of descriptive studies of physical activity in children (self-report measures) 1990-1995*

Study pop.	**N**	**Gender m > f % difference**	**Years**	**Decline boys %**	**Decline girls %**
Holstein et al.(1990) Denmark	809 m 862 f	16	11 to 15	+ 8	+ 7 *
Riddoch (1990) N Ireland	1540 m 1671 f	**	11 to 18	30	48 #
O Reilly & Shelley (1991) Ireland	223m 222f	28 ¶	13 to 17	9	19
Sallis, Mc Kenzie & Alcaraz (1993) U.S.	274 m 254 f	3	10 to 11	N/A	N/A
King & Coles (1992)					
Spain	3372 m/f	25	11 to 15	13	25 ♣
Canada	2782 m/f	12		3	19 ♣
Boreham et al.(1993) N Ireland	503 m 512 f	9	12 and 15	+ 2	+ 2 ##

* Percentage change in those taking two hours or more MVPA per week
\# Decline in activity causing 'slight and considerable breathlessness'
** Mean values of activity not included in report (data not normally distributed)
¶ Percentage difference in participation in sports *'at least 4-times a week'*
\## Activity score inclusive of everyday activities (transportation to school etc.)
♣ Percentage decline in numbers who exercise twice per week or more

The accumulated epidemiological data clearly indicate that some children are inactive, many children seldom experience the intensity and duration of physical activity associated with health-related outcomes, gender differences are significant, and there is a marked downward gradient in activity levels of adolescents as they progress through school. Regardless of measure used, boys are more active than girls, although the gender difference is higher when objective measures are used. In the analysis of intensity of activity of 9 - 12 year old children (objectively measured), no significant differences have been observed in moderate activity (equivalent to brisk walking) of boys and girls, but boys experience more short intense periods of physical activity than girls (Armstrong et al.,1990; Armstrong & Bray, 1991). In relation to amount of exercise, boys between the ages of 6 and 17 appear to be about 15 to 25 % more physically active than females, and at ages 11 and 12 years, the gender difference is already very marked. This pattern however has changed in Finland, where girls have "caught up" with boys (Telama et al., 1994) and similar developments have been noted in Sweden (Engstrom, 1990). In many other European countries, significant gender differences persist. Factors which influence habitual physical activity therefore require comprehensive investigation in the context of sex differences at such an early age.

There is strong evidence that physical activity declines throughout the school years, and the rate of decline in activity with age is almost twice as steep when assessed with objective measures. During childhood and adolescence, females reduce their physical activity levels more than males: the rate of decline, when objectively measured, being about 2.5 times greater in females than males. Although the decline in activity appears to have no effect on fitness levels in boys, downward trends have been observed in both activity and fitness in females, the latter experiencing a decline in relative fitness of about 2.2 % per year (Sallis,1993). Because girls are less active, even at early ages, and because females decline in their activity levels faster than do males, the gender gap appears to widen with age. Thus, whatever level of physical activity is found to be important for optimal health, the probability of meeting that standard decreases with each year of age from 6 to 17 years.

Standards of activity for 11 to 12 year olds therefore should be designed to achieve participation in several sessions of structured physical activity as well as free play periods. Children who participate in several periods of structured activity are likely to be involved in a range of sport / recreation areas, and hence have greater opportunity to internalise positive health behaviour and also to build a wider repertoire of motor skills. In this process of skill acquisition, children are more likely to achieve success and to feel confident enough in their own abilities to want to pursue more active lifestyles. Moreover, if participation during the teenage years is reduced or eliminated altogether, the early mastery of motor skill will greatly facilitate adoption or renewal of leisure-time physical activity in adulthood.

From the health-related perspective, it is important at this point to make a distinction between the effects of overall level of physical activity and the effects of structured exercise. It is a basic principle of exercise physiology that specific training activities will have specific training effects (American College of Sports Medicine, 1991). However, in general, children do not exercise; they engage in a variety of physical activities, including walking, running, bicycling, and a variety of games and sports. If children increase their physical activity, they are likely to increase the frequency, duration, and / or intensity of several types of activity, not just one. These activities are likely to have effects on multiple components of health-related fitness.

Clearly there are many 11-12 year-old children who currently follow the optimal activity pattern. Conversely, there are many boys and an even greater number of girls whose physical activity experience is unacceptably low in the final years of Primary School. Why so many are active in these formative years, and some so inactive, must be the focus of careful inquiry. Only then can intervention measures be meaningfully considered.

3

INFLUENCES ON PHYSICAL ACTIVITY IN YOUTH

3.0 Introduction

Lifestyle of an individual is defined by Wenzel (1982) as the entirety of normative orientations and behaviour patterns which are developed through processes of socialisation. This means that lifestyle is not only behaviour, but also includes the attitudes and values of the individual. It also means that these aspects of the individual must be more or less interrelated and must be understood within a social context.

The physical activity component of a child's lifestyle is influenced therefore by a variety of inter-related factors. Some factors may also be interactive. Influences extend from diffuse macroscopic sources such as the mass media to the more specific influences assignable to actual people known and interacting with children. Some influences have been shown to be particularly important at different developmental periods, and it is suggested that certain variables may have greater relevance for specific population sub-groups, although this has received little attention in the literature. No one variable or category of variables is anticipated to account for most of the variance in children's physical activity. Primary socialisation in the family unit is one of the major influences on health behaviour patterns formed early in childhood. It is accepted however that the primary responsibility for engaging children in opportunities to be physically active and to learn physical skills rests with school physical education (McKenzie et al.,1993). The primary school therefore has a vital role to play in the socialisation of children into active lifestyles at the important developmental stage of preadolescence.

In activity behaviour research with adults and youth, psychological models that emphasise the role of knowledge, beliefs, attitudes, motivations, and emotions have been dominant. These models include the Theory of Planned Behaviour (Godin & Shephard, 1990), the Intrinsic Motivation Model (Whitehead, 1993), the Health Belief Model (Rosenstock, 1974; Becker, 1977), the Theory of Reasoned Action (Ajzen & Fishbein, 1980), the Health Promotion Model (Pender, 1987), and theories derived from behavioural analysis of choice (Allison, 1983; Rachlin, 1989). Although the Health Promotion Model is widely used, and includes 'modifying factors' as well as 'cognitive-perceptual' influences on behaviour, it is not all-inclusive of the variables that determine participation in a health-promoting lifestyle. Many questions have also been raised about

the applicability of some of these models to the behaviour of children (Iverson & Portnoy, 1977; Kirscht, 1988; Godin & Shephard, 1986; Godin & Shepherd, 1990). The only available model designed specifically for youth physical activity patterns is the Physical Activity Model (Sonstroem, 1978). Although some cross-sectional evidence supports this model's validity for spontaneous exercise in children, the model has not been experimentally tested. More extensive evidence supports the validity of Social Cognitive Theory (Bandura, 1986), and variables in this model are shown to be equally relevant to the study of exercise determinants both with adults and children (Sallis & Hovell, 1990; Dishman & Sallis, 1994; Stucky-Ropp & Lorenzo, 1993). Social-cognitive theory (SCT) posits that behaviour is a function of personal and environmental factors. It is therefore an appropriate theoretical framework in which lifestyle behaviour can be studied. Four domains of influence which apply to youth activity behaviour are derived from this theory:

1. Biological and developmental factors, 2. Psychological factors, 3. Physical environmental factors, and 4. Social environmental factors

The influence of any one social factor on lifestyle behaviour therefore must be understood, not only in the context of a wider social matrix, but also in relation to the totality of influences in the social cognitive paradigm. A model of such influences is proposed [Figure 3.1]. This model uses both observed and expected variables from the four domains as constructs, and includes the hypothesised relationship between primary PE, recreational activity and health.

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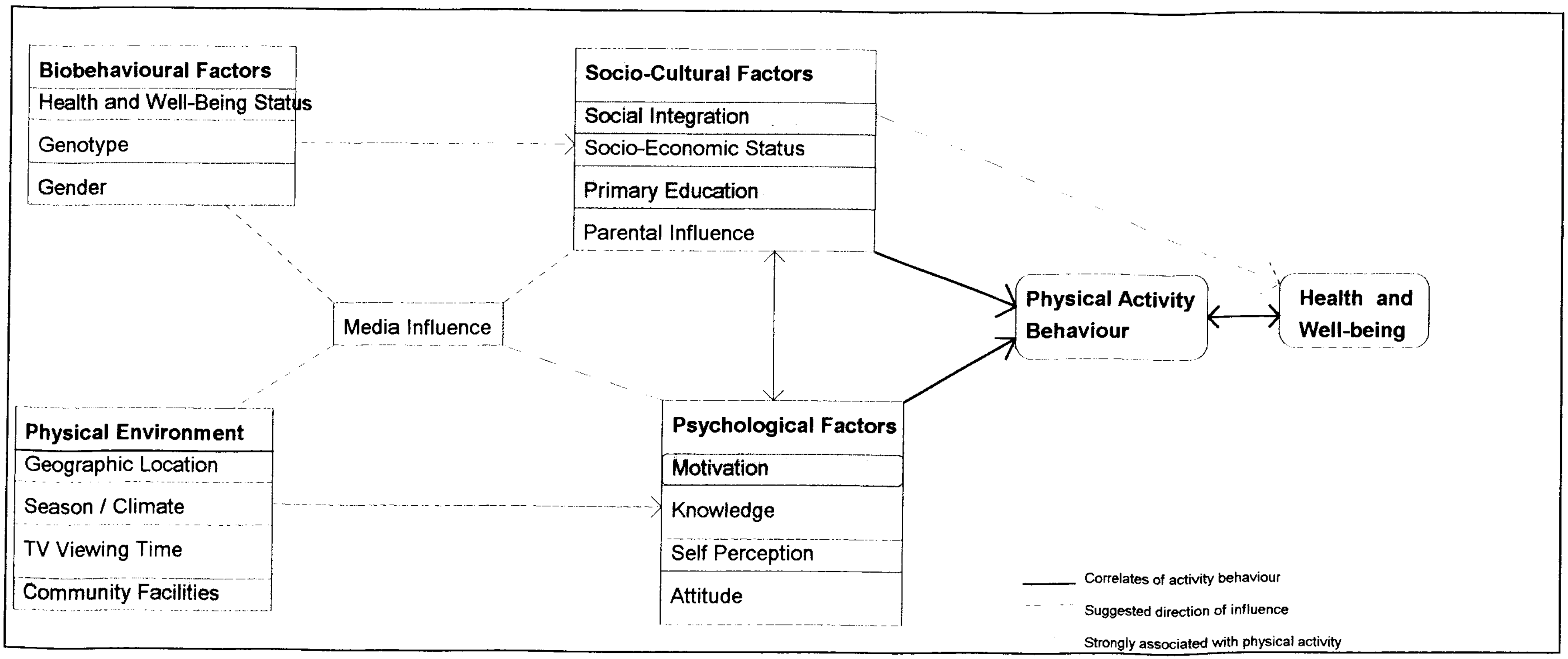

Figure 3.1 *Hypothesised relationship between personal and social variables, physical activity, and health*

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3.1 Biological and developmental factors

The role of genetic and biologic factors in determining behaviour is complex. These factors may interact with or modify the actions of other influences, and therefore, though not usually subject to direct intervention, are important elements in activity behaviour determination. A child's rate of physical development for example, may profoundly influence the level of social support and encouragement received from parents, peers and coaches. The biological and social factor interaction particularly applies to youth sport, where customary differences in physical maturation are considerable (Malina,1988)

3.1.1 Genetic influences

Genetic contributions to children's activity have been studied by Kaprio et al. (1981), Bouchard & Malina (1983), Perusse et al.(1988), Thomas & Thomas (1988) and Perusse et al.(1989). In the large twin study of data from the Finnish Twin Registry (Kaprio et al., 1981) the authors found a significant heritability estimate of 0.62 for general physical activity characteristics, although this measure was probably inflated by the limitations generally associated with the use of twin data alone (Bouchard & Malina,1983). In a study of family aggregation in a 1,300 person sample, approximately 20% of the variation in daily physical activity was attributable to genetically transmissible variation (Perusse et al.,1989). On the other hand, in this sample, no genetic effect was observed for the indicator of exercise participation, and the transmissible variance was entirely of cultural origin ($t^2 = b^2 = 12$ per cent)[1]. For both indicators, most of the phenotypic variance was accounted for by non transmissible environmental factors (71 per cent $\leq e^2 \leq$ 88 per cent)[2] These results confirm earlier conclusions of Thomas & Thomas (1988), which suggested that heredity is a direct influence on initial differences between boys and girls physical activity in childhood, but interacts with environmental circumstances as children grow and develop. Two recent studies of young children (4 to 9 years) found significant relationships between parents and children's activity levels (Moore et al.,1991;

1 t^2 = total transmissible variance

2 $e^2 = 1 - t^2$ = non transmissible variance

Freedson & Evenson, 1991). Possible mechanisms, suggested by the researchers, for familial aggregation included genetically transmitted factors that predispose the child to increased levels of physical activity.

