The relationship of participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance to fundamental motor skill ability among adolescents

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THE RELATIONSHIP OF PARTICIPATION IN ORGANISED SPORTS AND GAMES, PARTICIPATION IN NONORGANISED PHYSICAL ACTIVITY, AND CARDIORESPIRATORY ENDURANCE TO FUNDAMENTAL MOTOR SKILL ABILITY AMONG ADOLESCENTS

A thesis submitted in partial fulfilment of the requirements for the award of the degree

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ABSTRACT

THE RELATIONSHIP OF PARTICIPATION IN ORGANISED SPORTS AND GAMES, PARTICIPATION IN NONORGANISED PHYSICAL ACTIVITY, AND CARDIORESPIRATORY ENDURANCE TO FUNDAMENTAL MOTOR SKILL ABILITY AMONG ADOLESCENTS

By

Anthony D. Okely

Physical inactivity has been considered a major public health issue among adolescents because of its high prevalence and its association with numerous adverse health outcomes during adolescence which may carry over to adulthood. A key to addressing this issue has been to identify the determinants that may influence an adolescent’s decision to be physically active. A determinant that has been hypothesised is the level of proficiency of the motor skills used to participate in physical activity; however, this relationship has been virtually unexplored. This study investigated how organised sports and games, nonorganised physical activity, and cardiorespiratory endurance were each related to fundamental motor skill ability among adolescents.

One thousand and seventy-two and 954 adolescents from Year 8 and Year 10, respectively, participated as subjects in this study. Organised sports and games and nonorganised physical activity were assessed by a self-report recall questionnaire
of participation in physical activity. Cardiorespiratory endurance was measured by performance on the Multistage Fitness Test. Fundamental motor skill ability was qualitatively assessed by performance on a six-item fundamental motor skills test battery.

Descriptive statistics plus multiple regression were used to analyse the data. Results suggested that participation in organised sports and games was significantly related to fundamental motor skill ability, $F (4, 1831) = 14.30, p < .0001$, and that this relationship was stronger for males than for females. Participation in nonorganised physical activity was not significantly related to fundamental motor skill ability. Cardiorespiratory endurance was significantly related to fundamental motor skill ability, $F (4, 1808) = 79.05, p < .0001$. For adolescents, fundamental motor skill ability may be an important variable influencing participation in organised sports and games and cardiorespiratory endurance and development of motor skills may increase adherence to a physically active lifestyle during adolescence which may carry over to adulthood.
DEDICATION

This thesis is dedicated to my Lord and Saviour, Jesus Christ, who is the true source of all knowledge, understanding, and wisdom.

To him who loves us and has freed us from our sins by his blood,
and has made us to be a kingdom and priests to serve his God
and Father—to him be glory and power for ever and ever! Amen.

(Revelation 1: 5b-6).
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- Lyndall McLellan and PH Phongsavan for their help with school and student recruitment.
- The field staff who assisted with data collection.
PREFACE

It is important for me to note that although the research questions investigated in this study were entirely my own work – from conceptualisation through to completion – the data gathered from the instruments used in this study were part of a larger project, namely the New South Wales Schools Fitness and Physical Activity Survey, 1997. I was an investigator on this study and was involved in the design, training of field staff, collection of data, liaison with schools, analysis of data, interpretation of results, and writing of the report that accompanied the larger project. Therefore, much of the Methods chapter and Appendices, whilst still my own work, is consistent with the publication from the larger report, of which I was an author.¹

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 CHAPTER I

INTRODUCTION

During the second half of this century, in the area of physical activity and health, two consistent themes have emerged, among others, in the professional literature. First, moderate, intermittent, and accumulated amounts of physical activity can provide substantial health benefits; and second, the prevalence of physical inactivity among adult populations, including Australia, is a major public health concern.

At this early juncture, it is important to highlight that physical activity encompasses more than sport, exercise, or fitness and is defined as “bodily movement that is produced by the contraction of skeletal muscle and that substantially increases energy expenditure.” (U.S. Department of Health and Human Services, 1996, p. 21). This definition includes exercise, which is planned, structured, and repetitive physical activity aimed at improving or maintaining physical fitness; organised sports or games (football, cricket, netball); transport (walking, cycling); occupational physical activity (manual labour, household chores); and nonorganised, recreational physical activities (skateboarding, dancing, walking; Okely, Patterson, & Booth, 1998).
Physical inactivity has been considered a major public health issue because of its association with coronary heart disease, colon cancer, hypertension, non-insulin-dependent diabetes mellitus, osteoporosis, obesity, and symptoms of mental ill-health (Bouchard, Shephard, & Stephens, 1994). As a result, governments and professional health organisations, in line with the recommendations from a number of reports, have developed guidelines and strategies for promoting physical activity.

A common thread in these strategies has been the need to focus efforts on adolescents. Although physical inactivity and its clinically manifested health risks are essentially an adult concern, the antecedents of some of them such as coronary heart disease and osteoporosis begin during adolescence and may “track” into adulthood. An important aspect of these age-specific promotional strategies is identifying what factors may influence an adolescent’s decision to be physically active. These factors are referred to as “determinants”.

One potential determinant may be the level of mastery of the movement skills that are used to participate in physical activity. Competence in performing these various movement skills has been collectively called fundamental motor skill ability (Pangrazi, 1998). A fundamental motor skill is defined as “an organised series of basic movements that involve the combination of movement patterns of two or more body segments” (Gallahue, 1996, p. 37). Since fundamental motor skills are considered a prerequisite to or foundation of...
the specific skills used in popular forms of adult physical activity (Gallahue & Ozmun, 1995; Payne & Isaacs, 1995), it seems logical to assume that there may be a relationship between an individual’s participation in physical activity and their motor skill level, particularly during adolescence.

In the absence of research, questions arise as to what is the nature of the relationship between physical activity and fundamental motor skill ability at the adolescence stage of development. Given the broader definition of physical activity, not only were organised sports and games of interest, but also nonorganised activities. These were the questions that were pertinent to this study.

1.1 Purpose of the Study

The purpose of this study was to investigate the nature of the relationship between participation in physical activity and fundamental motor skill ability among adolescents. Specifically, the major research questions investigated were:

1. Is participation in organised sports and games related to adolescents’ fundamental motor skill ability?

2. Is participation in nonorganised physical activity related to adolescents’ fundamental motor skill ability?
3. Is cardiorespiratory endurance related to adolescents’ fundamental motor skill ability?

Data gathered to provide answers to these questions were used for the purposes of testing the following research hypotheses:

1. There is a positive relationship between participation in organised sports and games and fundamental motor skill ability among adolescents.

2. There is a positive relationship between participation in nonorganised physical activity and fundamental motor skill ability among adolescents.

3. There is a positive relationship between cardiorespiratory endurance and fundamental motor skill ability among adolescents.

To explore the potentiality of participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance being related to fundamental motor skill ability, these relationships were examined using self-reported assessments of participation in physical activity, an objective measurement of cardiorespiratory endurance, and objective qualitative assessments of fundamental motor skill ability in Year 8 and Year 10 students in a stratified random sample of 44 high schools in New South Wales (NSW). A qualitative assessment of fundamental motor skill ability is one that focuses on correct technique – that is, how the skill is performed – as opposed to a quantitative test that measures outcomes of
to a quantitative test that measures outcomes of a skill performance such as distance or speed (Holland, 1986). The measurement of physical activity is still without a universally accepted “gold standard”; therefore, it was necessary to provide an objective measure, cardiorespiratory endurance, as a way of confirming the findings.

1.2 Significance of the Study

The answers to the research questions posed in this study have the potential to provide information on adolescents’ level of involvement in organised and nonorganised physical activity, fundamental motor skill ability, and cardiorespiratory endurance. More importantly, the relationship between these variables may be explored with a view to enhancing the growing body of literature concerning the determinants of physical activity among adolescents.

A further major outcome of the study was to add to the research concerning the assessment and determination of fundamental motor skill ability. The dearth of valid and reliable qualitative batteries has been a major barrier to all forms of research in this area (Holland, 1986; Rarick, 1982). In attempting to deal with this dearth, not only has this study enabled the important relationship of fundamental motor skill ability to physical activity to be addressed, it has also allowed the investigation of a valid and reliable fundamental motor skill ability test battery.
Physical activity is a health behaviour, just as smoking and dietary patterns are considered health behaviours; and just as particular behavioural components can be identified as being fundamental to smoking and dietary patterns, analogous behavioural components can be identified as underpinning physical activity. This study focused on fundamental motor skill ability as one of the behavioural components which may possibly influence the behaviour of physical activity. Using social learning theory (Bandura, 1977; Bandura, 1986), this behavioural component was examined. Up until now, research has focused in general terms on physical fitness and its relationship to health. However, with the emergence of evidence associating activities less exercise-based, intense, and sustained with health benefits, came the realisation that the behaviour of physical activity may be just as important as the attributes of health-related fitness in enhancing health.

A reason why this information may not be currently available is that the importance of nonorganised physical activities is only beginning to be considered. In the past, valid and reliable measures of involvement in physical activity, whether they be organised or nonorganised, have not been strong. This study attempted to provide a more valid measure of physical activity through the assessment of both participation in organised sports and games and participation in nonorganised physical activity.
The measure of cardiorespiratory endurance had a twofold function in this study: first, as a stand alone health-related fitness measure; and second, as a criterion validation of the assessment of physical activity.

The results of this study provided information on how, collectively, measures of different fundamental motor skills were related to measures of physical activity among adolescents and contributed to the limited literature available in this population. This information has the potential to be used to enhance interventions and programmes designed to increase adolescent physical activity levels which are needed if effective strategies are to be designed and implemented.

1.3 Overview of Methodology Used in the Study

Prior research has used a variety of techniques to assess physical activity, fundamental motor skill ability, and cardiorespiratory endurance in adolescents. For this study, data were collected from a sample drawn from a predetermined population using cross-sectional survey research methodology. Cross-sectional survey research is classed as a method of systematic, descriptive data collection that allows the researcher to determine present practices or opinions of a specific population (Borg & Gall, 1983; Thomas & Nelson, 1996).
In this study, the cross-sectional survey approach was used to identify, explore, analyse, and predict the relationships between selected variables and involved the use of questionnaires and normative surveys of dependent and independent variables. Although causality cannot be inferred from this descriptive study, the acceptance or rejection of specified research hypotheses can provide valuable information in the design of subsequent experimental studies.

1.4 Limitations

The investigation undertaken in this study contributed to understanding the nature of the relationship of participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance to fundamental motor skill ability among adolescents. There existed, however, uncontrollable circumstances that may have affected the results of the study:

1. Schools with enrolments of less than 180 students and schools in the remote far west of NSW (STD area codes 075 and 080) were not included in the sampling frame to limit the extent of long travel for a small number of students. However, very few students were lost and the sampling frame included 97% to 98% of students enrolled in New South Wales high schools.
2. Written permission from parents/carers was required prior to student participation in the study, and students were allowed to decline participation in any of the tests, or to withdraw from any test at any time. Despite this, response rates were above 80% for all groups of students except Year 10 girls who had a response rate of just over 70%.

3. The study was cross-sectional in design, therefore, only relationships between participation in organised sports and games and fundamental motor skill ability, participation in nonorganised physical activity and fundamental motor skill ability, and cardiorespiratory endurance and fundamental motor skill ability can be made – no causal inferences are possible.

1.5 Delimitations

The study was delimited in the following manner:

1. The subjects were Year 8 and Year 10 students enrolled in high schools across the state of NSW, Australia.

2. Measures of physical activity included: (a) self-reported participation in organised sports and games and (b) self-reported participation in nonorganised physical activity during summer school
terms (one and four). These measures were identified as dependent variables.

3. Measurement of cardiorespiratory endurance was via the Multistage Fitness Test. This measure was identified as a dependent variable and as the indirect criterion measure in the construct validation of the self-report questionnaire.

4. Objective qualitative measures of six fundamental motor skills included the run, vertical jump, overhand throw, catch, kick, and forehand strike. These were identified as the independent variables.

5. Students’ self-reported information on their sex, school year, postcode of residence, and suburb of residence were identified as control variables labelled “gender”, “school year”, “socioeconomic status”, and “geographic location”, respectively. (Note: postcode of residence was used as a proxy measure for socioeconomic status.)

1.6 Definition of Terms

Because of the diversity of literature in the area, there is a plethora of definitions used for some of the following terms. Therefore, it is important to clearly define them in the context of this study.

1. *Organised sports and games:* Those physical activities which involved formal and structured training sessions or classes,
competitions or matches, and were generally supervised or coached by an adult. Examples included being part of a sporting team or club and attending a gymnastics or dancing school.

2. *Nonorganised physical activity*: Those physical activities which did not involve formal and structured training sessions or classes, competitions or matches, and were generally not supervised or coached. Examples included walking, cycling, skateboarding, and rollerblading for pleasure or transportation; surfing; and, casual games with friends.