It is well accepted that there is a genetic component of cardiovascular fitness (Bouchard & Lortie, 1984; Bouchard et al.,1986). The estimated contribution is about 30%, and similar influences on other health related fitness components are expected (Sallis, McKenzie & Alcaraz, 1993). The physiological condition of fitness may in turn facilitate or hinder participation in physical activity (Sallis et al., 1992), although in 10 -12 year old children, evidence relating habitual physical activity to peak VO_2 is conflicting (Armstrong et al.,1990; Atomi et al.,1986; Kemper, 1985; Mirwald & Bailey, 1986; Pate et al.,1990; Rowland, 1985; Sallis, McKenzie & Alcaraz, 1993, Rowland, 1994). Cross-sectional results of a US study of 10-year old children (Sallis, McKenzie & Alcaraz, 1993) showed significant associations between components of health related fitness and an index of physical activity (canonical correlation = 0.29). One interpretation of data in this study is that children with high fitness levels may tend to be particularly active, and evidence of genetic influences on physical activity and physical fitness supports such an interpretation. An alternative explanation however, is that children who are physically active have increased fitness scores because they participate in a variety of physical activities. This argument has been supported by randomised training studies showing exercise-induced increases in cardiovascular fitness (Rowland, 1985).

The relatively low association between measures of cardiorespiratory fitness and habitual physical activity is endorsed by Cureton (1987) because of the effects of body fatness (Buskirk & Taylor, 1957: Montoye, 1975) and inheritance (Bouchard & Lortie, 1984) on $VO_{2\,max}$ and work capacity. Recent research in Britain does not support the argument of a fitness-activity association in children. Data compiled from objective measures of children's activity show that 11-12 year old children rarely experience the levels of physical activity associated with increases in peak VO_2 (Armstrong & Welsman, 1994), and the alternative direction of association suggested, viz. that high levels of aerobic fitness may encourage children to engage in strenuous leisure-time activities, remains to be proven (Armstrong,1994).

3.1.2 Gender effects

Biological differences between boys and girls prior to puberty (Thomas & French, 1985) and post-pubertal (Schwartz & Reibold, 1990) have been shown to contribute to gender differences in motor performance. Such differences in turn may be responsible for the gender differential in physical activity pattern, in that they act as incentives for boys and girls to select activities at which they are more competent (Eaton & Enns, 1986). Performance-related gender differences however are suggested to be small prior to puberty, and in Thomas & Thomas' study (1988) adjusted to zero by degree of fatness and intensity of exercise. After puberty, hormonal differences in combination with environmental opportunities are suggested to produce better performance by males (Thomas & Thomas, 1988). The mean age of menarche, the most commonly used indicator of the age of puberty, was 13.52 years for Irish girls at the latest recording (Hoey, Cox & Tanner, 1986), indicating that the majority of girls in 5th and 6th classes are prepubertal. Many girls however experience considerable changes in physique in their senior primary school years. Physiological changes and accompanying psychological effects influence girls' activity selection and intensity of activity participation. Irish clinical growth standards for example, have shown that the adolescent gain in skinfold thickness which precedes the growth spurt in height and weight is more marked in girls than in boys (Hoey & Cox, 1987; Hoey, Tanner & Cox, 1987). These influences are quite distinct from the socialisation of boys and girls into sports and physical activity (Herkowitz, 1980; Greendorfer, 1980; Lewko & Greendorfer, 1982.). Definitive research on the psychological and biological effects of puberty on physical activity however, is not available.

Gender differences in peak VO_2 have been reliably substantiated (Krahenbuhl et al., 1985; Armstrong & Welsman, 1994). Data suggest that at age 11 years, male values are greater than those of similarly aged female by about 18%. At age 12 years, male peak VO_2 values were found to be 23% higher than females and 40% higher by age 16 (Armstrong & Welsman, 1994). As the cardiorespiratory fitness-activity association in young children is equivocal, such gender differences are unlikely to significantly affect activity behaviour.

Although gender differences in frequency of activity are reported in most national surveys and studies of youth activity behaviour, only a small number of studies have determined the predictive strength of this variable in data analysis. In the study of children grades 6-8 (Ferguson et al.,1989) gender was a significant and independent predictor of current exercise behaviour (B, 0.12 $p=.0007$). Godin & Shephard (1986) found gender to be significantly correlated with current behaviour ($r=.264$, $p<.001$) and intention to exercise ($r=.249$ $p<.001$) of children in grades 7-9. 'Being male' was the variable most strongly related to exercise frequency in Gottlieb and Chen's study (1985) of a similar age cohort ($F=36.80$ $p<0.001$, BETA=1.40). Shephard and colleagues study (1980) of 10-12 year olds in the Trois Rivieres Project reported that girls engaged in 0.5h/day less moderate-vigorous activity than boys ($p<0.001$ weekdays, $p<0.004$ Saturdays).

The relationship between developmental factors and socialisation factors is suggested to be a strong influence on sport participation and achievement (Brustad, 1992). Boys who mature early are more likely to receive encouragement from socialising agents as a consequence of their more advanced physical capacities, while boys who mature late face obstacles to sport success not only due to size and skill disadvantage, but also due perhaps to a lower level of social support. Early maturing girls will likely receive more social support during the early years of sport involvement but later maturing girls, due to weight-height ratio and lower body fat, have greater potential for success in most sports. Thus differences in physical maturation levels may greatly influence children's perceptions of their sport involvement and the extent of social support that they receive for such involvement. This relationship however is not suggested to affect participation in physical activities outside the traditionally defined realm of 'sport'.

3.1.3 Health status

Children classified as sedentary may be so due to health problems associated with chronic disease or due to other factors that predispose them to both inactivity and disease. Whether the increased morbidity/mortality risk is due to the sedentary lifestyle or the health problems responsible for the sedentary lifestyle or to other factors producing both health risk and inactivity is unknown.

The health status of children however is generally expected to influence their physical activity, in that children with good health and well-being are assumed to have more energy for exercise. Benefice's study (1992) of mildly malnourished Senegalese children, for example, found that when children were divided on the basis of weight deficits for age into well nourished and malnourished groups, malnourished children registered poorer functional performances in sub-maximal tests, spirometric tests and motor skill tests. Activity levels of the entire sample were low, although no difference with respect to intensity of physical activity was found between groups in the 6-hour heart rate monitoring period. These results highlight the negative effect of just one health status indicator, viz. malnutrition, on children's physical performance.

Two self-assessed health status measures in the socio-medical study of Danish schoolchildren (Holstein & Due, 1990) were significantly correlated with frequency of exercise ('being in very good health' $p<0.001$; 'symptom free' $p<0.05$) and the 'inactive' children's scores were indicative of poor well-being compared to the total sample, e.g. 70% of the 'inactive' thought they were not 'in good shape' compared to 43% of all, ($p< 0.001$). While health and well-being items assessed in this study were in all cases associated with higher frequency of exercise ($p < 0.05$), the authors caution against interpreting the data as a one-way causation. The competing hypothesis may also be true, or a third alternative may be that good health, well-being and exercise are a collective result of other factors, e.g. social relations, psychological factors, good physique or some unexplored factor (Holstein & Due, 1990).

Psychosocial health must also be considered a factor which influences health behaviour. Although there is a broad consensus, on abstract terms, that psychosomatic and psychosocial co-determination of diseases are increasingly important, guidelines for health education have largely excluded avoidance of psychosocial risk factors, and there is little documented research in this domain. Eder (1989a; 1990) has investigated the mutually reinforcing processes of segregation, impairment of health, and life satisfaction.

The former study analyses data from an Austrian survey, which included an expanded repertory of questions on social integration and school adaptation. In the 1990 study, data from the WHO trans-national survey (Aaro et al.,1986) are analysed. The author observes a feedback loop between somatically manifest well-being and social integration, in which social processes in the classroom-society seem to have a reinforcing effect (Eder, 1990). For example, in the 'internal' loop described, self-perception as lonely, self-perception as unhappy, and self-perception as unhealthy are likely to stimulate each other mutually. In the 'external' loop, the 'social' activities of children seem to have quite a strong reinforcing effect both on the feelings of loneliness and on the related use of medicines, etc. Eder (1990) reports that groups with the most dramatic shortage in health and social integration are the 15-year old girls, and the group in best psychosocial condition are the 11-year old boys (Eder, 1990). It is interesting that these are correspondingly the groups for whom the lowest and highest levels of exercise participation are recorded. It is likely that, for young children, physical activity provides many such 'social' activities, and thus may feed into the external loop, having a reinforcing effect on somatically manifest well-being and subjective feelings of health. A counter-mechanism may also be at work, in that children with good psychosocial health are more likely to enjoy socialisation through physical activity, and hence increased participation in such activity.

Results of a recent cohort study of British adolescents (Steptoe & Butler, 1996) support the association between emotional well-being and physical activity. The longitudinal, demographic, and clinical study of over 5,000 adolescents found that, after adjustment for social class, sex, and health status, greater participation in vigorous sport and recreational activity was associated independently with positive emotional well-being. The associations were significant for the psychological symptom subscale of the malaise inventory (regression coefficient - 0.024, 95% CI -0.036 to -0.011, $p<0.001$) and the General Health Questionnaire (odds ratio of emotional distress per unit increase in vigorous physical activity 0.992, 95% CI 0.985-0.998, $p<0.01$). A surprising corollary to the analysis was that boys and girls who engaged in more non-vigorous activities, such as darts and snooker, reported high rates of psychological and somatic symptoms on the malaise inventory. Although the study found no evidence that sickness resulting in a poor psychological state can account for the association of sport and well-being, the authors cite the possibility that adolescents with psychological difficulties may choose not to play sports or engage in other vigorous activities.

Clinical studies have examined specific aspects of children's health status and activity measures, usually with small samples. For example, evidence suggests that asthmatic children are either more active than, or about as active as, non asthmatic children (Weston et al.,1989) in spite of the aerobic fitness limitation described (Varray et al.,1991).

The most widely studied aspects of health status as related to physical activity, are overweight and obesity. Obese[3] children are traditionally considered to be less active than lean youth. Data from numerous studies however are inconclusive on the confounding effect of body size on physical activity (Corbin & Fletcher, 1968; Epstein & Wing, 1980; Shapiro et al., 1984; Huttunen et al.,1986; Gortmaker et al.,1987; Vara, 1989; Epstein, Koeske & Wing, 1984; Cooper et al.,1990; Epstein et al.,1990; Gortmaker, 1990; Epstein et al.,1991; Cohen et al.,1991; Crepaldi et al.,1991; Taylor & Baranowski, 1991; Blaak et al.,1992; Muecke et al.,1992; Eposito-del Puente, 1993). Studies of the aetiology of obesity have indicated that the distinct measure of *inactivity* seems to be a key factor in predisposing to obesity (Walberg & Ward, 1985; Shah & Jeffrey, 1991; Moore-Groarke & Thompson, 1995). Results of cross-sectional studies which indicate a relationship between low activity levels and obesity however, cannot be used to test the competing hypothesis, that obesity leads to reduced activity. Studies of activity choice have indicated that obese children choose vigorous activities less often than their lean peers do (Dietz & Gortmaker, 1985; Epstein et al.,1991), although when controlled by environmental factors e.g. reduced access to sedentary activity or increased access to concurrent 'more liked' vigorous activity, differences in activity choice were observed to be not significant (Epstein et al.,1991).

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[3] A diagnostic criterion for childhood obesity is the 85th percentile of triceps skinfolds (Seltzer & Mayer, 1965) or 120% of average weight for age, height and sex (Epstein et al.,1991). Limits of acceptable BMI for children have yet to be defined (White et al., 1995)

Excess fat has been found to prove a hindrance to the performance of tasks requiring movement of the body weight (e.g., Slaughter et al.,1977; Maffeis et al.,1993), and risks of enforcing physical activity on young children for example, pertain to obese children where the regulation of the ratio energy input:energy output is one of the therapeutic components (Kucera & Golebiowska, 1994). It is accepted that controlled physical activity must always respect the total burdening with excessive body weight as well as the physical action of overweight. Maffeis and colleagues (1994), in their study of 9-10 year-old children, found that the activity index, or TEE/PMR ratio[4] of obese children was comparable to that of the non-obese in a 3-day monitoring period. Similarly, the energy expenditure devoted to physical activity, that is TEE - PMR, per kilogram of fat-free mass (FFM), or per kilogram of body weight, was not significantly different in the two groups. However, in absolute terms it was 24% higher in obese children; thus for a similar level of activity, the greater body weight of obese children causing a higher energy cost of weight-bearing activities than in non-obese children. Because body mass is a primary determinant of energy expenditure, Bar-Or & Baranowski (1994) explain an obese adolescent, with an observed low physical activity, can have a higher total energy expenditure (EE) than a leaner (lighter) somewhat more active peer.

In an earlier laboratory controlled trial, Maffeis and colleagues (1993) measured body composition and energy expenditure during walking and running in 40 prepubertal children, 23 obese and 17 age-matched controls (9-10 years). Data indicated that walking and running are energetically more expensive for obese children than for children of normal body weight.[5] Expressed per kilogram of body weight, the rate of energy expenditure increased with speed but did not differ in either of the two groups. Overweight children however had significantly ($p < 0.05$) higher METs than the control group had. For example, while walking at a speed of 5 km/hr, the obese children expended approximately 50% more energy than the control children (Maffeis et al.,1993).

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4 Total daily energy expenditure / Post absorptive metabolic rate

5 Weight considered as normal when in the -10% to 10% range of the 50th percentile of weight for actual height, calculated on the basis of the Tanner (1966) tables, as recommended by the National consensus Conference on Obesity (Crepaldi et al., 1991)

Data in studies by Cooper and colleagues (1990) showed that obese children generally have adapted to their increased body weight, so that they have the same ability to perform activity as do non-obese children. However, the data also suggest that the adaptation is more successful in younger subjects. Body mass index, for example, in a study of 9-year old children, was not significantly associated with Caltrac measured activity (Sallis, Alcaraz et al.,1992). Similarly, Caltrac monitoring of obese and lean children by Romanella and collegues (1991) showed no significant difference between obese and nonobese children's physical activity levels. Conversely, in a study of 8-16 year old obese, non-obese and controls, less time was spent for exercise (chronometer) by the obese than the other two groups (Kucera & Golebiowska, 1994), although the heart rate of the obese subjects did not differ signficantly from that of the control group during spontaneous physical activity. A study of 93 high adiposity and 93 low adiposity children by Taylor and Baranowski (1991) found that, for the high adiposity sample, physical activity score (PAS) [6] age, BMI, and gender were significant and the overall model was significant ($p < .001$) accounting for 38% of variance in physical working capacity. PAS thus was a significant predictor of cardiovascular fitness among the high adiposity children, but not the low adiposity children. The authors suggest that mechanisms that may account for this difference include greater work for equal activity among the obese, or differences in hormonal or metabolic factor mediating the activity-cardiovascular fitness relationship (Taylor & Baranowski, 1991).

As children grow older and perhaps the social stigma of obesity becomes more important, decreased activity and a consequent slower growth of the Δ AT and Δ $VO_{2\,max}$ become more evident.[7] This may be a more potent predictor of activity for girls than boys. In Reynolds and colleagues study of 14-16 year olds (1990) for example, BMI measured at baseline predicted activity at 16 months for the females (B, - 0.20, F = 4.61, p = 0.03) but not for the males (B, 0.05, F = 0.46, p n.s.)[8]. Certainly obesity needs to be better understood in its consequences as well as its causes, as Wardle (1995) suggests, and the assessment of this condition should include, amongst a number of measures, risk

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6 Physical activity score (PAS) computed from a 2-day observation period

7 Anaerobic threshold [AT] and maximal oxygen uptake [VO_{2max}]

8 A negative coefficient represents a positive relationship between variables

factor status and body image. Obesity carries a social stigma in affluent societies and overweight children in particular may suffer, as they tend to be disliked more than disabled or disfigured children. This has been assessed in several surveys of children's attitudes to each other (Richardson et al., 1961; De Jong, 1980, Tobias & Gordon, 1980; Weiss, 1980). Prevalence of such attitudes may influence spontaneous participation by overweight and obese children in group play, and subsequent opportunity for involvement in more structured and more competitive group activities.

The relation of motor skills to level of physical activity is unclear because as motor skills improve during childhood, physical activity declines with age. However, within specific age cohorts, motor co-ordination may impact on activity levels via peer networking variables. Schoemaker & Kalverboer (1994) found clumsy children to be aware of rejection by their peers, to have fewer invitations to play and fewer play activities with playmates. Similarly, Weiss & Duncan (1992) found that children who are more athletically competent were characterised by higher peer acceptance and interpersonal success contributing to higher involvement in sport activities.

3.2 Psychological influences

Brustad (1992) suggests that socialisation influences are integrally related to the psychological characteristics of children's sport involvement. Although considerable attention is devoted to socialisation into sport, these efforts, he contends, have not yielded an identifiable knowledge base regarding the psychological context within which children initiate their sport involvement. This appears to be the case also in the more global domain of children's physical activity. This may be due to the lack of cognitive development and /or inability to measure many of the psychological variables in younger children. Much of the research in this domain has been conducted with adolescents. The evidence in the smaller number of studies of primary school children indicates that certain psychological variables are significantly related to behaviour, and although such associations are fairly consistently observed across populations, the associations are not strong.

3.2.1 Self perceptions

It has been established that broad personality variables are not related to adolescents' physical activity, so enduring personality traits such as achievement motivation, self-confidence and independence are probably not strong influences on children's physical activity (Sallis et al.,1992) although Gruber (1986) and Fox (1988) have suggested that high self esteem may be a factor predisposing youth to be active. Sonstroem (1978) posits that self-perception (estimation) rather than physical fitness or self-esteem influences one's attraction to or interest in physical activity.

Specific beliefs about personal physical activity such as self-efficacy, have been associated with physical activity across multiple adolescent studies (Sonstroem, 1978; Godin & Shephard, 1986; Ferguson et al.,1989; Reynolds et al.,1990), and highly correlated with exercise in previous studies with adults (Sallis et al., 1989). Bandura's social cognitive theory (1986) suggests that individuals who see themselves as capable of achieving a particular outcome (perceived self-efficacy) will expend more effort to achieve that outcome. Although the theoretical basis for the perceived competence /

motivation relationship has emerged primarily from psychology, specialists in motor behaviour have attempted to explain the phenomena within the physical domain. Sonstroem (1978) has developed a model for physical activity in which he hypothesises that for people to participate in physical activity they must (a) be interested in or attracted to physical activity and (b) believe they are capable (possess the necessary physical abilities) of achieving success at that activity. This model is derived from research with the Physical Estimation and Attraction Scales (PEAS). In such research with adolescent boys, self perceptions of physical ability were positively related to measured physical performance, obtaining coefficients of 0.53, 0.41 and 0.48 respectively for three small high-school population samples (Sonstroem, 1978). Self-estimates of physical ability by 12-13 year-old children correlated significantly with the number of activities played (r =.24, $p<.01$) in an earlier study by Neale, Sonstroem & Metz (1970). This study also found measures of self esteem to be significantly correlated with perception of physical ability (r =.37). Self-esteem influences themselves may be bi-directional.. In a meta-analysis of studies by Gruber (1986), physical activity is observed to exert a potent influence on self-esteem. This may in turn influence physical activity and exercise adherence.

Results of more recent studies with adolescents generally support the relationship between perceived competence and participation. Reynolds (1990) for example, found that higher levels of self-efficacy were related to higher levels of activity for both adolescent males (r = - 0.28, $p<0.0001$) and females (r = - 0.46, $p<0.0001$)[9], but predictive only of females' activity when measured 16 months post baseline ($F = 4.60$, $p = 0.03$). Griffin and Keogh (1982) refer to movement confidence as a construct reflecting an individual's feeling of adequacy in a movement situation. Underlying interpretations of these studies, is the notion that children who are confident about their movements will choose to be active, will do so in an assured manner, and will be more likely to persist.

Results of measures of physical self perception in primary school children however, are not consistent. Ferguson et al. (1989) found that perceived athletic ability correlated

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[9] A low score represented a high degree of behaviour measured, thus a significant negative correlation indicates a high degree of self-efficacy is related to higher levels of physical activity.

significantly with exercise intent ($r=.27$ $p<.01$) in a study of children in grades 6-8, but was not predictive of exercise intent or current exercise behaviour. In the study of 4th and 5th graders by Roberts, Kleiber and Duda (1981), the Perceived Competence Scale for Children (Harter,1981) was administered to 143 children. Male and female participants in organised sports had higher mean scores on the physical competence subscale than non participants [$F = 4.43$, $p < .05$] but no significant gender main effects or interactions were found. In a sample of younger children [Grades K through 4] Ulrich (1987) reported that perceived physical competence was not significantly related to participation in organised sports programmes. Similarly, in the study by Stucky-Ropp & Lorenzo (1993), self-efficacy (i.e. confidence in one's abilities) regarding physical activity similarly did not emerge as an important predictor of exercise behaviour. The authors suggest this finding may be due to a deficiency in the assessment of self-efficacy in this age group, or to the quite plausible explanation that there are less stringent requirements for participating in physical activity at this age. Both factors may be contributory to such a relationship in preadolescence.

Assessment of self-efficacy is complex, and requires considerable sub-scale measurement. For example, Biddle & Armstrong (1992) found that indicators of physical self-perception did not discriminate active from less active 11 to 12 year old boys, while specific sub-scales of physical self-perception (body attractiveness, physical self-worth), discriminated active and less active girls [$F(1,69) = 4.21$, $P<0.05$]. Correlation coefficients between the self-perception variable 'sports competence' and physical activity measure [% time heart rate > 139bpm] were 0.39 (P ,0.05) for boys and 0.06 for girls in this study. Higher scores for males compared with females on domains associated with sports competence have been reported both with college students (Fox, 1990) and with children (Ulrich, 1987; Whitehead & Corbin,1988; Biddle & Armstrong,1992) and Fox (1990) recommends that analyses should be conducted separately for each gender. Active girls in Biddle & Armstrong's study (1992) were characterised by higher scores on perceptions of attractive body as well as physical self-worth and global self-esteem. The authors denote physical appearance to be a predictably important factor, either as an antecedent or consequent variable and one that is likely to increase in importance with age, as girls move into adolescence. Positive perceptions of the physical and general self may also be more important for girls, in order to combat negative stereotypic attitudes associated with gender roles in physical activity.

Self-efficacy may also have an indirect influence which may not be evident in univariate analysis. For example, Weiss & Duncan (1992) conclude that children who perceive themselves as more competent and successful, and who use appropriate causal attributions, are more readily integrated into the social networks that facilitate sport participation. Weiss & Duncan also included a 'teacher-rating' of children's physical competence. A moderate correlation (r = 0.40) was found between these ratings and children's perceived competence [recorded on the Harter (1982) PCSC scale]. In one of the few studies of self-concept that included actual measures of competence, Ulrich (1987) found that children aged 5-10 years in the lowest tertile of perceived competence did not perform as well as children in the other tertiles, both in basic motor ability tasks and more specialised sports skills, trends in means suggesting a dose-response effect. These results also suggest that children have a reasonably accurate perception of their motor competence, and emphasise the need for developmentally appropriate programs of physical education at these ages when basic motor skills are developing. Lack of success in motor activities at young ages retards the motor skill development process, and is likely to impact on the motivation to learn and to participate in physical activities at later stages. Thus while self-efficacy may not be predictive of 10-12 year-old children's current activity behaviour, physique and competency beliefs formed at this period may be important behavioural influences in longer term activity participation.