4. *Participation in physical activity*: The number of minutes spent in vigorous physical activity during a usual week in summer based on students’ responses to the self-report physical activity questionnaire items. Vigorous physical activity was defined as greater than or equal to 6.0 METS of energy expenditure (Aaron et al., 1995b).

5. *Fundamental motor skills*: Those utilitarian skills that children use to enhance their quality of life; they are necessary for children to
function effectively in the environment, and form the basis of
competent movement (Pangrazi, 1998).

6. **Fundamental motor skill ability**: A student’s cumulative score on six
fundamental motor skills tests: run, vertical jump, catch, overhand
throw, forehand strike, and kick. Each fundamental motor skill test
was comprised of between five and seven qualitative components.
These components were standardised and summed for each student
to provide an overall index of fundamental motor skill ability.

7. **Cardiorespiratory Endurance**: A health-related component of
physical fitness that relates to the ability of the heart, blood vessels,
blood, and respiratory system to supply fuel, especially oxygen, to
the muscles and the ability of the muscles to utilise fuel to allow
sustained exercise (Corbin & Lindsey, 1997). For this study,
cardiorespiratory endurance was determined by the level and shuttle
attained by a student in the Multistage Fitness Test.

8. **Adolescence**: The period of transition between childhood and
adulthood that, chronologically, occurs between the ages of 10
and 19 years (World Health Organisations, 1993).
CHAPTER II

REVIEW OF LITERATURE

The development of a physically active lifestyle has been considered a key aim of Personal Development, Health, and Physical Education (PDHPE) programmes in NSW schools (Board of Studies NSW, 1991; Board of Studies NSW, 1992; Board of Studies NSW, 1994; Board of Studies NSW, 1997). Acquisition of fundamental motor skills by students is seen as being strongly related to achieving this aim because it is believed competency greatly increases the options available to children for participation in physical activity both at school and in later life (Board of Studies NSW, 1991). However, this belief is based largely on anecdotal reports; a dearth of empirical evidence is available. This study aimed to contribute to the paucity of literature in this area by investigating the nature of the relationship between participation in physical activity and fundamental motor skill ability in adolescents with a view to providing information regarding a potential determinant of physical activity which may better assist educators in the development of a key component of PDHPE programmes.
As such, it was necessary to investigate, critique, and summarise literature from a number of areas. The key areas of this review of literature are:

1. The risks associated with physical inactivity.
2. A rationale for promoting physical activity during adolescence.
3. The role of health behaviour theory in promoting adolescent physical activity.
4. Social learning theory as a basis for understanding adolescent physical activity.

2.1 The Risks Associated with Physical Inactivity

Physical inactivity is a major public health problem in Australia with recent evidence suggesting that approximately half of the Australian adult population do not participate in sufficient activity to gain the associated health benefits (Bauman et al., 1996; Department of the Environment, Sport and Territories, 1995). The ramifications of insufficient physical activity for individual health have been well documented and include a greater risk of developing or suffering from colon cancer (Giovannucci et al., 1995); hypertension (Folsom, Prineas, Kaye, & Munger, 1990); non-insulin-dependent diabetes mellitus (Helmrich, Ragland, Leung, & Paffenbarger, 1991); osteoporosis (Kohrt, Snead, Slatopolsky, & Birge, 1995); obesity (Blair, Jacobs, & Powell, 1985); symptoms of mental ill health (Paffenbarger, Lee, & Leung, 1994); and coronary heart disease (Blair, 1994). In fact, physical inactivity is
coronary heart disease (Blair, 1994). In fact, physical inactivity is now listed as one of the 10 major risk factors for ill health and disease (Murray & Lopez, 1996).

It is not only the number of adverse health outcomes associated with physical inactivity, but also the potential magnitude of each negative outcome that is of concern. Recent evidence suggests that coronary heart disease is one of the major causes of death in Australia, accounting for 23% of all deaths in 1996 (Australian Bureau of Statistics, 1997a). It has also been reported as the major cause of chronic disability between the ages of 30 and 65 (Shephard, 1996) and as a significant factor in rising health care costs (Harrell, 1994). Although physical inactivity has a relative risk for coronary heart disease of similar magnitude to the other major risk factors, inactivity shows a greater population-attributable risk than hypertension, hypercholesterolemia, and smoking because it is more prevalent than these other risk factors (Kemper & van Mechelen, 1995). This suggests that more lives could be saved through modifying inactive behaviour patterns than by modifying any other major coronary heart disease risk factor (Sallis & McKenzie, 1991).

In addition, the diseases and conditions associated with physical inactivity are almost entirely chronic in nature. Unfortunately, chronic diseases have accounted for over 65% of all deaths in Australia in recent years (Australian Bureau of Statistics, 1997a) and it is estimated that more than 11%
of these deaths may be attributable to physical inactivity (Pratt & Koplan, 1996). In NSW alone, it is predicted that 3476 deaths per year would not occur if the entire NSW population were physically active at the recommended level (Bauman et al., 1996).

Similarly, there are enormous salutary effects associated with an increased prevalence of physical activity, not the least of which are the economic benefits to the individual and community. Data from a decade ago revealed that if just 10% more Australians engaged in recommended levels of regular physical activity, there would have been a potential economic benefit of over $1.61 million per day. If this number rose to 40%, it would have represented an economic benefit (determined by the amount of money saved from reduced risk of coronary heart disease and low back pain, less absenteeism, and increased productivity) in the vicinity of $6.46 million per day (Department of the Arts, Sport, Environment, Tourism and Territories, 1988).

In addressing the problem of physical inactivity, the key issue – then and now – is how to get more Australian adults active to the level of the current recommendations for physical activity. These recommend that every individual should accumulate a minimum of 30 minutes of moderate-intensity physical activity – equivalent to a brisk walk – on most, preferably all, days of the week (Pate et al., 1995). A strategy that can be used to help achieve this is to promote physical activity during adulthood. This is a beneficial approach as it has been
activity during adulthood can provide substantial gains to an individual’s health. Furthermore, health benefits can still be achieved even if physical activity is not taken up until well into late adulthood (Paffenbarger et al., 1993). However, a barrier to this approach is the difficulty adults have in modifying sedentary lifestyles, and in particular, maintaining these modifications on a long-term basis (Atsalakis & Slep, 1997; Dishman, 1988; Dishman & Sallis, 1994). Another strategy that has much merit and potential to address the problem of physical inactivity among Australian adults is to promote physical activity during adolescence. A rationale for this strategy is outlined in the following section.

2.2 A Rationale for Promoting Physical Activity During Adolescence

Adolescence is a period in which many health-compromising behaviours have their origins (Heaven, 1996). Since health behaviours are believed to be more amenable to change during adolescence when compared to adulthood (Coates, Perry, Killen, & Slinkard, 1981), the burden of physical inactivity in the adult population may also be potentially reduced by adopting the strategy of promoting physical activity during this developmental stage. Adopting this preventive approach has much credibility and benefit in both economic and health terms. Although a direct link between adolescent physical activity and adult health has yet to be established, a persuasive rationale can be made for promoting physical activity and adult health has yet to be established, a
a persuasive rationale can be made for promoting physical activity during adolescence for health throughout a person’s lifespan. This rationale rests considerably on three factors: (a) antecedents and tracking of chronic diseases, (b) carry over effect of physical activity, and (c) direct benefits.

### 2.2.1 Antecedents and Tracking of Chronic Diseases

Although the diseases and conditions associated with physical inactivity generally do not clinically manifest themselves until adulthood, there is evidence to suggest that they may start, and be related to or modified by behaviours at a young age (Després, Bouchard, & Malina, 1990). Though there is equivocal discussion with respect to mental health, the two conditions for which the support of this evidence is most robust are coronary heart disease and osteoporosis.

There are four major risk factors associated with coronary heart disease: (a) elevated blood cholesterol (hypercholesterolemia), (b) high blood pressure (hypertension), (c) smoking, and (d) physical inactivity (McBride, Einerson, Hanson, & Heindel, 1992). Evidence has shown a direct link between these risk factors and the development of atherosclerotic lesions in the aorta and coronary arteries – which is a sequela for cardiovascular disease – in adults (Solberg & Strong, 1983) and in children (Berenson et al., 1992). In fact, definitive studies have revealed lesions in the coronary arteries during the second decade of life.
(Strong & McGill, 1962) and in the aortas of children as young as three years old (Holman, McGill, Strong, & Geer, 1958). Moreover, data suggest that these risk factors are common among Australian youth (Australian Institute of Health and Welfare, 1996; Department of Community Services and Health, 1990; Wilcken, Lynch, Marshall, Scott, & Wang, 1996) with high-risk coronary heart disease profiles occurring in 21% of adolescents (Beilin, Burke, & Milligan, 1996).

Although osteoporosis itself is not a cause of death, the condition reduces health-related quality of life by greatly increasing the risk of fractures if a fall occurs and through the deterioration of health that commonly occurs after a fall, particularly in the elderly (Commonwealth Department of Health and Family Services, 1997). A risk factor in the development of osteoporosis is an insufficient peak bone mass, which is almost entirely – more than 90% – attained during childhood and adolescence (Bailey & Martin, 1994; Blimkie, Chilibeck, & Davison, 1996) and is causally influenced by the amount of weight-bearing physical activity done during this period (Kimm & Kwiterovich, 1995).

Given the idea that some hypokinetic diseases and conditions of adulthood may actually start in childhood and adolescence, predicting adult diseases and conditions based on childhood risk factors is important and requires answers. Answers may be derived from studies known as “tracking” studies
studies which look at predicting a child’s or adolescent’s future health status based on earlier measurements of particular health indicies, such as cholesterol and body composition levels, and determining whether his or her health relative to a group remains stable over time (Bar-Or & Malina, 1995). Because the antecedents of many hypokinetic diseases and conditions such as coronary heart disease and osteoporosis begin in childhood, tracking can provide important information on at-risk individuals early in life, thus maximising their exposure to preventive interventions (Twisk, Kemper, & Snel, 1995). An important consideration regarding tracking is that although it is the most accurate method of establishing effects over a period of time, it does require longitudinal data (Bar-Or, 1994) which is difficult to gather. When analysing tracking studies, Bloom (1964) has proposed an interage correlation of .5 as a determinant of stability. Using this value, studies have demonstrated that conditions such as overweight and obesity (Twisk et al., 1995) and hypercholesterolemia (Lauer, Lee, & Clarke, 1988; Orchard, Donahue, Kuller, Hodge, & Drash, 1983; Twisk et al., 1995) may track from early adolescence (11-13 years) to adulthood (20-27 years), with correlations ranging from .49 to .6; and hypertension (Rosner, Hennekens, Kass, & Miall, 1977) may track from late adolescence (15-19 years) to adulthood (30-34 years), r = .51. In light of these studies, questions may arise as to the lifestyle behaviours of adolescents which may be important to risk
adolescents which may be important to risk factors both as an adolescent and as an adult.

2.2.2 Carry Over Effect of Physical Activity Participation Habits

Adolescence represents a critical developmental stage characterised by experimentation and initiation into adult behaviour patterns (Perry & Murray, 1982). The argument that many health-compromising and health-enhancing habits and behaviours commenced and consolidated during adolescence may set a pattern that carries over to adulthood, has provided a cogent rationale for their promotion during the developmental years for long-term health benefits (Myers, Strikmiller, Webber, & Berenson, 1996; Perry & Murray, 1982). Recent evidence suggests that this premise may exist for physical activity. Using Bloom’s (1964) value of .5 as the minimum determinant of stability, studies have reported that the tracking of physical activity from adolescence into adulthood ranges from $r = .54$ for ages 18 to 21 (Raitakari, Porkka, Taimela, Telama, & Rasanen, 1994) and ages 16 to 21 (van Mechelen & Kemper, 1995b) to $r = .64$ for ages 16 to 27 (Glenmark, Hedberg, & Jansson, 1994). However, it is important to note that several studies have reported interage correlations of less than .5, particularly those that have tracked individuals over longer periods of time than those above (Taylor, Blair, Snider, & Wun, 1993; Telama, Yang, Laakso, & Viikari, 1997; Vanreusel et al., 1993). In fact, the results of a recent
review of the literature revealed that, generally, physical activity may only track at low to moderate levels (.3 < r < .6) from adolescence into adulthood (Malina, 1996). In other words, it appears an equivocal, but nonetheless apparent, rationale may exist for promoting physical activity during adolescence based on the argument that it is a salutary behaviour that may carry over into adulthood.

2.2.3 Some Direct Benefits of Physical Activity During Adolescence

Although regular physical activity during adolescence can potentially be beneficial to adult health, there are also direct health benefits for adolescents. Regular physical activity during adolescence is positively associated with skeletal health (Bailey & Martin, 1994); emotional well-being (Steptoe & Butler, 1996); academic performance (Shephard, 1997); and mental health variables such as self-esteem, self-concept, depression, and anxiety (Calfas & Taylor, 1994). In addition, regular physical activity during adolescence is inversely associated with obesity (Bar-Or & Baranowski, 1994; Fripp et al., 1985; Lariviere, Lavallee, & Shephard, 1974; Tell & Vellar, 1988); hypertension (Alpert & Wilmore, 1994; Fraser, Phillips, & Harris, 1983; Fripp et al., 1985; Tell & Vellar, 1988); hypercholesterolemia (Craig, Bandini, Lichtenstein, Schaefer, & Dietz, 1996; Fripp et al., 1985); marijuana use (Pate, Heath, Dowda, & Trost, 1996); and the initiation (Aaron et al., 1995a) and frequency
(Pate et al., 1996) of cigarette smoking. Thus, on the evidence available, there are direct benefits in participating in physical activity during adolescence.

In summary, despite the fact that hypokinetic diseases and conditions are typically chronic and generally do not manifest themselves clinically until adulthood, a rationale exists for commencing preventive promotional strategies prior to this stage of life based on the following factors:

1. Some diseases and conditions associated with physical inactivity such as coronary heart disease and osteoporosis have their antecedents in youth.

2. Conditions associated with physical inactivity such as overweight and obesity, hypercholesterolemia, and hypertension, may track from adolescence into young adulthood.

3. A malleable relationship may exist between physical activity levels in adolescents and adults, with exercise habits established during this time purported to carry over into later life.

In addition to this rationale, there is also a health rationale for promoting physical activity during adolescence based on the benefits it can provide immediately to adolescents.
2.2.4 Physical Activity Patterns During Adolescence

If compelling reasons were sought to promote greater physical activity participation among Australian adolescents, it would be consistent to base them on the same two factors which exist for adults: first, that physical inactivity is associated with numerous adverse health conditions; and second, that a high prevalence of physical inactivity currently exists. Assuming that this is the case, it has already been established that physical inactivity during adolescence is associated with several adverse health conditions during adolescence that may carry over to adulthood. However, data on the prevalence of physical inactivity among Australian adolescents is required for the construction of an argument as compelling as that which exists for adults.

Only two studies of the physical activity levels of Australian adolescents have been reported in the literature. The Australian Health and Fitness Survey 1985 (Pyke, 1987) provided the only national survey data available on the physical activity patterns of children and adolescents. This study employed a random sample of 2676 thirteen- to fifteen-year-old adolescents and collected self-reported data on participation in moderate-to-vigorous physical activity. The results showed that approximately 50% of males and 58% of females aged 13 to 15 years did not participate in sufficient moderate-to-vigorous physical activity. The definition of sufficient physical
activity was that it “occurred three or more times a week, lasted half an hour and caused the students to huff and puff.” (Pyke, 1987, p. 78).

In the NSW Schools Fitness and Physical Activity Survey, 1997, Booth et al. (1997) employed a stratified random sample of 2026 thirteen- to sixteen-year-old adolescents educated in NSW and measured self-reported participation in organised sports and games and nonorganised physical activities. They found that approximately 19% of males and 26% of females in Year 8 and Year 10 respectively, did not meet Guideline 2 of the internationally developed Physical Activity Guidelines for Adolescents Consensus Statement (Sallis & Patrick, 1994) which recommended that “Adolescents should engage in three or more sessions per week of activities that last 20 min or more at a time and that require moderate to vigorous levels of exertion.” (p. 308).

Collectively, these data present a disturbing picture that the moderate-to-vigorous physical activity levels of Australian adolescents are currently suboptimal. This fact, coupled with the strong immediate and long-term benefits of participating in regular physical activity during adolescence, provides the cogent rationale required to modify these sedentary behaviours in adolescents, especially females.

Modification of adverse health behaviours during adolescence is important because of their strong link to adolescent health status (Evans & Stoddart, 1990; Heaven, 1996). However, to enhance or improve behaviour
suggests behaviour change and any such notion of behaviour change has to be considered in the framework of an appropriate theory of health behaviour change.

2.3 The Role of Health Behaviour Theory in Promoting Adolescent Physical Activity

A critical step towards effectively promoting greater physical activity among adolescents is to identify the determinants of physical activity in this age group (Sallis et al., 1992b). Identification of these determinants might enhance the design, relevance, and effectiveness of interventions and programmes that increase physical activity among adolescents (Reynolds et al., 1990; Sallis, 1995; Sallis & Hovell, 1990) and help define and fulfil the public health potential of physical activity (Dishman, Sallis, & Orenstein, 1985).

Physical activity is a complex behaviour with multiple determinants; therefore, it is important that any study of the determinants of adolescent physical activity be examined within a valid theoretical framework (Dzewaltowski, 1994; Sallis & Hovell, 1990; Sallis et al., 1992b). This increases the conformity of the study, allowing comparisons to be made with other health behaviours (Dishman & Dunn, 1988) and leads to more appropriate intervention content and strategies (Saunders et al., 1997).
2.4 Social Learning Theory as a Basis for Understanding Adolescent Physical Activity

A number of psychosocial theories have been used to describe the determinants of physical activity (U.S. Department of Health and Human Services, 1996). In recent times, social learning theory\(^2\) (Bandura, 1977; Bandura, 1986) has emerged as one of the dominant models for understanding physical activity participation, especially among adolescents. Social learning theory assumes that there is a dynamic and reciprocal interaction between the person, the behaviour, and the environment (see Figure 1; Lytle et al., 1994). In other words, all three factors will influence an individual’s health behaviour. This means that for effective health behaviour change to occur, each of these three interacting components must be modified. Bandura (1994) suggests four major areas of foci for doing this:

1. Increase individuals’ cognisance of the health behaviour.
2. Give them the behavioural skills or “tools of the trade” needed to participate in the behaviour.
3. Provide them with opportunities to practice, and receive feedback.
4. Provide an encouraging and supportive environment for the behaviour.

\(^2\) Although many recent studies have used Bandura’s (1986) framework and renamed social learning theory as social cognitive theory, for the purpose of this study the long-standing and earlier label of social learning theory will be used.
Within social learning theory, a number of constructs or determinants have been identified as being fundamental to understanding and modifying health behaviour (Perry, Baranowski, & Parcel, 1990). These include aspects of all four areas of major foci suggested by Bandura (1994), with each area comprising perhaps several determinants.

Determinants identified within social learning theory that have been found to be positively associated with adolescent physical activity include self-efficacy (Bungum & Vincent, 1997; Reynolds et al., 1990; Zakarian, Hovell, Hofstetter, Sallis, & Keating, 1994); parental and peer influences (Anderssen & Wold, 1992; Butcher, 1983; Sallis, Patterson, Buono, & Nader, 1988; Trost et al., 1997); perceived benefits (Bungum & Vincent, 1997; Ferguson, Yesalis, Pomrehn, & Kirkpatrick, 1989; Zakarian et al., 1994); perceived barriers (Tappe, Duda, & Menhes-Ehrnwald, 1990; Trost et al., 1997); and physical

Figure 1. The components of social learning theory and their relationships (modified from Bandura, 1986).
environmental influences (Zakarian et al., 1994). As such, it is appropriate to apply this model to physical activity and adolescence.

2.4.1 Behavioural Capability as a Construct of Social Learning Theory and a Determinant of Adolescent Physical Activity

A key to interpreting social learning theory is understanding all determinants within the theory, and in particular in this study, a determinant not yet mentioned, namely behavioural capability. Behavioural capability proposes that in order to perform a specific type of behaviour, an individual must know what the behaviour is and how to do it (behavioural cognition), and have the skills to be able to perform or execute the behaviour (behavioural skills; Perry, Baranowski, & Parcel, 1990).

Behavioural capability is considered an important explanatory factor of social learning theory (Resnicow et al., 1997; van Ryn & Heaney, 1992), and an essential prerequisite for performing a behaviour (Bartholomew et al., 1991). Educationally, behavioural capability is integral to many physical and health education programmes and curricula. For example, the Year 7-10 NSW Personal Development, Health and Physical Education (PDHPE) syllabus – one of eight key learning areas in the secondary school (Board of Studies NSW, 1991) – is concerned with “developing the knowledge and skills…that will empower students to adopt healthy lifestyles.” (p. 1). The notion here is that behavioural cognition and behavioural skills are prerequisites for behaviour
cognition and behavioural skills are prerequisites for behaviour change and adherence in health and physical education.

Of these two constructs of behavioural capability (behavioural cognition and behavioural skills), it is suggested that possessing the necessary behavioural skills may be more important for behaviour change as an individual may know what to do, and how to do it, but still not be able to perform the behaviour correctly. However, being able to perform the behaviour presume knowing what and how to do it (Perry et al., 1990). In other words, knowledge alone does not necessarily result in modifying health-compromising behaviours; rather, individuals need to have the behavioural skills to do so (Bandura, 1994). Therefore, although behavioural cognition is one of many factors influencing behaviour, its significance is primarily linked to its role as a precursor to behavioural skills, and thus it may have a less direct effect on behaviour than behavioural skills (see Figure 2).

**Figure 2.** Possible relationship between behavioural cognition, behavioural skills, and behaviour.
Surprisingly, behavioural capability, or more specifically, behavioural skills, has not been extensively investigated as a determinant of adolescent physical activity, despite being recently identified as deserving further inquiry (Sallis et al., 1992b). No explanation is apparent for this undeveloped area of research. However, it may have to do with the difficulty researchers have had in determining what are classed as physical activity skills and in determining how to measure physical activity. This is somewhat understandable considering physical activity has only recently begun being studied as a dependent variable (Sallis, 1995), especially in youth populations; therefore, it is still unclear what skills are required to enhance the adoption of and adherence to this behaviour at a salutary level, and how it can be most effectively assessed.

2.4.2 The Relationship Between Behavioural Skills and Physical Activity

Within social learning theory, behavioural skills refer to those skills needed to be able to perform a behaviour, in this case, physical activity (Bartholomew et al., 1991). Examples of behavioural skills related to physical activity include self-motivation; goal setting; self-evaluation; role-modelling; and the ability to overcome distractive and negative thoughts, increase positive thoughts, reschedule missed sessions, and self-monitor one’s behaviour. Most of the research in this area has focused on the use of behavioural skills in assisting patients to initiate and adhere to exercise in corporate, community, and
clinical settings. As a result, the relationship between behavioural skills and physical activity has been more extensively studied in adults than in youth.

Two studies have reported the relationship between self-motivation and adherence to an exercise programme in a community setting. In the first, Dishman, Ickes, and Morgan (1980) reported a significant association between self-motivation and adherence to a 20-week habitual physical activity programme among adult males. In the second, Heiby, Onorato, and Sato (1987) found that scores on a self-motivation inventory were significantly and positively related to prior self-reported levels of exercise adherence. In addition, studies have reported that exercise adherers were more highly self-motivated compared with their dropout-prone counterparts in corporate (King, Taylor, Haskell, & DeBusk, 1990) and clinical (Dishman & Gettman, 1980) settings.

With respect to the setting and attainment of personal goals, Martin et al. (1984) reported that greater flexibility in personal goal setting was an important factor in enhancing adherence to a three-day-per-week exercise programme in healthy sedentary adults. A reason why flexibility in goal setting may be an important factor is that it increases the potentiality of attaining personal goals, which in itself has been found to significantly increase adherence to an exercise programme (Danielson & Wanzel, 1977).

Self-monitoring, which is defined as the keeping of records of one’s exercise (Knapp, 1988), has been reported as influencing exercise adherence. In
a university milieu, Nelson, Haynes, Spong, Jarrett, and McKnight (1983) found that self-monitoring increased adherence to exercise among undergraduate females. In a community setting, it has been reported that self-monitoring increased adherence to exercise in a 10-week programme (Belisle, Roskies, & Levesque, 1987; Nelson et al., 1983; Oldridge & Jones, 1983).

With respect to specific self-monitoring procedures, Lipsker (1983) found that the use of procedures such as making preparations in advance, placing personal reminders in prominent positions, and recruiting significant others to provide reminders resulted in increased levels of exercise adherence compared to nonstudy counterparts in a study of adults enrolled in a community-based exercise programme.

In a clinical setting, Oldridge and Jones (1983) investigated the exercise adherence of cardiac rehabilitation patients. Results revealed that the keeping of self-monitoring diaries, which were assessed regularly with the exercise programme coordinator, increased their adherence to the programme. Additionally, within self-monitoring skills, comparisons indicated better adherence to physical activity programmes in adults who self-monitored their activity on a daily basis, compared with those who self-monitored weekly (King et al., 1990).

Positive associations have also been reported between adherence to physical activity and the ability to self-evaluate the benefits and costs of the
behaviour (Dzewaltowski, Noble, & Shaw, 1990), the ability to increase positive thoughts (Keefe & Blumenthal, 1980), the ability to overcome negative and distractive thoughts (King & Frederiksen, 1984; Martin et al., 1984), and the ability to reschedule missed sessions (King & Frederiksen, 1984).

With respect to children and adolescents, Perry, Griffin, and Murray (1985) used a needs assessment survey to assess the self-monitoring skills that supported adolescent physical activity; however, the relationship between these behavioural skills and self-reported physical activity was not carried out.