Results of earlier studies have shown that perceptions of ability do become significantly related to sports involvement within a few years (Feltz & Petlichoff, 1983; Roberts, Kleiber, & Duda, 1981; Weiss et al.,1984). Young boys' feelings of competence and social acceptance in soccer, for example, have been shown to predict later outcomes in relation to dropout from this sport (Ommundsen & Vaglum,1991). On the broader lifestyle activity dimension, a meta-analysis of 23 studies of adolescents and adults (Gillis, 1993), identified self-efficacy as the strongest predictor of participation in a health-promoting lifestyle .

Beliefs concerning future physical activity have been examined in some studies by questioning children on their perceived activity involvement at 20 years of age (Ferguson et al.,1989; Holstein & Due, 1990; Stucky-Ropp & Lorenzo, 1993; King & Coles, 1992). While longitudinal studies are needed to assess the validity of this measure, responses have been observed to correlate with children's attitude to school PE and to habitual physical activity. In the study by Ferguson (1989), children who had positive attitudes about PE were more likely to say they planned to exercise in the future (r = .24, $p<0.01$) and exercise intent was a significant predictor of current exercise behaviour [B, 0.39, $p<.0001$]. In the study of Danish schoolchildren (Holstein & Due, 1990), a relationship was observed between exercise intent, socio-economic status and current exercise patterns 44% of children in socio-economic groups 1-3 intended to exercise at 20 years compared to 25% of children whose parents were unemployed ($p < 0.01$). Children in the latter group (SES 6) were the least active of the sample, 49% not exercising for a minimum of 1 hour per week. Due to insufficient analysis of data in the WHO survey (King & Coles,1992) it is difficult to draw inferences from this study. In the 11-year age cohort, percentage responses to the question of exercise intent at age 20 were markedly different for boys and girls in all countries surveyed, boys being much more positive about future exercise behaviour. Although Ajzen and Fishbein's model (1980) $[\, B \sim I = (Aact)w_1 + (SN)w_2 \,]$[10] proposes behavioural intention to be a function of both attitude and subjective norms, in cross-sectional studies it is not possible to determine whether attitudes influence intent, intent influences attitude, or both. Furthermore, results of the study of children by Godin and Shephard (1986) do not fully support the application of the Fishbein model in the context of intentions to exercise.

Children's beliefs concerning activity ten years in the future in general do not appear to provide meaningful information. Given that adult data indicate that just 30% to 60% of those who intend to be active will sustain habitual participation (Dishman, 1985), assessing young children's intentions with a view to increasing intention may not be a productive line of research.

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[10] B is the behaviour, I is the behavioural intention, Aact is the attitude towards the behaviour, SN is the subjective norm, and w_1 and w_2 are empirical weights indicating the relative importance of Aact and SN

3.2.2 Attitude

Leventhal (1973) has argued that persistence of exercise habits is strongly dependent upon the perceptions of physical activity formed during childhood, and that such perceptions are more potent predictors of health behaviour than health information. While attitudes towards physical activity are not stable in senior class children (10-12 years of age), relationships between attitudes and involvement in physical activity are generally consistent in the 10 - 12 year age span (Smoll, Schutz & Keeney, 1976; Smoll & Schutz, 1980). Correlations are observed to be generally low to moderate.

Child's enjoyment of physical activity is observed to be the most salient predictor of exercise behaviour for both boys and girls. In Stucky-Ropp & Lorenzo's study (1993), enjoyment of activity [Males: $F(1,119) = 11.53$, $p < 0.001$; Females: $F(1,119) = 7.34$, $p < 0.01$] accounted for 9% and 6% respectively of criterion variance. In the study of Junior High School students (Godin & Shephard, 1986) attitudes towards activity, measured from a series of semantic scales, correlated significantly with current behaviour ($r = .271$ $p < .001$). Attraction to physical activity in Neale, Sonstroem & Metz's study (1969) correlated significantly with number of voluntary activities played by adolescent boys ($r = .37$, $p < .01$). A later study by Sonstroem (1976) obtained a coefficient of 0.46 between attraction to physical activity scores and both number and frequency of participation in sport-type activities.

Some studies have examined the relationship between attitudes towards school PE and activity behaviour. Ferguson (1989) found that attitudes toward physical education were predictive of both exercise intent (coefficient 0.16, $p = .0001$) and current behaviour (coefficient 0.10, $p = .0001$) and together with perceived benefits of exercise, gender and outside sports activities accounted for 27% of the variance in current exercise behaviour. Attitudes about physical education ($r = .24$) self-esteem ($r = .34$) and perceived benefits of exercise ($r = .45$) were positively associated ($p < .01$) with likelihood of exercise participation in the future, and all three variables were significant and independent predictors of exercise intent. In the nation-wide sociomedical study of Danish children (Holstein & Due, 1990), attitudes towards school PE differed significantly between boys and girls, boys being more positive ($p < 0.001$) about PE lessons. Association of this variable with current activity was not examined in the study. Gender differences were also observed in British primary school studies. Boys were more positive about 'games in PE' ($p < 0.001$) (Davies & Brember, 1994), while girls were significantly more positive about gymnastics ($p < 0.05$) (Inner London Education Authority, 1990).

Dislike of PE emerged as a covariant of sedentary behaviour in a demographically homogeneous sample of children studied by Terre et al.(1990). In factor analysis, 'dislike of PE' clustered with sedentary behaviour items in the overall sample of 11-18 year olds [Factor loading (0.39)], and also at developmental level 'age 11' [Factor loading (0.30)]. Thus it seems reasonable to suggest that promoting positive attitudes towards physical education could influence current and future exercise, especially among students who do not exercise much outside of school physical education..

3.2.3 Motivation

There is a paucity of information on children's exercise motives, although clearly an understanding of activity motivation is relevant to lifestyle and health behaviour research. It has been suggested that the motivational stance adopted by the child reflects underlying reasons for participation, and as such could be a useful marker of physical activity (Weiss et al., 1986). The two primary reasons stated by most children for participation in sport according to Malina (1994) are: to have fun, and to learn new skills, objectives which apply to physical activity in general. However, when we examine responses in activity studies, health and physique motives become increasingly apparent. Motivational orientation has been addressed in studies by Telama & Silvennoinen, 1979, King & Coles (1992), Holstein & Due (1990), Biddle & Armstrong (1992), Whitehead (1993), and Borra et al.,(1995).

In a cross-sectional randomised survey of 3,106 Finnish school children 11 to 19 years of age, Telama & Silvennoinen (1979) found near-linear shifts in self-perceived motivation for exercise across age. Performance-oriented, competitive motivation and a normative emphasis on health decreased with age, whereas recreation for relaxation increased.

Most important, the motives most strongly linked to frequency and intensity of activity were perceived fitness and physical competence, recreation for relaxation, and functional health (e.g., maintaining one's health, improving endurance). Gender differences in activity motivation were also found. Boys, particularly the younger ages, tended to endorse competition and fitness motivation whereas girls, particularly older ages, endorsed recreation. These results are largely consistent with findings from earlier studies by Smoll & Schutz (1980), and Schutz, Smoll, & Wood (1981).

In the national study of Danish schoolchildren (Holstein & Due, 1990), the most important motives to exercise for 11 -15 yr. olds were health (73%), 'to get in good shape' (67%), to have fun (67%) and to make new friends (56%). When correlations between motives to exercise and the actual exercise reported were examined, the motives 'to get in good shape' [Ratio 2.6, $p<0.001$][11] and 'to win' [Ratio 2.1, $p< 0.001$] were most strongly associated with the actual exercise activity whereas two other motives 'to please my parents' and 'to look good' were not significant. Of particular interest were the significant differences in motivation observed between social groups, achievement motives being more important than health motives for children in the lower socio-economic groups. 'To be good at sports', 'to become a sports star' and 'to please parents' were more frequently mentioned by pupils from the lower social groups ($p<0.01$).

Health, physique and enjoyment were the most important motives for Canadian youth in the WHO study (King & Coles, 1992), but while Polish 11-year olds concurred with the two former choices, only 22% of these children considered fun to be important (King & Coles, 1992). Measures of association between variables were not analysed in the WHO study, hence there is no information on the relationship between motives and actual exercise reported, or differences between social groups. Similarly in the study by Borra et al., absence of cross-sectional analyses limits interpretation of data. The most important reason cited for being physically active by respondents in this survey was because 'it's fun and they enjoy it'. Although virtually all respondents agreed that regular

[11] Ratio is calculated as the percentage of children who exercise 4 + hours weekly among children in the response category 'very important', divided by percentage exercising 4 + hours weekly among those in response category 'not important at all'.

physical activity is important for good health, few respondents cited health benefits as the most important reason for being physically active [data percentages are not reported].

Three exploratory studies have investigated the role of intrinsic motivation in activity (Biddle & Armstrong,1992; Whitehead, 1993; Frederick et al., 1996)[12] and an extrinsic / intrinsic motivation scale was also used in the Northern Ireland Fitness survey (Riddoch, 1990). The motivation to do something for its own sake in the absence of extrinsic rewards is reported to be related to feelings of mastery, control and self-determination (Deci & Ryan, 1985). Biddle and Armstrong (1992) found that intrinsic motivation was significantly and positively correlated with 11-12 year old boys' activity. On the other hand, more active girls showed a tendency towards extrinsic autonomous judgement, and dependent on the teacher's opinion both about what to do and about their performance. Active girls were also motivated more by a preference for easy skills than challenging tasks. The authors suggest that results reflect socialisation factors, where it is more socially acceptable to be involved in sports as a boy.

The findings imply that creating social enjoyment, rather than physical challenge, may be more important for motivation of girls in the 11-12 year age group, whereas boys of this age can enjoy physical activity for its own sake. The low statistical power associated with the small sample size of this study [n=72] is however, acknowledged by the authors. The relative homogeneity of the sample also limits the applicability of these findings to the primary school population. Frederick (1996) and colleagues found extrinsic motivation to be predictive of exercise adherence in college years, but for males only. In the Northern Ireland adolescent study (Riddoch, 1990), the number of boys who played sport for extrinsic reasons decreased with age, intrinsic reasons becoming more important, whereas girls were generally extrinsically motivated, and there was little change with increasing age. Riddoch (1990) considers that this may go a little way in explaining the difference in activity participation between boys and girls in the older age groups. Intrinsically motivated boys may continue in sport for sheer enjoyment, and may be less affected by changes in their social and cultural life.

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12 Text of study by Whitehead (1993) is not available in published copy.

Intrinsic motivation may be a critical factor in the achievement of lifetime health objectives. Dishman & Dunn (1985) highlight the significance of distinguishing between abstract value endorsement (opinion learnt from health propaganda e.g. 'exercising to make your health better') and concrete, personal rewards or personal investment when physical activity attitudes are assessed. The implications of this distinction for predicting actual behaviour are clear, because, according to these authors, the reinforcement properties implied by enjoyment are greater than those implied by value. In other words, the habit of regular physical activity is more likely to persist into adult life when motivation is internalised, and when physical activities have intrinsic value.

3.2.4 Knowledge

Early health education campaigns reflected a very simple understanding of youth health behaviour which linked knowledge directly with behaviour. The assumption was that well-informed young people would respond in a medically rational way to information about future health risks. Studies conducted in the 1960s and 1970s however, showed consistently that the provision of information about health risks was rarely effective on its own in achieving sustainable health-behaviour change (Thompson, 1978). Research at this period further cautioned against simplistic interpretation of data as supporting a causal relationship between health knowledge and exercise behaviour (Iverson & Portnoy, 1977). Children who exercise more may be more likely to learn about health, and/or other covariants, e.g. initial knowledge, social class, may be predictive of both health knowledge and exercise frequency. An interaction between social class, gender and health knowledge is confirmed in the results of the recent Irish Lifeskills for Health Promotion project (Nic Gabhainn & Kelleher, 1995). In the sample of 13 year-olds, there was an independent main effect of social class on knowledge scores, [$F=7.54$ (df 1,210) $p<.001$], manual classes having lower scores.