Parcel, Simons-Morton, O’Hara, Baranowski, and Wilson (1989) reported a significant change in frequency of participation in aerobic activity as a result of a programme that included a module designed to enhance the behavioural skills of role modelling and self-monitoring among Year 4 students; however, similar changes were also observed in the control group which raises questions about the validity and reliability of the self-report measure which was not validated with activities performed outside physical education lessons. Moreover, it was previously demonstrated by one of the above authors (Baranowski, 1988), that children aged 10 years and below cannot accurately self-report their physical activity, casting further doubts on the validity of the study. Additionally, the relationship between behavioural skills and self-reported physical activity was not investigated.
Simons-Morton, Parcel, Baranowski, Forthofer, and O’Hara (1991) employed a classroom health education curriculum to teach the behavioural skills essential to promoting lifelong physical activity among Year 3 and Year 4 students. They found that the amount of time spent in moderate-to-vigorous physical activity during physical education increased substantially as a result of this curriculum in intervention schools, but that there were no changes in control schools. However, once again, the relationship between behavioural skills and physical activity was not investigated. Furthermore, there is little evidence that interventions or programmes that solely target increasing activity levels during physical education have much success in establishing lifelong physical activity habits (Blair, 1995; Rowland, 1990), as they are not the format that most individuals will use to participate in physical activity beyond adolescence. Students need to be taught the physical activity skills required to participate in physical activity once they leave the structure of school, and the physical education class has ceased to become an avenue for participation in physical activity. Promoting physical activity through teaching relevant behavioural and physical activity skills may be more successful for the adoption of physical activity outside school and its long-term adherence, rather than merely increasing the amount of time spent in activity during physical education (Sallis, 1995).
The major limitation of these studies is that the relationship between the behavioural skills used in the programmes and participation in physical activity was not examined or reported, making it difficult to distinguish behavioural skills from other components of the programmes. This limitation is substantiated by King et al., (1992) who claimed that little research has been conducted specifically in the area of behavioural skills and how they relate to promoting participation in physical activity.

A common thread within studies where the focus has been on behavioural skills, is that the skills all fall into the category of “personal” determinants. Recall that in social learning theory, three dynamic and reciprocal determinants are assumed: the person, the behaviour, and the environment (Lytle et al., 1994). Even less research has looked at behavioural skills that are influenced by the behaviour or the environment, especially in children and adolescents.

A study that has looked at behavioural skills from a behavioural perspective has been the Minnesota Heart Health Programme (Perry, 1991), a dietary intervention among eight-year-old children, which aimed to reduce the intake of sodium and fat and increase the intake of complex carbohydrates. Behavioural skills were taught as part of the programme to modify existing patterns of eating; these included reading food labels, differentiating between
“everyday” and “sometimes” foods, and preparing food. Some personal behavioural skills such as self-evaluation and goal-setting were also included.

Although the programme did not result in significant behaviour change, which is hard to accomplish in eight-year-old children who have little control over their diet, their behavioural skills improved. In fact, the author believed that the benefits of the skill development programme would be most evidenced in later years: “The provision of multiple opportunities to learn and practice new skills in selecting, preparing, and evaluating foods most likely led to increased self-efficacy around these skills and greater likelihood that the skills would be utilised in the future.” (Perry, 1991, p. 15). If this line of thought could be extended to the health-related behaviour of physical activity, there would be particular behavioural skills that would be needed to engage in the targeted behaviour. Increased competence in these skills could be extrapolated as a necessary behavioural skill for participation in physical activity throughout the lifespan, especially beyond formal schooling.

2.4.3 Use of Fundamental Motor Skill Ability as a Behavioural Skill and Its Relationship to Physical Activity

One component of behavioural skills that may be presumed as a determinant of physical activity is fundamental motor skill ability. Recall that fundamental motor skills are the building blocks or foundations of human
movement. Running, jumping, throwing, catching, striking, and kicking are all examples of fundamental motor skills. They are considered to be of paramount importance as evidence suggests that a developmental sequence exists in motor skill behaviour, with mastery of fundamental motor skills considered a prerequisite for the successful introduction of specific sports, games, and physical activity skills (Gallahue & Ozmun, 1995; Holland, 1986; Ulrich, 1985; Wickstrom, 1983). For example, a child would need to have mastered the basic overarm throw prior to being able to combine and modify it to develop and perform more advanced skills such as a cricket throw, softball throw, tennis serve, javelin throw, volleyball spike, and European handball shot which all use the overarm throw as their basis (see Figure 3).
Figure 3. Effect of fundamental motor skills instruction on the performance of sport specific skills.


To be clear, fundamental motor skills are not simply sport specific. They are more generic and widespread in their applicability. However, children who do not master fundamental motor skills may encounter a sport and games proficiency barrier (see Figure 3) whereby skill levels necessary for success in these activities are not readily achieved (Gallahue & Ozmun, 1995; Seefeldt & Haubenstricker, 1982; Ulrich, 1985) Furthermore, fundamental motor skill ability has been found to be positively related to enjoyment in physical activity.
(Caine, 1991) and peer status and social success in organised and nonorganised physical activities (Evans & Roberts, 1987) in children. As a corollary, limited but suggestive evidence emphasises that not experiencing mastery in these advanced skills may promote nonparticipation in physical activity which may carry over to adulthood (Commonwealth of Australia, 1992; Corbin, 1980; Department of Education, Victoria, 1996; Kuh & Cooper, 1992; Malina, 1995).

The recognition of fundamental motor skill ability as a behavioural skill has, surprisingly, not been extensively or prospectively studied. Sallis et al. (1993d) found no association between fundamental motor skill ability and participation in physical activity among preschool children. However, it is difficult to interpret these findings, given that only one fundamental motor skill, the bunny hop – a rather obtuse measure of coordination – was assessed.

This finding differs from the results of Butcher and Eaton (1989) who reported a significant relationship between running speed and agility, and participation in vigorous physical activity in preschool children. However, the authors used quantitative measures for speed and agility which is in contradiction to recent research trends in fundamental motor skill assessment which recommend that qualitative tests assessing how the skill is performed (technique) should prevail over quantitative measures of the skill outcome (Gallahue, 1982; Holland, 1986; Patterson, Anderson, & Klavora, 1997; Wickstrom, 1983). Furthermore, speed and agility are more accurately defined
as measures of skill-related fitness rather than measures of fundamental motor skill ability (Corbin & Lindsey, 1997).

Ulrich (1987) also reported a significant relationship between fundamental motor skill ability and participation in organised sport among Year 4 children; however, only sport participation was measured. The discrepancy between the former and latter two studies could be explained by the different fundamental motor skills measured – Ulrich used a far more comprehensive battery – and by the variations in the assessments of physical activity which makes it impossible for comparisons to be conducted.

The previous research may now be extended by examining multiple qualitative measures of fundamental motor skills (that are, where possible, relevant to the most common sports, games, and other physical activities in Australia) and their relationship to multiple indicators of physical activity that more accurately reflect the free-living participation behaviours of adolescents.

2.5 Effect of Gender, School Year, Socioeconomic Status, and Geographic Location on Adolescent Physical Activity

It is important to recognise that while this investigation is primarily concerned with the relationships between different types of physical activity and fundamental motor skill ability among adolescents, there are other variables that may influence these relationships. Generally, these fall under the heading
of sociodemographic variables and for adolescent physical activity, research suggests that four main sociodemographic variables (gender, age, socioeconomic status, and geographic location) may modify the relationships between the different types of physical activity and fundamental motor skill ability.

Gender differences in the prevalence of physical activity among youth have been frequently reported. Generally, boys are more physically active than girls (Aaron et al., 1993; Anderssen & Wold, 1992; Armstrong, Balding, Gentle, & Kirby, 1990; Fuchs et al., 1988; Janz & Mahoney, 1997a; Ross, Dotson, Gilbert, & Katz, 1985a; Sallis, Zakarian, Hovell, & Hofstetter, 1996; Saris, Elvers, van't Hof, & Binkhorst, 1986; Sunnegardh & Bratteby, 1987; Tell & Vellar, 1988; Trost et al., 1996; Trost et al., 1997; Zakarian et al., 1994). Gender differences in the determinants of physical activity among adolescents have also been reported (Reynolds et al., 1990; Stucky-Ropp & DiLorenzo, 1993; Trost et al., 1997; Zakarian et al., 1994).

The effect of age or school-year on the prevalence of physical activity has been commonly studied in children and adolescents. Generally, an inverse relationship has been described between age or school year and physical activity (Bungum & Vincent, 1997; Fuchs et al., 1988; Janz & Mahoney, 1997a; Myers et al., 1996; Ross et al., 1985a; Rowland, 1990; Simons-Morton, O'Hara, Parcel, & Huang, 1990; Sunnegardh & Bratteby, 1987; Zakarian et al., 1994), even when the measurements have been taken only one to two school
years apart (Aaron et al., 1993; Bungum & Vincent, 1997; Simons-Morton et al., 1990; Zakarian et al., 1994).

Low socioeconomic status has been identified as a correlate of several health-compromising behaviours such as smoking and alcohol consumption (Nutbeam, Aar, & Catford, 1989; Tucker et al., 1995), and cardiovascular disease risk factors (Beilin et al., 1996; Dwyer, Coonan, Worsley, & Leitch, 1980). Evidence suggests similar relationships may exist for physical activity. It has been previously documented that adolescents from low socioeconomic status families may be less active (Aaron et al., 1993; Epstein, Paluch, Coleman, Vito, & Anderson, 1996; Gottleib & Chen, 1985; Nutbeam et al., 1989; Sallis et al., 1996; Shropshire & Carroll, 1997; Vilhjalmssson & Thorlindsson, 1998) although it is unclear what percentage of the variance may be influenced by access to finances and facilities (Sallis et al., 1996) and cultural background which is rarely controlled (Bungum & Vincent, 1997).

Little evidence exists on how geographic location is related to physical activity. Studies have reported differences between urban and rural adolescents (Einspruch, 1994; Huang & Malina, 1996; Vilhjalmssson & Thorlindsson, 1998), and suggest that adolescents from urban regions may be less active (Meehan, 1993) than their rural counterparts; however, the reasons for this are unclear. It is possible that the wide, open, and safer environments of rural areas are more conducive to physical activity than densely-populated, high-crime
urban landscapes (Sallis, 1995). Crime in particular may contribute significantly as safety has been reported as the most important factor parents consider in selecting play spaces for their children (Sallis, McKenzie, Elder, Broyles, & Nader, 1997).

Collectively these studies suggest that there are age-, gender-, socioeconomic status- and geographic location-related differences in patterns of physical activity among youth. Therefore, it is important to recognise that any study investigating relationships involving adolescent physical activity needs to control for such influences.

2.6 Summary

Promoting physical activity during adolescence provides many proximal and distal benefits to an individual’s health. Research clearly suggests that there is a need for such promotion with the adolescent population in this country. Germane to promoting an active lifestyle is an understanding of the determinants of physical activity among adolescents. One determinant suggested is level of fundamental motor skill ability, which has been anecdotally identified as a precursor to participation in physical activity. Data suggest levels of fundamental motor skill ability in Australian adolescents are low (Booth et al., 1997; Walkley, Holland, Treloar, & Probyn-Smith, 1993), which may be a reason why physical activity levels are also suboptimal.
However, the relationship between physical activity and fundamental motor skill ability has not been thoroughly explored, thus giving rise to one of the explicit purposes of this study.

Understanding the behavioural skills associated with the adoption and maintenance of physical activity was recently identified as an important priority for future research (U.S. Department of Health and Human Services, 1996) especially among girls (Trost et al., 1996). It was also recently stressed (Sallis et al., 1992b) that research in this area with youth needs to be guided by a strong theoretical framework, especially in the selection of variables, and that determinants of specific intensities of physical activity need to be investigated. This study addressed this priority by investigating the nature of the relationship between vigorous physical activity and behavioural skills – recognised as a behavioural determinant in the form of fundamental motor skill ability – among adolescents.
CHAPTER III

METHODS

The purpose of this study was to investigate the nature of the relationship of participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance to fundamental motor skill ability among adolescents. This chapter describes the research design, sample, instrumentation, procedures, and statistical analyses used to conduct this investigation.

3.1 Research Design of the Study

For this study, data were collected from a sample drawn from a predetermined population using cross-sectional survey research methodology. Cross-sectional survey research is classed as a method of systematic, descriptive data collection that allows the researcher to determine present practices or opinions of a specific population (Borg & Gall, 1983; Thomas & Nelson, 1996)

The cross-sectional survey approach was used to identify, explore, analyse, and predict the relationships between selected variables and involved the use of questionnaires and normative surveys of dependent and independent
variables. Although causality cannot be inferred from this descriptive study, the acceptance or rejection of specified research hypotheses has the potential to provide valuable information in the design of subsequent experimental studies.