Some studies of multiple health behaviours have indicated that health knowledge is an important influence on activity behaviour. For example, in a study of children's health behaviour [grades 4 -7], (Luquis et al., 1995) attitude and knowledge were significant and independent predictors of behaviour (including physical activity) and together with age and sex, accounted for 25% of the variance. In contrast, in the study of Irish adolescents (O Reilly & Shelley, 1991), while knowledge levels were high, there was no significant associations between knowledge score and any of the health behaviours studied. Early reviews of the relationship between exercise knowledge and behaviour in youth have suggested that knowledge about the health effects of activity is not important (O Connell et al.,1985; Kirscht, 1988). Knowledge about physical exercise failed to correlate significantly with exercise intent or current behaviour in the study of adolescents by Ferguson et al.(1989), although in Gottlieb & Chen's study (1985), heart knowledge was significantly related to exercise frequency [$F = 21.64$, $p < 0.001$]. In the study of 5th and 6th grade children by Stucky-Ropp & Lorenzo (1993), exercise knowledge assessed by factual (true/false) questions, accounted for less than 1% of the variance in children's exercise behaviour. Borra and colleagues (1995) reported that virtually all respondents aged 9-15 years (n=410) in their survey agreed that regular physical activity is important for good health, indicating that children recognize the value of physical activity. These children however did not prioritise health reasons as their motives for participation. As no cross-sectional data were reported, it is not possible to prove the absence of a linkage, or identify a relationship between health awareness and exercise participation.

Very positive results however have been found in relation to children 'at high risk', i.e those with elevated serum cholesterol and the obese. For these children, nutrition and activity education have been shown to improve both dietary and physical activity patterns (Epstein et al.,1987; Dietz, 1991; Phinney, 1992; Badruddin et al., 1993; Foger et al.,1993). Badruddin and colleagues' study, for example, found that, following education and counselling of both parents and children in the former risk category, the activity level increased significantly in both the 5-9 year and 10-14 year olds ($p < 0.05$ to $p < 0.005$) in a 21 month follow up assessment.

For the general school population however, factual information on the effects of exercise on health appears to be a non-significant influence on current activity behaviour, although the long-term influence on behaviour remains to be tested. Different methods of presenting information need also to be investigated. Children may respond more positively to social modelling, including sports star modelling, especially when portrayed via film media. In smoking education intervention programmes, social modelling films have made positive use of role models, both for the reinforcement of positive health behaviour, and of future behavioural intention (Evans, 1981). Placing emphasis on the positive facets of a health behaviour is facilitated in physical activity promotion, as the core message in the adoption of this behaviour is concerned with salutogenic processes. Providing young people with "skills for life" has been found to represent an attractive option when compared to persuading them not to smoke or not to take alcohol and other drugs (Nutbeam, aaro & Wold, 1991). Similarly, providing children with 'activities for life' may be a more effective education medium.

In summary, attitudes about physical activity in general appear to be moderate correlates, whilst enjoyment of activity has a consistently strong relationship to exercise. Hence enhancing children's enjoyment of physical activity may have far-reaching effects. Beliefs such as self-efficacy, and health knowledge appear to be inconsistently related to activity. It is inherently plausible however that these variables may have delayed rather than immediate impact. Such a hypothesis is congruent with the philosophy of physical education and with current discourse on the long-term objectives of primary school PE (Leigh-Doyle, 1992).

3.3 Physical environment factors

One broad category of physical environment characteristics may be thought of as time and place factors. Influences on physical activity within this category include climatic conditions and the changes of the seasons, nature with its waterways, coastline and topography, population density and the industrial and occupational structure.

3.3.1 Influences of season and climate

Children are less active in the winter than in other seasons. Weekly activity time reaches its low point in the winter at 47% of the summer level (69% of the annual average). In spring, weekly activity time increases to the annual average (Ross et al., 1985). Due to the sedentary nature of school, children appear to be more active on the weekends and at non-school attendance periods. Within the school year, there appears to be little variation in activity levels. No significant differences were detected in a three day monitoring of a small sample (n=24) of British children during the autumn and summer terms (Armstrong & Bray, 1990). Activity levels however would be expected to vary in schools which have no indoor PE facility and/or a weather dependent outdoor play area. Percent of time spent outdoors is strongly related to children's physical activity. In the study of pre-school children (aged 4 years) by Sallis et al.(1993), time spent outdoors was the variable with the strongest association with children's physical activity (coefficient 0.613 Z value 3.32 p=.001), replicating earlier findings of Klesges et al.(1990) with this age-group. In the study of 11-13 year olds by Ferguson et al.(1989), participation in outside sports activities was a significant and independent predictor of current exercise behaviour (coefficient: .13 p =.0003).

3.3.2 Geographic location

Small variations in urban and rural participation in activity have been observed. Children in lower populated areas (<1,000 inhabitants) were observed to have lower activity levels (Sunnegardh et al.,1985), but similar fitness levels (Seliger, 1970; Shephard et al.,1974) as their urban counterparts. Adolescents in the Young Finns study (Telama et al.,1994) living in sparsely populated areas in the country participated less in sport activities than those living in conglomerations of people and much less than their urban counterparts. Only 5% of boys and 4% of girls categorised as 'active' in this study resided in the rural regions, explained perhaps by the fact that services of sports clubs do not reach these locations. Society in Finland, like Ireland, has become urbanized to the degree that the majority of the population live in urban conglomerations, yet a large number of children still live in sparsely populated areas. Contrary to Telama and colleagues' findings, Shephard et al. (1980) found no difference in provision of community sports facilities in rural areas of Canada. Given the strong rural participation in Irish national games, and the wide regional infrastructure of the national games organisation, the GAA, variations betweeen rural and urban participation may not be marked.

In many rural areas of Ireland however, consolidation of school districts has led to increased bus and car transport and also diminished opportunities for walking and cycling to school. For these children, not alone is the level of habitual physical activity reduced, but time available for recreational activity is also diminished.

Mobility constraints and levels of autonomy granted to children have been studied by Hillman and colleagues (1990) of the Policy Studies Institute. In a comparative time period study of English children aged 7 to 15 years, they observed that nearly four times as many children were chauffeured to school in 1990 as compared to 1971. This reduction indicates that the measure of daily activity normally attributed to travel to and from school is rapidly declining. Differences between levels of autonomy of British and German children were also noted in this study. Only 35% of British junior schoolchildren were allowed to come home from school alone compared to 91% of German children. Restrictions on cycling activity are also substantial, with 25% of British junior cycle owners (91% own cycles) and 34% of German children (88% own cycles) allowed to ride on main roads. Hillman notes that differences in attitude and legal prescription between the two countries signify important divergence. Legal prohibition on street playing in Germany, for example, is compensated for by comprehensive provision of recreation facilities. Hence, requests by children to travel to 'designated' areas are more likely to win parental support than requests to 'go out and play'. Imposed safety constraints on Irish children's activity in some urban areas may be contributory to children seeking alternative (sedentary) leisure activity.

3.3.3 Community facilities

Access to physical activity facilities and programmes may be considered a third type of environment factor. Regrettably little empirical study has been made of this domain, and few measures of physical environment variables exist. Proximity of physical activity facilities is associated with physical activity levels of adults (Sallis, Hovell et al.,1990), and it is suggested to account for urban/rural variance in children's activity (Telama et al.,1994). Children in Denmark who were members of local community clubs were observed to be more active than non-members of such organisations (Holstein & due, 1990). Children in the lower socio-economic echelons of rural society be at a disadvantage in terms of transport and access to a variety of activity programmes which are organised in urban centres. On the other hand, rural Irish children are well served by an extensive network of Gaelic games organisations. Environment infrastructure in terms of safe walkways, cycle paths and play areas also influence the patterns of out-of-school habitual activity. Although there are no comparative statistical data, patterns of cycling to school in Ireland are likely to differ from those in countries where public provision of cycle paths is an infrastructure norm.

3.3.4 Television viewing

A frequently studied environmental variable is television viewing. Television is a ubiquitous part of the environment of children and adolescents that encourages sedentary behaviour. Although television viewing may generally be regarded as antithetical to physical activity, the evidence is equivocal. There is little indication that children who watch the most television are the least active (Taras, 1989; Robinson et al.,1993). Cross-sectional and longitudinal studies however show an association between hours spent viewing television and body fatness, and television viewing does appear to be a strong predictor of obesity in children (Dietz & Gortmaker, 1985; Gortmaker et al., 1987; Fontvieille et al.,1993; Robinson et al.,1993). Some have reported that metabolic rate may be suppressed below the normal resting rate in children while they watched television (Klesges et al.,1993), although recent research refutes this finding (Dietz et al., 1994). Certainly the average viewing time of two and a half hours per day reported for Irish children (Morgan, 1994), and a similar viewing mean reported for other European children (King & Coles, 1992), reduce the time available to be active.

There may also be a role in which television can stimulate physical activity. Children's modelling of sports stars viewed on television may prompt increased participation in the activity viewed. Such media influence is likely to be considerable during preadolescence, when sports-star role playing is characteristic of activity behaviour. Increased playing of a sport which receives high media profile is typical. This can be observed for example in the World Cup Football period, and weeks circa and post Wimbledon tennis championships. Media predominance generally given to male competitive sport however may result in more extensive role modelling behaviour by boys than by girls. Such gender effects, and the whole role of TV and advertising media in exerting positive influences on physical activity, have not to-date been studied.

3.4 Social environmental influences

Physical activities occur within a social context, and they also provide the medium in which socialisation may occur. The individual is socialised into a specific role, for example, a physically active or inactive lifestyle, a sports participant or spectator. The individual is also socialised through specific roles into the learning of more general attitudes, values, and so on. Studies suggest that socialisation into a physically active lifestyle begins early in life (Malina, 1994). At older ages, the situation is more complex and probably involves an interaction between socialisation processes, that is, into and through physical activity. Although a major gap within the early sport socialisation literature pertains to the virtual absence of research on younger children (Lewko & Greendorfer, 1988), recent studies of activity behaviour answer some of the questions of how family, peers, and school shape children's socialisation into an active lifestyle. The role of the school in the socialisation process is perhaps the least informed.

3.4.1 Socio-economic status

Epidemiological evidence has demonstrated that health and illness are largely socially constructed (Mitchell, 1984). Qualitative research has contributed to this observation, identifying relevant social and cultural constructs in health behaviours. Respondents in two recent U.K. studies, for example, regularly accounted for health and illness, and their associated behaviours, in terms of individuals perceived social circumstances and obligations (Backett & Davison, 1995). WHO researchers have reported that the lifestyle of an individual, or of individuals belonging to a specific population subgroup, is related to the socio-economic circumstances and by the resources available to its members (Wold & Aaro,1985; Aaro et al.,1986). Certainly a very general phenomenon observed is the tendency for children from low status segments of the population to develop health habits which are not favourable to health. This was demonstrated by Wold & Aaro (1985) to be the case in young people as far as exercise is concerned. Additional analysis of the data however, showed moderate associations with father's occupational status, indicating that socio-economic inequality may explain only a part of the study findings (Aaro et al.,1986). Factors other than occupational status are inextricably linked in lifestyle behaviours and lifestyle choices. Given the close relationship between health and social constructs therefore, it is hardly surprising that critics of individualism in both health education (Townsend & Davidson, 1982; Hyland,1988) and physical education (Kirk & Coloquhoun, 1989; Coloquhoun, 1990) argue that individual lifestyles pale into insignificance beside the structural inequalities which militate against healthy living.

In adult activity studies, education and income are consistent and powerful correlates of physical activity habits (Dishman & Sallis, 1994), although research acknowledges the difficulty in some studies of disentangling the effects of ethnicity and socio-economic status (Sallis et al.,1993). Sociometric variables have not been as extensively investigated in studies of children, although clearly, socio-economic status is a major covariant of the type of physical and social environments to which the child is exposed repeatedly. Absence of data may in part be due to difficulties inherent in measurement of parents' occupational status based on children's answers. Many answers may be too unclear to be properly coded. Low reliability and validity is therefore assumed, and correlation with health behaviours can be expected to be underestimated.