3.2 Sample Selection

3.2.1 Selection of Schools

Schools were selected randomly (using proportional stratified random sampling) by the Australian Council for Educational Research (ACER) from primary and high schools in New South Wales (NSW). However, for the purposes of this study, only high school data were used. The sampling frame was prepared by the ACER using information from the Ministry of Education. In addition, information on nongovernment schools was supplied by the Department of Education, Employment, Training, and Youth Affairs (DEETYA). Only schools that had either small student populations (less than 180 students) or were in geographically isolated locations (STD area codes 050, 075, and 080) were excluded from the sampling frame in order to minimise travelling long distances for a small number of students; despite these exclusions, the sampling frame included 97% to 98% of students enrolled in NSW high schools. A list of all the schools in NSW was forwarded by the ACER, with those schools that had been selected highlighted. If a school declined participation, it was replaced with the next school on the list. The
sample included 44 high schools, comprising 31 from the Department of School Education (DSE), 10 from the Catholic Education Commission (CEC), and 3 Independent schools. The percentage of students from each education sector in the sample was the same as the percentage of students enrolled in each sector. The chance of a school being selected in each stratum was proportional to the size of its enrolment.

3.2.2 Selection of Students

If a school agreed to participate, students were selected using cluster sampling, with the class as the unit of sampling. That is, one entire class from Year 8 and Year 10 was selected randomly from each selected school. This has been recognised as the most practical method of gathering a random sample in a large and widely dispersed population (Cohen & Manion, 1986) as it provides a self-weighted sample whereby the approximate probability of each student being selected is equal. Each school was subsequently contacted and asked how many classes there were in Year 8 and Year 10 at the school, and how these classes were derived. That is, were they graded according to specific students such as Maths, Science, or English or were they nongraded? Where possible, nongraded classes were used in selections (generally roll-call classes), and a class was randomly selected using a table of random numbers which had been
prepared for each school and placed in a sealed envelope. The sample size was inflated accordingly in order to account for a potential clustering effect.

3.2.3 Sample Size Calculations

Although the data presented in this study were not stratified by gender and school year, the sample size calculations needed to be based on stratification. This was performed in the event that, during analyses, separate analyses for each gender and school year would be required due to the presence of either of them significantly interacting with the main independent variable. A large sample was necessary for this study because the population was considered highly heterogeneous on the variables being studied; the population may have needed to be broken into demographic subgroups in some analyses; and the behaviour being measured – physical activity – had no gold standard and, therefore, a larger error of measurement.

To estimate the required sample size for each cell, a cell being defined as the point at which a subgroup’s row variable (in this case gender) and column variable (school year) intersect (Hatcher & Stepanski, 1994), calculations were based on five parameters: (a) a prevalence for each variable of 50% in one subgroup, which maximised the sample size needed and provided the most conservative estimate; (b) a design effect – which refers to the amount of clustering – equal to one (see Appendix A); (c) an alpha level of 0.05; (d) a statistical power of .80; and (e) an effect size of 0.1 between groups,
considered large enough to identify meaningful differences. The alpha and power levels selected have been considered appropriate and recommended estimates in behavioural research (Thomas, Lochbaum, Landers, & He, 1997; Thomas & Nelson, 1996). Using this information, the number of students needed in each cell was calculated from Fleiss (1981). This calculation revealed that the study would require 407 students per cell in the analysis if simple random sampling were used. This sample size would also give a maximum 95% confidence interval of ±4.9% around a prevalence estimate in each cell.

3.3 Instrumentation

The instruments that were used to assess the association between participation in physical activity and fundamental motor skill ability among adolescents in Years 8 and 10 were:

1. Self-report Recall Questionnaire of Participation in Physical Activity.
2. Fundamental Motor Skills Test Battery.
3. The Multistage Fitness Test.

3.3.1 Self-report Recall Questionnaire of Participation in Physical Activity

For assessing the self-reported participation in physical activity among adolescents, the instrument used in this study (see Appendix B) was a modified version of others used in previous studies of physical activity among
Australian adults (for example, Bauman et al., 1996; Department of the Environment, Sport and Territories, 1995). A new self-report instrument was necessary because no existing measure met the specifications of the study. The instrument consisted of the following items:

**Years 2, 4, 6, 8, and 10.** Sociodemographic variables and self-reported height and weight.

**Years 8 and 10.** Self-reported participation in organised sports and games; self-reported participation in nonorganised physical activity; frequency of participation in, and attitudes towards physical education; amount of time spent daily and weekly in specific sedentary activities; and selected items based on social learning theory which included social influences towards participation, self-efficacy, outcome expectations, outcome values, barriers to participation, and preferred activities.

For the purposes of this study, only sociodemographic, self-reported participation in organised sports and games, and self-reported participation in nonorganised physical activity data from the Years 8 and 10 questionnaire were used. The sociodemographic variables that were assessed included: school year (8 or 10); sex; month, year, and country of birth; language spoken most at home; and suburb and postcode or residence. The self-report recall questionnaire of participation in physical activity was a single instrument which comprised four sections: (a) participation in organised sports and games during summer months; (b) participation in organised sports and games during winter
months; (c) participation in nonorganised physical activity during summer months; and (d) participation in nonorganised physical activity during winter months.

For this study, only data on participation in organised sports and games, and participation in nonorganised physical activity during summer months were used. A choice had to be made between using either year-round activity, or only activity participated in during the time of assessment (all measurements were taken during summer months). Because the former option would have placed a greater strain on the students’ level of recall accuracy, as they would have had to remember activities they had participated in during the previous winter months, some six months prior, the latter procedure was selected. Although this procedure may overestimate the year-round participation of students as individuals are generally more active in summer months (Mensink, Heerstrass, Neppelenbroek, Schuit, & Bellach, 1997), it was believed this limitation would still provide more accurate information about the nature of the relationships under investigation compared with year-round activity.

Organised sports and games were defined as those activities that involved regular classes, training, and competition; were reasonably structured or formal; and had a coach, instructor, or teacher. Examples included a dance or gymnastics class; touch football, netball, soccer, rugby, or basketball team; or swimming, athletics, or surf lifesaving club. Nonorganised physical activities
were defined as those activities that were not structured or formal; did not involve regular training or competition; and did not have a coach, instructor, or teacher. Examples included walking, cycling, or running for pleasure or transportation; skateboarding or rollerblading; casual ball games; and surfing.

3.3.1.1 Validity

A group of health and education professionals with expertise in the area of adolescent physical activity and physical activity assessment was formed. A draft of the instrument was developed, and distributed to each professional for their critical review of the face and content validity. Modifications to the instrument were made as a result of the professionals’ responses, and a new instrument constructed. The process was then repeated several times until consensus was reached by all professionals. As a result, the questionnaire was assumed to be valid based on face concurrent validity.

Due to the current absence of a universal gold standard of assessment for physical activity among adolescents, construct validation was necessary (LaPorte, Montoye, & Caspersen, 1985). The Multistage Fitness Test served as the criterion for indirectly assessing the construct validity of the self-report.

It is pertinent to note here that substantial investigation has occurred over the last 16 years on the relationship between cardiorespiratory endurance and physical activity in children and adolescents. Correlations have varied,
ranging from weak (Andersen, 1994; Sunnegardh & Bratteby, 1987) to moderate (Epstein et al., 1996; Janz, 1990; Marsh & Johnson, 1994), through to strong (Durant et al., 1993; Kemper & van Mechelen, 1995; Mirwald, Bailey, Cameron, & Rasmussen, 1981; Pate, Dowda, & Ross, 1990; Sallis, McKenzie, & Alcaraz, 1993c; Tell & Vellar, 1988). This variation can be partly explained by the methodological problems associated with measuring physical activity in these populations, with researchers yet to find a technique that can validly and universally assess energy expenditure (Bar-Or, 1994; Bar-Or & Malina, 1995; Freedson & Melanson, 1996). Because of these limitations, several leading authors (Bar-Or & Malina, 1995; Rowland, 1990; Rowland, 1996; Sallis et al., 1992a) believe cardiorespiratory endurance is portionally influenced by moderate-to-vigorous physical activity, and can be used as an indirect indicator in these developmental stages.

This belief is well supported by research which has reported a significant association between cardiorespiratory endurance and vigorous physical activity in adults (Bouchard et al., 1983; Dishman & Steinhart, 1988; Siconolfi, Lasater, Snow, & Carleton, 1985) and adolescents (Aaron et al., 1993; Aaron et al., 1995b; Bouchard et al., 1983; Fuchs et al., 1988; Marsh & Johnson, 1994; Tell & Vellar, 1988) and that this relationship is more consistently related to energy expenditure as the intensity of physical activity...
increases (Malina, R. M., personal communication, June 13, 1997; Tell & Vellar, 1988).

In addition, potentially confounding effects on cardiorespiratory endurance such as heredity, maturation, nutrition, climate, motivation, stress, and drug use (Dotson & Ross, 1985) are less likely to influence regular bouts of vigorous physical activity. Therefore, for these reasons, cardiorespiratory endurance was judged to be an appropriate criterion to indirectly validate the self-report of vigorous physical activity.

Criterion validity using another self-report recall questionnaire was not considered possible as there were no particularly well developed scales available, against which to compare the multiple measures used in this study.

3.3.1.2 Scoring

Students were asked to think about, for organised sports and games, and for nonorganised physical activity, a usual week during summer school terms, and a usual week during winter school terms – excluding holidays – and record three pieces of information: (a) all activities in which they participated (mode or type of activity); (b) the number of times they did this activity, including training (frequency of activity); and (c) the usual amount of time they spent doing this activity each time they did it (duration of activity). Examples of popular activities were developed and listed in the middle of the page to help
prompt students. This list provided an activity-related cue, or memory trace, which has been shown to enhance the accuracy of recall of an activity (Baranowski et al., 1984).

The questionnaire required students to make three distinctions when reporting their participation in organised sports and games, and their participation in nonorganised physical activity. These distinctions and the rationale for including them in the self-report instrument were as follows:

1. **Summer and winter.** Research suggests there are likely to be seasonal differences in participation levels (Magnus, Matroos, & Strakee, 1979; Sallis et al., 1992b; Simons-Morton et al., 1990), especially between summer and winter months (Ross et al., 1985a); therefore, summer and winter were analysed separately. However, for this study, only data on participation in physical activity during summer months were used. Summer was used because students could probably more accurately recall the activities they were participating in at the time of the study, since all measurements were taken during summer months, rather than activities they had done the previous winter, some six months previously.

2. **Organised sports and games and nonorganised physical activity.** Descriptive epidemiology suggests that nonorganised physical activity contributes substantially to the overall activity level of
adolescents (Pate, Long, & Heath, 1994; Ross et al., 1985a; Saris et al., 1986), with Dishman and Steinhart (1988) reporting that the average girl and boy devote 71% and 56% respectively of their overall physical activity to nonorganised activities; therefore, organised sports and games and nonorganised physical activities were selected as separate dependent variables.

3. Usual week. Concern has been raised (Sallis, Buono, Roby, Micale, & Nelson, 1993a; Sallis et al., 1988) about the representativeness and stability of a specific week – for example, “What have you done in the previous week?” and whether a specific week can be considered reflective of a usual or typical physical activity pattern. Because factors such as weather, ill-health, or study/work commitments may cause variations from week to week, results may be potentially confounded (Mensink et al., 1997); therefore, students were questioned about their normal or usual week in summer and winter. Usual activity is a more appropriate method of assessing physical activity compared with a representative week (Sallis et al., 1988) as it more accurately represents an individual’s true habitual activity pattern (Ainsworth, Montoye, & Leon, 1994) which is a more beneficial measure in determinants studies (Sallis et al., 1988).
From this information, physical activity categories were constructed by assigning a score to each activity. For example, walking for transport scored 4.0, jazz dancing scored 6.0, mountain biking scored 8.5, and basketball scored 7.0. These scores were primarily obtained from a compendium of physical activities from Ainsworth et al. (1993) and reflect the activity’s level of intensity. Level of intensity was defined in terms of multiples of resting metabolic rate (METS) with 1 MET approximately equivalent to 3.5 ml of \(O_2\) · kg\(^{-1}\) · min\(^{-1}\), which equates to the energy expenditure for sitting quietly (Ainsworth et al., 1994) The criterion for a vigorous level of intensity was defined as requiring greater than or equal to 6.0 METS of energy expenditure, a criterion which has been used in other youth studies (Aaron et al., 1995b; Booth, Macaskill, Phongsavan, McLellan, & Okely, 1998; Trost et al., 1996; Trost et al., 1997).

Some authors (Aaron et al., 1995b; Booth et al., 1998; Dishman & Sallis, 1994; Sallis & Hovell, 1990; Trost et al., 1997) have suggested that because the determinants of moderate and vigorous physical activity may be different, they should not be grouped together; therefore, for the purposes of this study, only vigorous physical activity was selected. Participation in vigorous activity was selected instead of moderate activity because:

1. Adolescents are more accurate in recalling vigorous activities compared to moderate activities (Aaron et al., 1993; Sallis et al., 1993a).
2. The fundamental motor skills measured are probably more closely related to the popular vigorous activities such as soccer, tennis, and netball, compared to popular moderate activities such as walking, cycling, and swimming.