As in adult studies, ethnicity and socio-economic status appear exert an interactive influence (Fontvieille et al.,1993; Wolf et al.,1993; Bernard et al.,1995). Pima Indian children, for example, were found by Fontvieille and colleagues (1993) to have decreased physical activity in comparison to Caucasian children of a similar age. In this study, the difference between girls' sport leisure activity was highly significant ($p < 0.01$), while Pima boys showed significantly lower activity than Caucasian boys ($p < 0.05$). A sample [n=100] of mildly malnourished Senegalese children aged 10 -13 years was studied by Benefice (1992). Motor skill test results were inferior to those of Western children and the level of their physical activity appeared also to be low. Contrary to these findings, in a multiracial cohort of 1,245 U.S. adolescents (Aaron et al.,1993), socio-economic status was not found to be a determinant of activity levels in either males or females aged 12-16 years. A significant racial difference was found in this population, with whites reporting more activity than nonwhites ($p < 0.05$), but after adjustment for intensity of exercise (MET-hours / week), this difference was no longer significant. In a large multiethnic cohort study (Sallis et al.,1996), few ethnic differences were found on summary physical activity or physical education variables, but both ethnic and socioeconomic differences were found in 10 of 25 potential correlates of physical activity. It is suggested that absence of differences between socio-economic groups on this health behaviour may be a result of an equal access and exposure to physical activities while in school (Aaron et al.,1993), thus negating any impact of socio-economic status on the activity levels of this age-group. Whether this argument would be valid for other age-groups, and could be applied in a cross-cultural context, is very much dependent on parallel provision of school PE and extra curricular physical activities.

Health and well-being analysis in Steptoe and Butler's cohort study of British children (1996), showed that greater emotional distress and somatic symptoms were reported by young people from less privileged backgrounds, [std. regression coefficients, 0.039, p=0.01; 0.094, p=0.001] and hence social class was suggested to be a potential confounding factor in the relationship between emotional well-being and sports participation. The independent effect of social class on sports participation however was not reported in the study. In the YPLL survey of Scottish adolescents, the associations observed between social class [measured by parent's educational and occupational status] and physical activity led the authors Hendry and colleagues (1993) to conclude that ... "within differing lifestyles ..[a variety of working class lifestyles, a variety of middle class lifestyles] adolescent psycho-social and leisure transitions appear to be predicated by elements of social position and material resource." [13]

It is inherently plausible that socio-economic status and parental influence exert an interactive effect on children's physical activity. This may not be readily apparent in univariate analysis. For example, availability of transportation by parents to sport and fitness activities has been shown to be significant in the physical activity levels of 9-year old children (Sallis, Alcaraz et al.,1992). Such support is unlikely to be available to children in the lower socio-economic groups. Similarly, purchase of sports equipment items by parents is a factor which favours privileged children, and the volume of such in a household has been shown to be related to activity (Stucky-Ropp & Lorenzo, 1993).

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[13] Hendry, L. B., J. Shucksmith, J. Love and A. Glendinning, 1993. *Young people's leisure and lifestyles*. London: Routledge. p.174.

The nature and extent of such interactive influences warrants further investigation.

In earlier studies, father's occupation has been shown to be a key component of social status in determining opportunities for sports participation by children (Kenyon & McPherson, 1973). Successive studies of Swedish children have also reported associations between father's educational level and daughter's physical activity, pointing to lower physical activity among girls of low-income families in Sweden (Eriksson & Gedmundsson, 1966; Engstrom, 1972; Sunnegardh et al.,1985). However, in a study of adolescents' (7th and 8th grade) activity by Gottlieb & Chen (1985), of the sociocultural correlates examined, father's occupation had the smallest relationship to exercise frequency [$F = 3.88$, $p < 0.05$], and in the Young Finns longitudinal study (Telama et al.,1994) socio-economic situation of the family as measured by father's occupational status did not correlate systematically with the child's participation in sport. Among Norwegian schoolchildren (Nutbeam et al.,1989) neither father's nor mother's occupational status were significant predictors of physical activity, although non-manual work of one or both parents was associated with more physical activity and several other health enhancing behaviours. In the Danish socio-medical study, significant differences between children of differing socio-economic backgrounds were observed (Holstein & Due, 1990), activity levels being highest among middle-class children. Children of unemployed parents were the least active of all Danish children in the sample ($p < 0.01$), with 49% of this group exercising less than 1-hour weekly. In a summary statement, Danish researchers, Holstein & Due (1990) conclude that.. "it is not important where you live, or what type of family you live in, but exercise activity is greatest among middle-class children" [translation].

Given that in studies of Irish adults (IHF, 1994; Mcauley, 1994), participation in physical activity is lowest among both men and women in the manual social classes, parallel patterns of children's physical activity might be assumed, but this relationship has not been investigated. Understanding the effects of ubiquitous social-environmental factors on children's physical activity is important, in that it is prerequisite to the structuring of appropriate educational and social policy, and to the identification of population groups that may benefit from intervention.

Lifestyle, as defined by Aaro (1986), is inclusive of patterns of behaviour, habits, attitudes and values, which are not necessarily in harmony with the groups an individual belongs to, as long as these patterns are anchored to other reference groups. This concept of lifestyle infers that change in health-related aspects of lifestyle may be effected through such non-material resources as support from significant others. Hence children may, with support from clubs, school and significant others, lead active lifestyles which are not necessarily family supported or parent role-modelled. It is also accepted however, that the ease with which an individual may choose certain lifestyles over others varies (Aaro et al.,1986), and lifestyle association with socio-economic circumstances is widely affirmed.

3.4.2. Parental influence

The changes in the process through which children become socialised and independent do not seem to have altered the fact that a prerequisite for children's participation in sport is a positive attitude and support from the parents. Primary socialisation in the family unit is one of the major influences on health-related behaviour patterns formed early in childhood (Gochman, 1988; Sallis & Nader, 1988; Sallis et al.,1989). As children move towards and through adolescence, developmental psychology suggests that the influence of parents on most types of behaviours weakens and the influence of peers strengthens (Buiirmester & Furman, 1987). In studies of activity behaviour, a parallel line of parental influence has been observed, but the direction of peer influence is not clearly defined. Consistently positive associations have been reported between parental encouragement of activity and young children's immediate physical activity (Greendorfer & Lewko, 1978; Higgenson, 1985; Klesges et al., 1986; Klesges et al.,1984; Sallis, Patterson et al.,1988; McKenzie et al., 1991), while fathers in particular have more influence on the sport participation of both male and female children (Greendorfer & Lewko, 1978). There is only one study of the younger age-groups (Sallis et al.,1993), which provides evidence to the contrary. Parent-adolescent physical activity associations however are weak (Godin et al.,1986; Anderssen & Wold, 1992), and in sport participation, there is evidence to suggest that as the child reaches adolescence the influence shifts from parents to the teacher/coach (Higgenson, 1985). The diminishing influence of parents in the adolescent years seems particularly plausible, as in this period many children become critical of parental authority and are seeking other role models among their teachers, coaches, peers and sport heroes (Cloutier, 1982). A recent survey of 410 children aged 9-15 years (Borra et al.,1995), reports in its findings that parents rank among the most influential sources of encouragement to be physically active (59%), while friends and schools/teachers were mentioned as sources of encouragement by 53% and 40%, respectively. There is little analysis of data however in this study, and error allowance in the telephone interview method is acknowledged by the authors.

Potential mechanisms of parental influence include the role of modelling, reinforcement, environmental prompts and other dimensions of family influence such as mobility opportunities (Sallis, Alcaraz et al.,1992) mobility constraints (Hillman et al.,1990), behaviour reinforcement (Perry et al.,1988) and such consumer behaviour indicators as the amount of exercise-related items in the home (Stucky-Ropp & Lorenzo, 1993). Certainly the role of parents in children's sport has increased, because children are steered to organised sport younger and younger. In a commentary on the growth in sport programmes for US children in the last two decades, Berryman (1988) cites concomitant changes in the American family structure. One such family system is characterised by a significant amount of the family's time, money, and emotional energies focused on the youth sport activities of children. While the socialisation research has pointed to the important role of parents, especially fathers, prior to the 1980's very little was known about specific contributions that parents make to their children's sport involvement (Lewko & Greendorfer, 1977). The exact mechanisms are still unclear, although recent research has begun to identify certain variables by which parents influence children's activity participation.

A study of 4th grade children (Weitzer, 1989) found that for both boys and girls, greater parental influence was associated with higher levels of involvement in sport, and for girls only, greater parental influence was related to higher perceptions of personal physical competence. In a study of 5th and 6th grade children, parental support (measured by mother's report of family support) was observed to be a significant predictor of exercise behaviour (Stucky-Ropp & Lorenzo, 1993), contributing significantly to the predictive ability of the model for boys with an r^2 increase of 0.01 [F (94,116) = 4.37, p < 0.01] and for girls, an r^2 increase of 0.02 [F (93,117) = 4.32, p<0.01] [14]. Parents' verbal encouragement to be active was not significant in any model in the study of 9-year-old children's physical activity and fitness (Sallis et al.,1992). Armstrong (1994) has suggested that the origins of low physical activity patterns of teenage girls may lie in parental attitudes. Two contributing factors have been cited (Lewko & Greendorfer, 1982). Parents encourage gross-motor behaviour at a young age more from their sons than their daughters and because exercise and sport have been sex-stereotyped as masculine in our culture, boys may have more parental reinforcement for exercise than girls. This father-son relationship has been observed in a variety of sport settings (Sage, 1980; McElroy & Kirkendall, 1981; Berlage, 1981; Scanlan & Lewthwaite, 1986). In the Young Finns study (Telama et al.,1994) the father's impact on boys' active participation in sport was particularly clear at the age of 12 to 15 years.

The effects of parental modelling have been examined via parent-reported activity measures, children's perceptions of parents' activity, and by Caltrac monitoring. Of the self-report measures, the former is considered to be the more reliable indicator. Mothers' role modelling in the study of Stucky-Ropp & Lorenzo (1993) was predictive of activity for girls only, and contributed an r^2 increase of 0.011 [F (5,115) = 3.24, p<0.01]. In a study of 9-year old children (Sallis, Alcaraz et al.,1992) which used objective measures for children's activity, neither parents' reported physical activity nor parents' verbal encouragement were associated in any analysis with child activity. In Romanella and colleagues' study (1991) of mothers and children's activity as measured by Caltrac monitors, no significant relationships between parent and child were found in either activity levels or attitude towards activity. Absence of such a relationship pertained to both obese and non-obese children. Similarly, Godin et al. (1986) found no significant association between children's perception of parental exercise patterns and their own like habits, whereas children of parents who were physically active in the Young Finns study (Telama et al.,1994) were significantly more active and participated in sport more than children of passive parents.

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14 The increase in r^2 does not indicate what proportion of the unexplained variation this increase constitutes (Norusis,1983)

The influence of parental modelling has also been observed in 4-to 7-yr.old children (Moore et al., 1991) and familial aggregation has been reported in a study of 5- to 9- yr. old children (Freedson & Evenson, 1991). Both of these studies used objective activity measures. In the former activity study, when both parents (n=200) were active, the children were 5.8 times as likely to be active (95% CI = 1.9, 17.4). In the latter study, familial resemblance [using chi-square analyses] occurred in 67% (father and child) and 73% (mother and child) of the families. Using the CAL REC,[15] familial aggregation was present in 70% (father and child) and 66% (mother and child) of the families (Freedson & Evenson, 1991). In the 6-18 year old age cohorts studied by Telama et al (1994), the fathers' impact on boys' participation was particularly clear at 12-15 years. Of the 12-year old boys categorised as 'active', 60% were sons of 'highly active' fathers, compared to 23% of 'active' girls.

The parental role as gatekeeper of access to activity and sport facilities was shown by Sallis, Alcaraz and colleagues (1992) to be significant (or nearly so) in two regressions for 9-year old boys [n=148] and in one regression for girls [n=149]. This factor however has not been investigated with other age groups and deserves further study. It is likely that parents' own physical activity may strengthen the idea fairly common among parents that competitive sport makes a good environment for children's development, thus active parents may be more likely to act as gatekeepers of access. For the majority of children, the parental role in physical activity behaviour is viewed as positive and supportive. There are, however, some parents who are so interested in children's sport that they press them to so do, and this may result in parent-child conflict or youth sport withdrawal (Hellstedt, 1988; Scanlan & Lewthwaite, 1988; Hellstedt, 1990; Ommundsen & Vaglum, 1991).

Different factors appear to operate to influence leisure activity among young people over the childhood and adolescent years. Thus while in early childhood the behaviour of

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[15] Caltrac Activity Record (CAL REC). An activity self-report completed by parents for themselves and their child

parents is of crucial importance, later as suggested by Engstrom (1979) "...friends, school, other adults and the mass media play an increasingly influential role."[16]

3.4.3 Peer influence

Sociologically based research strongly suggest that the peer group is a prominent influence upon children's participatory involvement in sport, particularly during adolescence (Lewko & Greendorfer, 1988). In the wider lifestyle activity domain, peer-rated popularity / sociability factors have been identified as correlates of children's activity. Both sports participation and leisure-time activity have been linked to the development of inter-personal trust (Clark & Gronbech, 1987), increased levels of social interaction observed in free play (Hops & Finch, 1985), peer-rated popularity (Gross et al., 1985), and more frequent self-reported social activities (Mechanic & Hansell, 1987). Strongest support for the role of peers however, comes from findings of Holstein & Due's study (1990). Pupils in this study whose best friends were active were more active themselves ($p < 0.001$). This relationship did not apply to siblings or teachers' exercise habits. An important association observed in this study was the relationship between the measures of social integration and physical activity. The 'inactive' children had lower scores on all twelve social network indicators ($p < 0.05$), with the strongest associations ($p < 0.001$) observed on items describing rapport with friends, and usage of free time.

Studies of children in the 11-15 year age group suggest that peer influence on activity behaviour may be stronger for boys than for girls (Anderssen & Wold, 1992; Stucky-Ropp & Lorenzo,1993). In the latter study, friend modelling and support was predictive of activity for boys but not for girls. The friend modelling/support variable for males contributed significantly to the predictive ability of the model with an r^2 increase of 0.02 [$F(2,118) = 7.19$, $p<0.01$]. The accumulated evidence of parental and peer influences on behaviour suggests that peer support is an important factor in boys activity behaviour, whereas girls may respond more positively to parental support and reinforcement.

Emerging evidence of a link between social integration, its corollary, the 'new' psychosocial risk factor social isolation, and health and well-being provides new insight

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16 Engstrom, L.M. Physical activity during leisure time. *Scan. Journal of Sports Science.* 1979,11, 34.

into the role of children's peers (Eder,1989a; 1990). In earlier studies (Eder, 1988,1989b) a relationship was observed between risk behaviour - such as smoking, inactivity, drinking alcohol - and risk manifestations - such as poor reported health. Being an outsider appeared to change the correlation between risk behaviour and reported health. In a later study, indices of social integration, reported health, and happiness were construed using analysis of data from WHO Cross-National surveys on health behaviour of children [11, 13 and 15 yrs.]. In all countries surveyed, the amount of healthy children was at least twice as high among the integrated than among the non integrated, and in some countries the ratio was almost 1 : 4. Correlations were also observed to be higher for 11-year old boys than for 15-year old girls: that is, they were higher for the groups with a higher overall level of social integration and reported health. Thus, the social processes in the classroom society seem to have a reinforcing effect on an apparent feedback loop between social integration and somatically manifest well-being. Although causality cannot be assumed, Eder (1990) contends that impairment of health by lack of social interactions could be argued to contribute more to the causal loop than inability to socially interact as a result of impaired health.

Such a parallel was not found in a multivariate study of the health behaviour of children aged 11-13 years (Terre et al.,1992). This study, which included physical activity, found that peer popularity provided no significant increment in the prediction of health habits over and above the effects explained by demographics.

3.4.4 Community

Community organisations, both public and private, have long played a major role in providing structured opportunities for participation in sports and other forms of physical activity. Participation through these channels is highest among younger students and tends to decrease with age (Ross et al.,1985; King & Coles,1992). Community sport in Ireland, generally organised by clubs affiliated to national governing bodies, has considerable interaction with school physical activity in the coaching and promotion of games for youth and in the organisation of games competitions for primary schools. Associations between being members of community sports clubs and children's activity levels are implied in the data of the large Northern Ireland and European health surveys (Riddoch, 1990; King & Coles, 1992), although there is no cross-sectional analysis of data to confirm such associations. Cross-sectional analysis in the Danish study showed that 88% of those who exercised at least twice per week were active sports club members, compared to 49% among non-members ($p<0.0001$) (Holstein & Due, 1990), and as expected, participation in sports competitions was also observed to be higher among club members. In the longitudinal study of young Finns (Telama et al.,1994), participation in sports club training was a significant predictor[17] of participation in physical activity in young adulthood.

Dynamic school-community links ensure that the games and recreation activities that are a part of community life are integrated into the school programme (Department of Education, 1995). Such links have traditionally been formed in many Irish schools via the involvement of teachers in sports organisations and extra-curricular sporting activities with children. There is a belief that the increasing feminisation of the primary teaching profession in Ireland has reduced the input into male competitive sports, although the growth in primary school games participation belies such criticism. Reduction in 'voluntary work' by teachers however, will certainly affect the type of school-community relationship proposed in the above cited national education policy document.

3.4.5 Influence of the primary school

It is accepted that the primary responsibility for engaging children in opportunities to be physically active and learn physical skills rests with school physical education (McKenzie et al.,1993). It is disappointing therefore that the influence of the primary school on children's level of habitual physical activity has not been widely studied, and much of the information available is intervention-based. Of all the factors which influence physical activity, it is perhaps the least informed. Authors of the longitudinal study (Telama et al.,1994) which examined the relationship between grade point in PE and activity participation, found that GPE at 9-15 years was a significant predictor of participation

[17] Values in regression model not reported

three years later[18], indicating the positive longer term influence of school physical education.

Maintenance of health has always been a dominant ideology in physical education. The health emphasis in PE curricula however has been dictated by very different social conditions and demands over time. While earlier syllabuses were underpinned by health considerations of mainly short-term therapeutic value, the current pedagogical emphasis is on the development of lifelong patterns of recreational exercise and positive attitudes to physical activity. The lifestyle focus in the Irish primary PE curriculum is in line with core educational objectives of physical education, viz. the mastery and enjoyment of movement, and the acquisition of skills, knowledge and attitude which facilitate participation in activity after school, in adolescence and in adult life (Leigh-Doyle, 1992). The revised national curriculum [draft] seeks to retain the lifestyle health emphasis, defining PE as a process "which helps children to lead full, active and healthy lives" (NCCA, 1996). There has however been no evaluation of the pursuit and outcomes of PE curriculum objectives to-date, from either an educational or a public health perspective.

3.4.5 (a) Influence of intervention PE programmes

Although several PE curriculum intervention programmes have been described, and authors point to the measured success of some of these programmes, the findings are primarily concerned with physiological outcomes (Burke et al., 1995; Keays & Allison, 1995). Five studies (MacConnie et al.,1982; Dwyer et al.,1983; Maynard et al.,1987; Duncan et al.,1983; Siegel & Manfredi, 1984) documented that primary PE curricula which emphasised vigorous aerobic activities produced improvements in cardiovascular fitness and cardiovascular risk factors. Criteria in terms of fitness measures alone however are narrow indicators of success.

Some interventions in PE class teaching, with a focus on increasing the amount of moderate-to-vigorous activity (MVPA) within lessons, have also been described (Parcel

[18] Values in regression model not reported

et al.,1987; Simons-Morton et al.,1991; Simons-Morton et al.,1993; Simons-Morton et al.,1994). The intervention rationale of the combined physical and health education programme, the *Go for Health Project* (Parcel et al.,1987), was that cognitive and affective outcomes expected from classroom instruction can only be achieved if physical activities in school are of the appropriate intensity . Thus quite an extreme focus was placed on aerobic activity in PE lessons. While improvements in physical activity in PE classes were observed [in intervention schools percentage lesson time at MVPA increased from 10% at baseline to 40% at post-test] no measures of increased physical activity outside of school were reported (Simons-Morton, Parcel et al.,1991). The curricula in all of the studies cited above however, were not comprehensive approaches to physical education, and mere training or conditioning improvements are unlikely to produce active lifestyles in the long term.

Three studies which examined the effects of daily physical education sessions on primary school children (MacConnie et al.,1982; Sleap and Dwyer et al.,1983; Pollatschek et al.,1986) found no detrimental effect upon academic performance, distinct gains in increased physical work capacity but no improvements in activity outside the required exercise programme. Although MacConnie and colleagues construed that some portion of the total elevated heart rate scores (amount of time with rates >160 bpm) observed in the experimental group must have been due to additional vigorous activity initiated by the 6-7 year-old children themselves, outside the required intervention activity. In the Canadian experimental study (Shephard et al.,1980) which involved an additional 1-hour of school-based activity daily, some suggestion of a *reduction* in weekly leisure-time activity in the experimental group was observed, although these students surpassed the 'controls' in aerobic power and muscle endurance. Authors were self-critical of many of the study findings, and acknowledged that some of the responses observed in the study were a non-specific "Hawthorne" effect rather than a specific consequence of the increased physical activity.

It is regrettable that post-intervention measures of children's attitudes towards such PE programmes have not been included in study designs cited above. It is likely that such imposed frequency and intensity of activity may stifle enjoyment of early school activity experience, and reduce motivation for further exercise. Children's resistance to participation in compulsory, structured programmes of vigorous physical activity has been well documented (e.g. Cooper et al.,1975). Notwithstanding the accumulated evidence, recommendations of daily sessions of vigorous activity have been proposed by national sport and education authorities (British Sports Council, 1988; Department of Education, 1992), and the US Department of Health and Human Services (1994) set daily school PE as a health objective for the year 2000 [increase from baseline 36% of children to 75%]

Curriculum initiatives with a broad health education focus have attempted to influence lifestyles by providing education about the risk factors of diet, smoking and physical activity. The activity outcomes of such programmes are disappointing. The Australian programme which used a self-reporting technique via *The Body Owner's Manual* children's workbook (Worsley & Coonan, 1984), reported health knowledge and health status improvements, but no increases in leisure time physical activity. The results of the American *Know Your Body* programme showed similar increases in health knowledge but none of the desired changes in body mass, physical fitness or blood pressure were achieved (Walter et al., 1988). The American *Heart Smart* programme added an imaginative dimension to the evaluation process (Downey et al.,1987), in seeking to compare the effectiveness of 'population' and 'high-risk' approaches. The results of this programme are still awaited. Earlier projects which have directly involved parents in effecting behaviour change however have been found to be expensive and less than optimal (Nader et al., 1983, 1989; Hopper et al., 1992). Results of these studies indicated that including the family was primarily effective in facilitating nutrition knowledge rather than in diet and exercise behaviours, and in Petchers' study (1992), the increase in knowledge was observed to be achievable via school alone. Positive results of family-based interventions however have been reported in effecting behaviour change with obese children (Epstein et al.,1987; Badruddin, 1993).

An intervention project in a Texas school district by Simons-Morton and colleagues (1991) was specifically designed to improve children's diet and physical activity behaviour while at school. The three intervention components were classroom health education, vigorous physical education and lower fat, lower sodium school lunches. The measure of MVPA (by observation) in PE lessons was 10% of class time at baseline, increasing to 40% of class time at post-test (Simons-Morton et al.,1991). The authors conclude that the feasibility of improving physical activity at school is demonstrated in this study.

An educational intervention has been developed towards the creation of positive health lifestyles for schoolchildren in Antigua, one of the countries of the English-speaking Caribbean in epidemiological transition. Following 30 years of socio-economic change, obesity and chronic diseases have almost replaced malnutrition and infectious diseases as public health problems in these countries. "Project lifestyle" is an intervention programme for grades 1-12, modelled on risk interventions in developed countries (Sinha, 1992). The programme was originally perceived as inclusive of a daily PE component, but this proved to be impracticable in many schools. Teachers aimed for a thrice-weekly PE period. The project concept was commendable in that it was not to be conducted under experimental conditions, as are many intervention projects, but replicated in all schools nation-wide The in-service training of teachers for the programme however was limited, and Antigua's specialist teachers, who helped to devise exercise guidelines, were acknowledged in the report to be much less professionally qualified than in developed countries. Pre-intervention and post-intervention questionnaires were planned for schools, but the results of the project have not been published to-date.