3. Vigorous physical activity has a stronger relationship to health benefits (Baranowski et al., 1992; Craig et al., 1996; Haskell, Montoye, & Orenstein, 1985; Mensink et al., 1997; Paffenbarger, Hyde, Wing, & Hsieh, 1986; Paffenbarger, Wing, & Hyde, 1978; Sallis et al., 1993a) and, as such, is the preferred intensity of physical activity in which young people should be encouraged to participate.

4. It has been rarely studied among youth (Simons-Morton et al., 1990).

Body weight was not taken into account when calculating the MET values because the Physical Activity Guidelines for Adolescents recommendations (Sallis & Patrick, 1994) are not framed in terms of energy expenditure, but rather more broadly for public health prescription. Therefore, the data were expressed in a form that was compatible with these recommendations. The MET value for each activity was calculated according to the compendium of physical activities from Ainsworth et al., (1993). Although the calculations for these values were made on adults, the underestimation in Year 10 and Year 8 students is only about 5% to 9% respectively (Sallis, Buono, & Freedson, 1991) Furthermore, these underestimations have been
reported as being lower for vigorous physical activity, compared to moderate or low intensity physical activity (Sallis et al., 1991).

In addition, the following caveats were applied when constructing categories:

1. When an activity was not listed in the compendium – primarily due to its uniqueness to Australia or lack of uniqueness to North America – MET values from similar activities were used as a proxy measure.
2. When a student neglected to record the frequency, duration, or both of an activity, an approximation was made based on the corresponding median value of other students who participated in the same activity. The purpose of this procedure was to reduce the chance of misclassifying the activity level of such a student.
3. Only those activities with a MET value greater than or equal to 6.0 – the definition of vigorous activity – and that were participated in for at least 10 minutes during any one bout were used in the calculations.

3.3.2 Fundamental Motor Skills Test Battery

To assess fundamental motor skill ability, a modified version of the test battery found in Fundamental Motor Skills: A Manual for Classroom Teachers (Department of Education, Victoria, 1996) was used. Three major considerations were taken into account when selecting this battery:
1. **Ease of administration.** The test battery had to be able to assess students using standard, nonspecialised equipment and facilities; with a minimal level of tester expertise; and in a relatively short period of time.

2. **Meaningfulness of tests.** The skills included in the test battery had to relate to aspects of motor development that were considered most important for students to master. Each skill was composed of observable, qualitative components which when put together constituted the whole fundamental motor skill (Department of Education, Victoria, 1996). It was believed that these should prevail over quantitative components as they measured technique rather than distance and speed, and provided a greater scope for feedback due to the focus on how the skill was performed (process oriented), rather than its outcome, (product oriented; Gallahue, 1982; Holland, 1986; Wickstrom, 1983).

3. **Relevance of tests.** The test battery was closely related to activities and sports that students in the schools being assessed would be inclined to select as part of their habitual participation in physical activity. The original battery consisted of 11 critical fundamental motor skills (catch, kick, run, vertical jump, overhand throw, ball bounce, leap, dodge, punt, forehand strike, and two-hand side arm strike) which were deemed as being the most essential for children to learn. From this battery, six fundamental motor skills (catch, kick, run, vertical jump, overhand throw, and forehand strike)
were selected on the basis of advice from a relevant expert in the fundamental motor skill development area who had developed and used the test battery with similar age groups (B. V. Holland, personal communication, October, 1996).

The set of six fundamental motor skills was divided into two subsets: locomotor skills (run and vertical jump) and manipulative skills (catch, overhand throw, kick, and forehand strike).

3.3.2.1 Reliability

In order to obtain reliability data authors of Fundamental Motor Skills: A Manual for Classroom Teachers (Department of Education, Victoria, 1996) performed a seven-day test-retest study using a group of 42 primary school children – comprised of three boys and three girls in each year from Kindergarten through Year 6, who were randomly selected from their class rolls. The test-retest reliability coefficient for each fundamental motor skill was as follows:

- run (.17)
- vertical jump (.74*)
- catch (.92*)
- overhand throw (.92*)
- kick (.78*)
- forehand strike (.95*)

(* Significant at p < .01)

A test-retest reliability coefficient of $r = .7$ has been suggested as a standard of acceptability (Sallis et al., 1993b); therefore, only the run has failed to meet this standard. However, other studies have reported equivocal levels of reliability on the run (Holland, 1986; Ulrich, Ulrich, & Branta, 1988). The low level may be explained by the fact that because components had to be demonstrated throughout the run and it was a continuous skill with less discrete beginning and end points; it was less objective to assess; and it was more open to variation between assessments.

### 3.3.2.2 Validity

To assess the validity of the Fundamental Motor Skills Test Battery, the authors (Department of Education, Victoria, 1996):

1. Extensively reviewed the literature in the area of fundamental motor skills, and recorded the frequency distribution of each skill cited. This came to a total of 48 fundamental motor skills.
2. Developed a panel of 52 fundamental motor skills experts who acted as consultants and assisted in the selection of skills to be included in a fundamental motor skills test battery for Australian children.
3. Asked the expert panel to review the 48 fundamental motor skills cited in the literature, and rank them in order of importance to the skill development of primary school children. As a result, 12 skills were selected as the most essential. However, one of these skills was subsequently omitted from the final list due to difficulties in its assessment.

4. Reviewed the literature for the 11 skills and identified the components for each skill. The expert panel reviewed the component checklist for each fundamental motor skill and critiqued and made suggestions to improve the description of each component. Each response was recorded and adjustments made to the descriptions. A final set of protocols was devised from this information.

3.3.2.3 Scoring

Each fundamental motor skill was partitioned into its qualitative components (see Appendix C), which were identical to those described in Fundamental Motor Skills: A Manual for Classroom Teachers (Department of Education, Victoria, 1996). The number of components for each skill varied from five for the run and vertical jump, to six for the catch and overhand throw, to seven for the kick and forehand strike. Students performed each skill five times in a row, except for the run. On the score sheet provided (see Appendix
D) a number was placed in each of the boxes that corresponded with each component of that skill. A 1 signified that the student successfully demonstrated that component on four out of five trials and a 2 indicated that they were unsuccessful. For the run, the student had to successfully demonstrate the component throughout the performance in order to score a 1.

For each skill, a score was calculated for each student based on the total number of skill components successfully demonstrated. These were then standardised and all six fundamental motor skills summed to create an index of overall fundamental motor skill ability.

3.3.3 The Multistage Fitness Test

The Multistage Fitness Test, first described by Léger and Lambert, (1982) is a field measurement that was used to indirectly assess cardiorespiratory endurance. This test was selected over other field measures of cardiorespiratory endurance such as time and distance runs as it has been shown to be more motivational and appropriate for indoor testing, and less influenced by pacing among adolescents (ACHPER, 1996; Docherty, 1996a)

3.3.3.1 Reliability

Adequate test-retest reliability has been demonstrated for this test in adults, with correlations ranging from .91 to .97 (Léger & Lambert, 1982; Léger, Mercier, Gadoury, & Lambert, 1988; Sproule, Kunalan, McNeill, & Wright, 1993) and in adolescents, with correlations ranging from .89 to .93
(Léger et al., 1988; Liu, Plowman, & Looney, 1992). A test-retest reliability of $r = .7$ has been cited as a standard of acceptability in behavioural sciences (Sallis et al., 1993b).

3.3.3.2 Validity

Validity of the Multistage Fitness Test, as an indirect measure of cardiorespiratory endurance, has been established in relation to directly determined maximal oxygen consumption in adults, with correlations ranging from .84 to .92 (Léger & Gadoury, 1989; Léger & Lambert, 1982; Léger et al., 1988; Ramsbottom, Brewer, & Williams, 1988); and in adolescents, with correlations ranging from .71 to .76 (Barnett, Chan, & Bruce, 1993; Léger et al., 1988; Liu et al., 1992; Mercier, Léger, & Lambert, 1983; van Mechelen, Hlobil, & Kemper, 1986).

3.3.3.3 Scoring

The level and shuttle reached by each student was converted into the number of laps which were used for subsequent analyses.

3.3.4 Control Variables

The following control variables were measured:

1. Gender
2. Age

3. Socioeconomic status

4. Geographic location

3.3.4.1 Gender

Gender was a dichotomous variable indicated by whether the student was a male (1) or a female (2).

3.3.4.2 Age

Age was a dichotomous variable based on school year and indicated by whether the student was in Year 8 (8) or in Year 10 (10).

3.3.4.3 Socioeconomic Status

Socioeconomic status was a trichotomous variable based on postcode of residence, using the Australian Bureau of Statistics (ABS) Tertile Index of Relative Socioeconomic Disadvantage. Postcodes were assigned a value and, according to this value, were grouped into a low (1), medium (2), or high (3) tertile.

Because these values were based on ABS census data from 1991, some postcodes from newer suburbs were not available. In this case, Australia Post provided information about how to assign the index value that most closely
corresponded with that suburb. Students who neglected to provide a postcode of residence were assigned the most frequent postcode from their school.

3.3.4.4 Geographic Location

Geographic location was a dichotomous variable based on location of school. Schools were assigned as either urban (0) or rural (1) based on Department of School Education classifications. For Catholic Education Commission and Independent schools, urban schools were classified as those in the Sydney Metropolitan, Illawarra, Newcastle, and Central Coast regions. Rural schools comprised all others.

3.3.5 Summary

Specific instruments were used to measure the variables under investigation in this study. Instruments with established reliability and validity characteristics were used or modified to measure the relationship of participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance to fundamental motor skill ability among adolescents. A summary of the variables and instruments or questions used in this study appears in Table 1.
Table 1

Variables and Instruments Used in the Study

<table>
<thead>
<tr>
<th>Variable</th>
<th>Instrument or Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organised sports and games</td>
<td>Self-Report Recall Questionnaire of Participation in Organised Sports and Games</td>
</tr>
<tr>
<td>Nonorganised physical activity</td>
<td>Self-Report Recall Questionnaire of Participation in Nonorganised Physical Activity</td>
</tr>
<tr>
<td>Cardiorespiratory endurance</td>
<td>Multistage Fitness Test</td>
</tr>
<tr>
<td>Gender</td>
<td>“Are you a boy or a girl?”</td>
</tr>
<tr>
<td>Age (School Year)</td>
<td>“What Year are you in?”</td>
</tr>
<tr>
<td>Socioeconomic Status</td>
<td>Postcode of Residence</td>
</tr>
<tr>
<td>Geographic Location</td>
<td>Location of School</td>
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</tbody>
</table>

3.4 Procedures

Data were collected with the aforementioned instruments using the following procedures.

3.4.1 Authorisation

To collect data for this study, authorisation was required from a number of sources:
3.4.1.1 University of Wollongong Human Research Ethics Committee

Protocol requirements established by the University of Wollongong Human Research Ethics Committee were satisfied prior to data collection (see Appendix E).

3.4.1.2 Education Sectors

District Superintendents (Department of School Education) and Diocesan Directors (Systemic Catholic Education Commission) were contacted regarding participation in the study by their PDHPE Chief Executive Officer and Catholic Education Commission Education Sector Liaison Officer respectively, as they were in charge of the schools in their district or diocese. Their approval was sought to approach the selected schools in their district or diocese. They were provided with information about the study (see Appendix F), and requested to inform and encourage the selected schools to participate. Principals were directly contacted in nonsystemic Catholic Education Commission and Independent schools.

3.4.1.3 Principals of Selected Schools

Contact with school principals was sought after approval had been given by respective District Superintendents and Diocesan Directors. This was initiated by a mailed package containing an information sheet outlining the school’s involvement in the study, the study protocol, guarantee of
confidentiality, steps to protect the students’ well-being, contacts for further inquiries, and names and contact details of a member of the Human Research Ethics Committee for expressions of dissatisfaction about unethical behaviour (see Appendix F); no such expressions were received. Approximately one to two weeks after the mailing out of the information package, a follow-up telephone call was made to each principal. They were asked if they approved the study being conducted in their school, and if so, they were asked to render the name of a teacher who would act as liaison officer for the study.

Subsequently, a facsimile containing the school’s confirmation of agreement to participate, a preferred, but negotiable, date for data collection, and protocol for randomly selecting school classes (see Appendix G) was sent to the liaison officer of each school. Approximately two days after the facsimile, follow-up telephone contact was made with the school liaison officer and one class each from Year 8 and Year 10 was selected using a standard protocol (see Appendix H).

3.4.1.4 Parents and Students

Following the random selection of one Year 8 and one Year 10 class, information letters and active consent forms were sent home by the school to the parents or carers of each student (see Appendix I). It was entirely at the discretion of the school when they decided to have the consent forms returned,
however, active consent was required for participation. That is, parents or carers had to return the consent form to their child’s teacher in order for them to participate. If a parent did not return the consent form, it was assumed they did not want their child to participate in the study, and alternative arrangements during the testing period were made by the school for those students. It was also stressed to participating students that they were entitled to decline or withdraw at any time from any of the tests.

3.4.2 Pilot Testing

Prior to data collection, pilot testing was conducted on all three instruments to assess their suitability for the sample, and the appropriateness of time allocation to each.

3.4.2.1 Self-report Recall Questionnaire of Participation in Physical Activity

The self-report recall questionnaire of participation in physical activity was pretested and refined in pilot studies with two Year 8 classes (of approximately 40 students each) prior to the study. Questions that needed clarification or that elicited socially desirable responses were reworded.

3.4.2.2 Dress Rehearsals

Two days were set aside immediately prior to data collection to refine the administration procedures for the fundamental motor skills test battery,
Multistage Fitness Test, and self-report questionnaire. Each dress rehearsal day was separated by a debriefing session in which the administration protocols were reviewed and further refined to maximise the accuracy of subsequent data collection. In addition, regular feedback was obtained during the first week of formal data collection and further refinements passed on to all field officers.

3.4.3 Data Collection

3.4.3.1 Assessor Recruitment

There were 16 assessment staff who were specially seconded and trained for the larger project. These staff comprised: eight current secondary PDHPE teachers and six current primary school teachers who had been selected by their relevant education system on the basis of written applications; one project officer; the chief investigator; and the author. In addition, the larger project employed: two half-time project officers who had educational survey research experience; a full-time school support liaison officer seconded from the Department of School Education; and a biostatistician/epidemiologist.

3.4.3.2 Assessor Training

To ensure the reliability, validity, and stability of the data, assessors undertook the following training over a two week period:
1. Three days of anthropometry, to Level 1 of the International Society for the Advancement of Kinanthropometry (ISAK) accreditation scheme.

2. Two days of fundamental motor skill and health-related fitness assessment techniques.

3. Two days of learning and practising correct self-report administration techniques.

4. Two days of dress rehearsals.

3.4.3.3 Collection in Schools

Data collection occurred between 17 February and 27 March 1997. Data were collected by the assessment staff simultaneously in DSE, CEC (Systemic and Nonsystemic), and Independent schools; and in urban and rural areas. This was done to prevent the potential bias associated with measuring physical activity during different times of the year (Sallis et al., 1992b) and progression through the school year.

The assessment items and procedures were identical for students in Years 8 and 10. Year groups were assessed separately, and each group took approximately two-and-one-half to three hours to complete. The normal procedure was that one class was assessed in the morning and the other in the afternoon.
3.4.3.4 Self-report Recall Questionnaire of Participation in Physical Activity

Students sat at individual desks in a classroom, preferably with their school teacher out of the room, in order to prevent potential bias of student responses and ensure confidentiality. The assessors had been trained to administer the self-report questionnaire in a standardised manner.

Before commencing, students were given a brief explanation of the purpose of the Survey and informed that their participation was voluntary. After receiving a questionnaire, general directions from a detailed, prompted script were read aloud to the class, and students were asked to fill in their name, the name of their school, and distinct school and year code on the first page. In addition, the student’s name, school code, and year code were filled in on the last page which was used for the fundamental motor skills and cardiorespiratory endurance tests. This allowed the matching of each student’s questionnaire and objective measurement record sheets prior to data entry. Questionnaires were numbered sequentially within each class to create a unique, five-digit identification number for each student. Student names were removed from questionnaires before analysis to protect confidentiality. At least two field officers remained in the classroom during the completion of the questionnaire. Generally, one assessor read the instructions (see Appendix J), while the other circulated throughout the classroom answering any individual questions and checking that students had answered all questions.
Upon opening the questionnaire, the questions were read aloud to the students. This procedure resulted from the pilot studies where it was found that if students were left to their own devices to answer the questions, some had inquiries that indicated a conceptual misunderstanding of what was required, or completed the questions incorrectly. Therefore, it was decided to provide extra verbal clarification of the questions. Once this had been done, students were free to complete the questionnaire in their own time. They were reminded that if they still had any further questions to raise their hand, and an assessor would assist. Upon completing the questionnaire, students took it to a designated assessor who briefly checked each page and resolved any concerns with the student. The assessor then removed the rear page from the questionnaire, which was required for the fundamental motor skills and cardiorespiratory endurance tests, and placed the completed questionnaire in an unmarked envelope to ensure confidentiality. Administration time was approximately 40 minutes per class.

3.4.3.5 Fundamental Motor Skills Test Battery

Prior to each test, students were given a visual demonstration by an assessor of the correct technique for performing the skill, but were not told what the components were that were being assessed. This was done to clarify to students the correct protocol for each skill, and to avoid misinterpretation of
the performance of the skill, without revealing what components were being assessed. The simple instructions given to students were, “This is how I want you to perform the skill. Watch how I am doing it, then try to repeat my performance.” The fact that students had several trials for each skill meant that even if they were trying to unnaturally mimic the assessor, they reverted back to their natural technique after one of two trials, thus not influencing their final score. No verbal feedback on student performance was given during or after the tests.

Each class was split evenly into four groups with one assessor taking each group and assessing them separately on all skills except for the catch and forehand strike, which required two assessors for assessment. This procedure was found to be the most time-effective and the smaller groups made students easier to manage. Each student was assessed from a side-on position. For the overhand throw, kick, and forehand strike this was the side corresponding with the hand or leg the student used to perform the skill as this was the only way some components could be accurately assessed.

Run. Two markers were placed approximately 20 metres apart with the starting point at one of the markers. Students were instructed to run as fast as they could to the other marker, stop, turn around, and then repeat the run in the opposite direction. The run was assessed from a position midway between the two markers in a side-on position as this gave the best vision of the student at
full speed. At the end of the second lap, a number was placed in each of the five boxes that corresponded with each component of the run. A 1 signified that the student possessed that component, a 2 meant they did not. These were the skill components assessed:

1. Eyes focused forward throughout the run.
2. Knees bend at right angles during recovery phase.
3. Arms bend at elbows and move in opposition to legs.
4. Contact ground with front part of foot.
5. Body leans slightly forward.

**Vertical jump.** The vertical jump test required students to stand in a two-by-two metre square – designated by four markers – and to jump as high as possible in the air. Once they had landed, they were to come to a completely stationary position, and assume the demonstrated starting position before commencing their next trial. These were the skill components assessed:

1. Eyes focused forwards or upwards throughout the jump.
2. Crouch with knees bent with arms behind body.
3. Forceful upward thrust of arms as legs straighten to take off.
4. Contact ground with front part of feet and bend knees to absorb landing.
5. Balanced landing with no more than one step in any direction.
**Catch.** The students stood in the middle of a two-by-two metre square, designated by four markers. One assessor stood 15 metres away and, when the student signalled that they were ready, threw a tennis ball using a firm overarm or underarm throw, so that the student was required to catch the ball at chest height. The throw needed to be from this distance and quite firm in order to allow Component 6 to be demonstrated. If the student caught the ball, they were to roll it back to the assessor; if they missed it, they simply left it and concentrated on their next catch. These were the skill components assessed:

1. Eyes are focused on ball throughout the catch.
2. Preparatory position with elbows bent and hands in front of body.
3. Hands move to meet the ball.
4. Hands and fingers positioned correctly to catch the ball.
5. Catch and control of the ball with hands only.
6. Elbows bend to absorb the force of the ball.

**Overhand throw.** For this test a two-by-two metre square – designated by four markers – was set up approximately five metres from a wall. Five bean bags were placed in a pile at the back of the square. Students were instructed to pick up one bean bag at a time, move into the middle of the square, face the wall, and throw the bean bag as hard as they could against the wall. They then picked up the next bean bag from the pile and repeated the sequence. At the
completion of five throws, students recovered the bean bags and placed them in a pile for the next student. These were the skill components assessed:

1. Eyes are focused on the target throughout the throw.
2. Stand side-on to the target.
3. Throwing arm nearly straightened behind the body.
4. Step toward the target with foot opposite throwing arm during the throw.
5. Marked sequential hip-to-shoulder rotation during the throw.
6. Throwing arm follows through down and across the body.

Kick. A foam ball, the size of a soccer ball, was placed on a bean bag approximately 10 metres from a wall. Students were asked to kick the ball as hard as they could against the wall, then move back into the starting position ready for their next kick. The ball was meanwhile retrieved and placed on the bean bag. These were the skill components assessed:

1. Eyes are focused on the ball throughout the kick.
2. Step forward with nonkicking foot placed near the ball.
3. Bend knee of kicking leg during the backswing for the kick.
4. Hip extension and knee flexion of at least 90° during preparatory phase.
5. Contact the ball with the top of the foot.
6. Forward and sideways swing of the arm opposite to the kicking leg.

7. Kicking leg follows through towards the target after ball contact.

**Forehand strike.** The students stood in the middle of a three-by-three metre square – designated by four markers – with a small paddle tennis bat. One assessor stood 10 metres away and when the student signalled they were ready, bounced a tennis ball using a gentle overarm or underarm throw, such that the student was required to strike the ball on the first bounce, on the forehand side, at waist height. The student was instructed to strike the ball firmly, aiming at the assessor who had bounced them the ball. These were the skill components assessed:

1. Eyes are focused on ball throughout the strike.
2. Stand side-on to target with bat held in one hand.
3. Striking arm nearly straightened behind shoulder at the end of the swing.
4. Step towards the target with foot opposite to the striking arm during the strike.
5. Marked sequential hip-to-shoulder rotation during the strike.
6. Ball contact made opposite to front foot with a straight arm.
7. Follow through towards the target then around the body.
3.4.3.6 The Multistage Fitness Test

The Multistage Fitness Test performed by the students in this study was identical with that described in the Australian Fitness Education Award: User’s Manual and Curriculum Ideas (ACHPER, 1996). Briefly, this involved the students having to shuttle-run between two lines placed 20 metres apart, at increasing speeds, keeping in time with the beeps on the accompanying audio cassette. The test took place on a wooden, bitumen, concrete, or grass surface. To ensure that the tape in the audio cassette had not stretched from regular use and that the speed of the tape recorder was correct, the tape was calibrated before each test and the distance between the two lines modified accordingly. The running speed started at 8.5 km · hr\(^{-1}\) and increased 0.5 km · hr\(^{-1}\) each successive minute, with each increase corresponding with a change in level. Students ran in groups of no more than 15 to ensure adequate spacing. Assessors instructed students regarding the test and pacing, and generally ran the first level with them to provide visual demonstration. The test was terminated when a student could no longer follow the set pace – that is, make the end of the 20 metre track within the given time period on two successive shuttles – or when a student withdrew voluntarily. Upon termination, each student approached one of the assessors who wrote the level and shuttle on their hand in a water-soluble marker. When all students had finished the test, their scores were recorded by an assessor.
3.4.4 Data Entry

At the completion of testing, the self-report questionnaire and objective measurements sheets, which contained the fundamental motor skills and cardiorespiratory endurance data for each student, were matched up. This was possible as each student’s name appeared in pencil on both sheets. The final two digits, comprising an individual code number, were added to each student’s existing three-digit number, which comprised a school code number (first two digits) and year group (middle digit), to create a unique five-digit number for each student. Each self-report questionnaire was then inspected by hand to ensure acceptability for scanning. Common corrections made during this procedure included entering the correct postcodes, removing foreign pencil marks, and tracing over responses which were filled in lightly in pencil and may not have been identified by the scanner. Student names were also removed or blacked out at this stage to ensure confidentiality of student data.

The sociodemographic items from the self-report recall questionnaire of participation in physical activity were scanned directly into an ASCII tab-delimited format using a Scanmark 2500 Optical Mark Reader and subsequently imported into and stored in EpiInfo 6, Version 6.04. The self-reported participation in organised sports and games, and the self-reported participation in nonorganised physical activity sections of the self-report recall questionnaire of participation in physical activity, were manually entered into EpiInfo 6, Version 6.04, in compliance with the activity coding sheets
constructed for this study (see Appendix K). Data from the cardiorespiratory endurance and fundamental motor skills tests were double entered by a private data entry business.

All data files were converted to and stored as SAS (Statistical Analysis System) files. The data from each student’s self-report questionnaire and objective measurements’ tests were subsequently merged using their unique five-digit identification number to create a separate data record for each student.

The files were then obtained by the author from the project statistician, who had applied the appropriate cleaning and checking procedures to the data. The statistician checked for duplicated and missing records, and these were rectified before the analyses began.

3.5 Statistical Analyses

Specific instruments were selected to measure the variables under investigation in this study. These were administered using standardised and recognised procedures. Subsequent to data collection, the following statistical analyses were performed on the data using the Statistical Analysis Systems, version 6.12 (SAS Institute Inc., 1997).
3.5.1 Independent and Dependent Variables

In scientific investigation, some variables are identified as independent or dependent. The variables that are measured and manipulated to determine their relationship to an observed phenomenon are referred to as independent variables, and the variables that are observed and measured to determine the effects of the independent variable(s) are referred to as dependent variables (Borg & Gall, 1983; Thomas & Nelson, 1996; Tuckman, 1994).