A recent Irish health education intervention (NicGabhainn & Kelleher, 1995), which includes physical activity behaviour, is a four year school project based on the principles of a Lifeskills teaching model for self empowerment. In project evaluation, comparisons of activity levels between control and intervention (Lifeskills) groups, were based on the aggregate measurements of post-primary school students and 3rd and 4th class children in primary schools. The Lifeskills group did not perform well in terms of exercise participation, 44% of the children exercising 4-6 times per week or more in comparison to 49% of the reference children. In relation to amount of time spent at activity, there were no significant differences among the schoolchildren. Results of these studies clearly indicate that broad health education intervention programmes are not effective in achieving activity behaviour change, and confirm earlier conclusions of Terre and colleagues (1990) that targeting of health behaviours might be better achieved if intervention measures were multifaceted and behaviour specific.

One Irish physical education intervention project was designed to.. "improve the health and well-being of children in the 9-member primary schools and to broaden their participation in sports and leisure" (PEP, 1992). Post-intervention measures of fitness of children in four of the selected schools were reported by one of the project directors. There were however no pre-intervention measures of either children's fitness or participation in sports and leisure, thus the results and commentary on the intervention are meaningless. The study provides no measures of children's attitude towards PE, an important outcome of an intervention project, nor any data on children's extra-curricular participation in sport.

More positive outcomes have been achieved in British and U.S. activity intervention programmes which focus on the quality of primary school PE (Abbott & Farrell, 1989; McKenzie et al.,1993). Specially selected class teachers in the British *Staying Well* project used the approach of applied learning through experience with a small experimental group (n=55). The computation of the pre-post percentages change values indicated that, between the four groups, there was a highly significant increase of children reporting that they belonged to a sports group or class either in or outside school ($F, (3,107) = 4.44$ $p < 0.01$), the change in activity participation being much higher for girls. Similarly, compared with the boys, the girls reported the most significant increase in local facility usage ($t = 2.84$, $df=109$, $p<0.01$). Another important observation of the study was the overflow effect to other school pupils and family. Findings from such a homogenous population however (middle-class schools) have limited application to the school population at large.

McKenzie and colleagues' study (1993) evaluated the effects of a combined health-related curriculum and teacher in service programme on quality and quantity of PE lessons in a 28-class sample of 4th grade children. Students in the intervention conditions had substantially more opportunities to be physically active and learn physical skills, as in service teachers allocated more curriculum time to PE than 'controls' [72.5% vs. 17.5% of standard 90 min per week]. There were however no significant differences in the amount of activity within the lessons taught by the intervention and control teachers. Regarding lesson content, children in intervention classes were provided with more time for fitness activities (8.5 vs.4.2 min per lesson), skill drills (4.1 vs. 1.7 min per lesson), and general knowledge (4.2 vs.1.0 min per lesson) than those in control classes. While this study did not measure carryover effects of intervention PE teaching to children's leisure-time physical activity, results indicate that a combined curriculum and in service programme is a direct mechanism for augmenting children's school activity experiences.

Results of the *Child and Adolescent Trial for Cardiovascular Health* (CATCH), a 3-year multi-site intervention research study (Perry et al., 1990) were published in 1996 (Luepker et al.,1996), and the effects upon psychosocial determinants of the behaviours studied were also documented (Edmundson et al.,1996). The activity component of this health education study was focused on increasing moderate to vigorous physical activities in PE lessons, and a family-based exercise intervention in the home environment to improve out-of-school activity. The percentage of PE class time devoted to MVPA significantly increased in the intervention schools compared with the control schools, surpassing the study and US Year 2000 goals of 50% of class time.[19] Results from the activity recalls (after school) indicated significant increases in vigorous activity in the intervention students (58.6 minutes vs. 46.5 minutes, $p<.003$). The authors acknowledged that the magnitude of the changes in physical activity across the population (n=5106), while statistically significant, were modest. In a research commentary however, Garrison, Klesges &Applegate (1996) considered the results to be important and understated. Certainly the programme offered methods for elementary schools to improve students' health through increased physical activity and better eating patterns, and from the public health and preventive medicine perspectives the study

[19] US Public Health Service. *Healthy People 2000: National health promotion and disease prevention objectives.* Washington, DC: US Dept of Health and Human Services; 1990. DHSS publication (PHS), 91-50212.

findings were important. Findings related to the psychosocial determinants of activity behaviour were disappointing. Intermittent effects only were observed for perceived support and self-efficacy for physical activity, and the authors point to a need for greater understanding of both adolescent developmental issues and the role of community environment in creating effective curricula (Edmundson et al.,1996).

3.4.5(b) Potential influences of organisational factors in primary PE

Time

While allocation of curriculum time to PE is defined by education authorities, the practice of teaching the required lessons is in many schools discretionary, and such discretion is evidenced in McKenzie's study (1993). Figure 3.2 shows the statutory time allocated to physical education in both the United Kingdom and Ireland, and the comparative allocation in other European countries[20]. The most recent British primary school survey however showed that 25% of schools allocate two hours per week for the PE programme, and a further 25% allocate 1.5 hours per week (CCPR & NAHT, 1992). A survey of Irish primary schools (Deenihan, 1990) reports that the average time devoted to PE for each class varies from ten minutes to one hour per week. In the school classes surveyed, 75% of classes had less than 30 minutes physical education per week. The recommended curriculum allocation in Ireland is one hour per week. Inability to meet this minimum requirement may in the case of large school enrolment be due to the logistics of sharing an all-purpose area amongst a number of teachers and amongst other space-dependent school activities. The monitoring of curriculum teaching lies ultimately with the Department of Education. The disparity in time devoted to children's physical education may result in clear disparities in children's physical activity experiences and their socialisation into active lifestyles.

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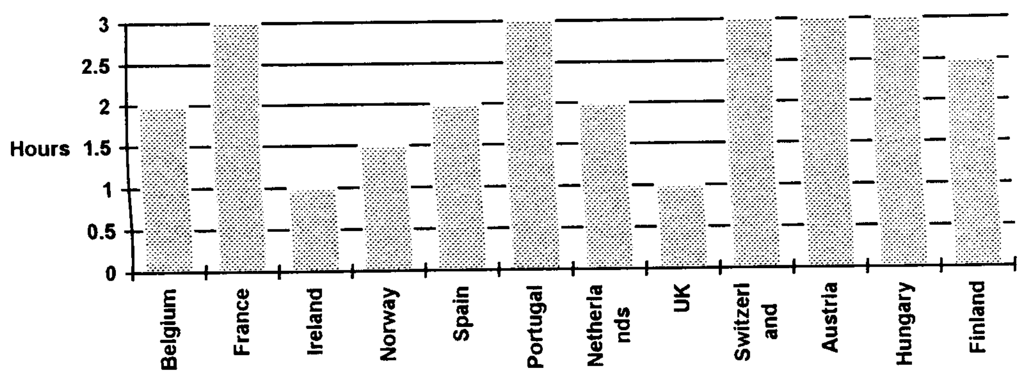
20 Where allocated time may be selected by schools from within a 1-or 2-hour band, the higher allocation is shown

Figure 3.2 *Hours of physical education per week in European primary schools*



Class size

Average class size is also a factor which may impinge upon the quantity and quality of children's PE experiences. The most recent statistical report shows that, in Ireland, almost 6,000 primary school children attend classes with 40 or more pupils, and a further 249,525 pupils are in classes with between 30 and 39 pupils. (Department of Education, 1995). The management of large classes at activity, and the attendant safety concerns, places considerable physical and pedagogical demands on the non-specialist teacher. Class size thus may limit or dictate the diversity of curriculum activities explored.

Access to a suitable PE teaching facility must also be considered in the context of the range of activities children may experience in school PE. A 1990 survey of Irish primary schools reports that 30% of schools surveyed had no indoor facility for PE (Deenihan, 1990). The number of schools without access to an indoor facility is reported by the Irish National Teachers Organisation to be as high as 48% (INTO, 1995). The most recent Department of Education information, currently being compiled, confirms that 48% of schools have no indoor teaching facility.[21] It is generally the case that only schools with more than three teachers have access to a GP room. Without GP room access, weather dependence gives an option to the teacher to omit PE from the weekly class schedule.

21 Department of Education, 1996. Personal communication from Mr.B Sheehan, Higher Executive Officer, Buildings Branch; 12 February, 1996.

In contrast to the paucity of facilities in Irish primary schools, 93% of British primary schools have an indoor space and 73% of schools state that the space is large enough to cope with the subject (CCPR & NAHT, 1992). The declining school population in Ireland may improve access to indoor facilities, as all-purpose areas previously utilised for class teaching are re-allocated to the teaching of subjects such as PE. Absence of essential PE facilities significantly limits the quality, quantity and variety of PE lessons children experience.

Voluntary commitment to activities after school may compensate, in part, for poor provision of curriculum PE, whilst in many schools, extra-curricular activity enhances the current PE programme. Such activity provision however is specific to the interest of the teacher, often gender specific, and it is not inclusive of all children. By its nature, it specifically excludes the very young children. It also excludes pupils who perceive themselves to have limited skill acquisition, those who are unwilling to be so involved, and also those who are unable to avail of activity after school hours. While very many Irish primary school children have traditionally been well served by teachers thus committed to extra curricular activity, it cannot be accepted de facto as a responsibility of the teacher, nor implemented as education policy.

PE equipment

The type of basic PE equipment available to Irish primary school teachers to carry out a programme of PE is illustrated by the results of the most recent INTO (1995) survey. Less than half of the schools surveyed had the type of equipment which would enable gymnastics to be taught at a basic level, while approximately 30% of the schools did not have balls for games teaching [Table 3.1]. Data were not updated in the most recent school survey (INTO, 1996). This report cites 51% of teachers as 'satisfied' that there was adequate equipment in their schools for the teaching of PE.

Item of PE equipment	*% of schools*
Large balls	77
Small balls	69
Bean bags	63
Hoops	49
Mats	46
Ropes	44
Benches / Beams	40
Rackets	29
Skittles	26

Source: INTO, 1995

Table 3.1 *PE equipment in Irish primary schools*

Many Irish primary schools appear to have been ill-advised on the most appropriated use of grants or moneys collected for PE equipment, and expend considerable sums of money on large pieces of gymnastic equipment. The purchase however does not translate into a sufficient volume of equipment for large classes, and teachers find that the difficulties in gymnastics teaching are ever present. Schools who are budget restricted, might be better advised to purchase less costly, but a greater quantity of games equipment and small apparatus. This would enable diversification of the games programme, greater activity participation, and less wastage of 'idle' gymnastic apparatus.

School management

National education policy states that the primary school teacher is the person best suited to the teaching of physical education to children (NCCA, 1996). In optimal school management, a member of staff with an additional qualification in primary PE may be assigned overall responsibility for planning the PE programme. This may have a very positive influence on children's structured PE experience. This situation however does not pertain in many schools, and is most unlikely to occur in the smaller rural schools. The quality and quantity of PE experiences the child receives is therefore dependent on both his/her own class teacher and the school management's commitment to ensure PE is taught on a regular basis. Critical to PE programme quality also is management's choice and decisions concerning the employment of peripatetic teachers, coaches, and personnel outside the primary teaching profession to supplement the PE programme. The traditional notion of the PE specialist peripatetic teacher is not relevant to Irish primary schools. The number of specialists available to, or more importantly, affordable by schools is strictly limited. Many schools however can avail of the services of personnel who have specific games coaching qualifications (viz. IRFU rugby coaches; GAA Gaelic games coaches; IASA swimming teachers). Such provision broadens the dimensions of the curriculum and the quality of teaching of specific PE areas. The practice of employing personnel who have no formal teaching qualifications, such as interested parents, or personnel who are specifically trained in adult fitness teaching, is however a worrying trend, and raises serious questions as to the responsibility of the school, and the Department of Education, to provide children with structured physical education.

The primary school has a responsibility to ensure that children are socialised into active lifestyles from an early age. Contingent on the provision of a modicum of teaching resources, this responsibility includes regular provision of PE lessons, provision of opportunities for enjoyment and success in a wide range of activity experiences, opportunity to improve self-esteem through mastery of skill, and opportunity to enjoy the variety of social interactions inherent in PE. Thus the school plays a central role in facilitating the child's participation in, and enjoyment of physical activity.