In this study, fundamental motor skill ability (research questions one, two, and three) was treated as the independent or predictor variable. Time spent participating in organised sports and games (research question 1), time spent participating in nonorganised physical activity (research question 2), and cardiorespiratory endurance (research question 3) were treated as the dependent or outcome variables. A summary of the independent and dependent variables in this study appear in Table 2.
Table 2

Description of Independent and Dependent Variables for Each Research Question Under Investigation in this Study.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Dependent Variable</th>
<th>Independent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question One</td>
<td>Time spent participating in organised sports and games</td>
<td>Fundamental motor skill ability</td>
</tr>
<tr>
<td>Question Two</td>
<td>Time spent participating in nonorganised physical activity</td>
<td>Fundamental motor skill ability</td>
</tr>
<tr>
<td>Question Three</td>
<td>Cardiorespiratory endurance</td>
<td>Fundamental motor skill ability</td>
</tr>
</tbody>
</table>

As discussed in Chapter II, previous studies on the prevalence and determinants of physical activity and fundamental motor skill ability have reported variations attributable to gender, school year, socioeconomic status, and geographic location. Furthermore, preliminary analyses in this study reinforced these significant differences; therefore, gender, age (identified as school year), socioeconomic status, and geographic location were controlled for in all analyses between relevant variables.
3.5.2 Time Spent Participating in Organised Sports and Games

The recall questionnaire concerning self-reported participation in organised sports and games was administered and the following steps were taken:

1. Each activity was assigned a MET value according to the 
   *Compendium of Physical Activities* (Ainsworth et al., 1993).
2. Only those activities with a MET value greater than or equal to 6.0 were classified as vigorous activities and used in subsequent calculations.
3. Descriptive statistics and frequency tables were calculated for the number of minutes spent participating in vigorous organised sports and games. From this, a continuous variable was created.

3.5.3 Time Spent Participating in Nonorganised Physical Activity

The recall questionnaire concerning self-reported participation in nonorganised physical activity was administered and the following steps were taken:

1. Each activity was assigned a MET value according to the 
   *Compendium of Physical Activities* (Ainsworth et al., 1993).
2. Only those activities with a MET value greater than or equal to 6.0 were classified as vigorous activities and used in subsequent calculations.

3. Descriptive statistics and frequency tables were calculated for the number of minutes spent participating in vigorous nonorganised physical activity. From this, a continuous variable was created.

3.5.4 Fundamental Motor Skill Ability

The fundamental motor skills test battery was used to assess fundamental motor skill ability and the following steps were taken:

1. Each skill was standardised to a score of five.

2. The standardised scores for the six skills were added together to create an index of fundamental motor skill ability (scores could hypothetically range from 0 to 30).

3. For each gender, students’ standardised scores for the fundamental motor skills test battery were used to rank order them into very low, low, medium, high, or very high quintiles among their peers based on level of fundamental motor skill ability.

3.5.5 Cardiorespiratory Endurance

The Multistage Fitness Test was used to measure cardiorespiratory endurance and the following steps were taken:
1. The level and shuttle reached was converted to the number of laps, using a table from the Australian Fitness Education Award: User’s Manual and Curriculum Ideas, (see Appendix L; ACHPER, 1996).

2. Descriptive statistics and frequency tables were calculated for the number of laps reached on the Multistage Fitness Test. From this, a continuous variable was created.

3.5.6 Analysis of Research Hypothesis One

The self-report recall questionnaire of participation in organised sports and games and the fundamental motor skills test battery were administered and the following steps were taken:

1. A descriptive mean score and standard deviation were calculated for each of the categories of each independent variable.

2. A multiple regression analysis was performed to examine the relationship between time spent participating in organised sports and games and fundamental motor skill ability controlling for gender, school year, socioeconomic status, and geographic location and all interactions between them (the control variables were entered into the analysis as independent variables).

3. All nonsignificant independent variables (referred to as main effects) and interactions were omitted each time the model was run.
3. This process was repeated until all nonsignificant main effects and interactions were removed from the model.

3.5.7 Analysis of Research Hypothesis Two

The self-report recall questionnaire of participation in nonorganised physical activity and the fundamental motor skills test battery were administered and the following steps were taken:

1. A descriptive mean score and standard deviation were calculated for each of the categories of each independent variable.

2. A multiple regression analysis was performed to examine the relationship between time spent participating in nonorganised physical activity and fundamental motor skill ability controlling for gender, school year, socioeconomic status, and geographic location and all interactions between them (the control variables were entered into the analysis as independent variables).

3. All nonsignificant independent variables (referred to as main effects) and interactions were omitted each time the model was run. This process was repeated until all nonsignificant main effects and interactions were removed from the model.
3.5.8 Analysis of Research Hypothesis Three

The Multistage Fitness Test and the fundamental motor skills test battery were administered and the following steps were taken:

1. A descriptive mean score and standard deviation were calculated for each of the categories of each independent variable.
2. A multiple regression analysis was performed to examine the relationship between cardiorespiratory endurance and fundamental motor skill ability controlling for gender, school year, socioeconomic status, and geographic location and all interactions between them (the control variables were entered into the analysis as independent variables).
3. All nonsignificant independent variables (referred to as main effects) and interactions were omitted each time the model was run. This process was repeated until all nonsignificant main effects and interactions were removed from the model.

3.5.9 Summary

Table 3 presents a summary of the statistical analyses used and the variables for each research question investigated in this study.
### A Summary of the Research Questions, Variables, and Statistical Analyses Performed in this Study

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Variables</th>
<th>Statistical Analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is participation in organised physical activity related to adolescents’</td>
<td>• Self-report recall questionnaire of participation in organised sports</td>
<td>Descriptive statistics, correlations, and Multiple regression.</td>
</tr>
<tr>
<td>fundamental motor skill ability?</td>
<td>and games</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fundamental Motor Skills Test Battery</td>
<td></td>
</tr>
<tr>
<td>2. Is participation in nonorganised physical activity related to adolescents’</td>
<td>• Self-report recall questionnaire of participation in nonorganised</td>
<td>Descriptive statistics, correlations, and Multiple regression.</td>
</tr>
<tr>
<td>fundamental motor skill ability?</td>
<td>physical activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fundamental Motor Skills Test Battery</td>
<td></td>
</tr>
<tr>
<td>3. Is cardiorespiratory endurance related to adolescents’ fundamental motor skill</td>
<td>• Multistage Fitness Test</td>
<td>Descriptive statistics, correlations, and Multiple regression.</td>
</tr>
<tr>
<td>ability?</td>
<td>• Fundamental Motor Skills Test Battery</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER IV

RESULTS

A study was undertaken to investigate whether participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance were each related to fundamental motor skill ability among adolescents. Data were gathered and analysed and the results are reported for each of the research questions that guided the development of this study.

4.1 Sample

The sample consisted of 2026 adolescents randomly-selected from 44 high schools throughout NSW. The numbers of students who were enrolled in the selected classes; who refused participation; who were absent on the day of assessment; and who participated in the self-report recall questionnaire of participation in physical activity, the fundamental motor skills test battery, and/or the Multistage Fitness Test are shown in Table 4. Included in Table 4 is the calculated response rate (80%) which is in excess of the 75% considered acceptable in educational research (Tuckman, 1994).
Table 4
Details of the Sample

<table>
<thead>
<tr>
<th>Class Enrolment</th>
<th>Refused</th>
<th>Absent</th>
<th>Number Participated</th>
<th>Response Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2518</td>
<td>117</td>
<td>375</td>
<td>2026</td>
<td>80</td>
</tr>
</tbody>
</table>

All of the participants completed the self-report recall questionnaire of participation in physical activity. Not all of the participants, however, completed the other two data gathering instruments. No distinction was made between those students who completed all three instruments, and those who completed only one or two instruments. As a result, the numbers of students who completed each instrument differed as follows: Self-report recall Questionnaire of Participation in Physical Activity (N = 2026), Fundamental Motor Skills Test Battery (N = 1844), and Multistage Fitness Test (N = 1942).

4.2 The Research Questions

The major foci of this study were to investigate how participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance were each related to fundamental motor skill ability among adolescents. In order to investigate all research questions in this study, multiple regression analyses were conducted to investigate relationships
between variables of interest, having controlled for other important variables.

For each research question, the analyses involved six variables. The relationship between the dependent variable (either time spent participating in organised sports and games, time spent participating in nonorganised physical activity, or cardiorespiratory endurance) and the independent variable labelled fundamental motor skill ability was of prime concern in each research question.

In addition, research suggests that gender (Aaron et al., 1993; Anderssen & Wold, 1992; Armstrong et al., 1990; Fuchs et al., 1988; Janz & Mahoney, 1997a; Ross et al., 1985a; Sallis et al., 1996; Saris, 1986; Sunnegardh & Bratteby, 1987; Tell & Vellar, 1988; Trost et al., 1996; Trost et al., 1997; Zakarian et al., 1994), age (identified as school year in this study; Bungum & Vincent, 1997; Fuchs et al., 1988; Janz & Mahoney, 1997a; Myers et al., 1996; Ross et al., 1985a; Simons-Morton et al., 1990; Sunnegardh & Bratteby, 1987; Zakarian et al., 1994), socioeconomic status (Aaron et al., 1993; Butcher, 1983; Godin & Shephard, 1990; Gottlieb & Chen, 1985), and geographic location (Einspruch, 1994; Huang & Malina, 1996; Meehan, 1993) are related to physical activity and cardiorespiratory endurance. Therefore, these variables (labelled control variables) and all possible interactions were entered into the regression model to investigate the possibility that the relationship of time spent participating in nonorganised physical activity, and cardiorespiratory endurance
to fundamental motor skill ability may vary in relation to gender, school year, socioeconomic status, and/or geographic location.

The relevant dependent variable was regressed on the effects of five separate independent variables (called main effects and labelled fundamental motor skill ability, gender, school year, socioeconomic status, and geographic location) along with all possible interactions between these variables. Because the five independent variables were all categorical in nature and because two of these variables (fundamental motor skill ability and socioeconomic status) had more than two categories, the general linear model for regression analysis procedure, available in the SAS statistical package (SAS Institute Inc., 1997), was used. This procedure automatically generated dummy variables and allowed the relationship between variables to be examined while holding them constant to all other variables in the model (Freund & Littell, 1991).

Table 5 details the descriptive statistics for each of the variables under investigation in this study.
Table 5

Descriptive Statistics for Dependent and Independent Variables Under Investigation in this Study

<table>
<thead>
<tr>
<th>Category and Variable</th>
<th>n</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Time spent participating in organised sports and games</em>&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2026</td>
<td>190.30</td>
<td>289.58</td>
<td>0-2700</td>
</tr>
<tr>
<td><em>Time spent participating in Nonorganised physical activity</em>&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2026</td>
<td>278.92</td>
<td>478.50</td>
<td>0-7140</td>
</tr>
<tr>
<td><strong>Cardiorespiratory endurance</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1942</td>
<td>45.11</td>
<td>24.31</td>
<td>2-140</td>
</tr>
<tr>
<td><strong>Independent Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Fundamental motor skill ability</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Low</td>
<td>369</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>369</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>367</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>374</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very High</td>
<td>365</td>
<td></td>
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<td><strong>Gender</strong></td>
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<td>Male</td>
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<tr>
<td>Female</td>
<td>945</td>
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<tr>
<td><strong>School Year</strong></td>
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<tr>
<td>Year 8</td>
<td>1072</td>
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<tr>
<td>Year 10</td>
<td>954</td>
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<td><strong>Socioeconomic status</strong></td>
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<tr>
<td>Low</td>
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<tr>
<td>Medium</td>
<td>688</td>
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<tr>
<td>High</td>
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<tr>
<td><strong>Geographic location</strong></td>
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<td></td>
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<tr>
<td>Rural</td>
<td>604</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Urban</td>
<td>1422</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Scores represent number of minutes per usual week

<sup>b</sup> Scores represent number of laps completed on the Multistage Fitness Test
An alpha level (level of significance) of .1 was initially used in all analyses to maximise the detection of potentially important main effects and interactions that may have been overlooked had a lower alpha level been set. This is in line with conventional educational procedures (Borg & Gall, 1983). When the model was re-fitted (with the nonsignificant main effects and interactions omitted), a more stringent alpha level of .05 was used and this was the level of significance in all final regression calculations.

4.2 Research Question One

Research question one investigated how the variable time spent participating in organised sports and games was related to adolescents’ fundamental motor skill ability. Data were obtained through the questionnaire that asked respondents to report the amount of time spent in organised sports and games during a usual week and through the fundamental motor skills test battery.

In order to investigate this relationship, regression analysis was used with time spent participating in organised sports and games as the dependent variable. Independent variables were fundamental motor skill ability, gender, school year, socioeconomic status, and geographic location. Table 6 shows the
means, standard deviations, and frequencies for time spent participating in organised sports and games for each independent variable.

Table 6

Mean Scores for Time Spent Participating in Organised Sports and Games

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>M</th>
<th>SD</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Spent Participating in Organised Sports and Games (Minutes per Week)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fundamental Motor Skill Ability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Low</td>
<td>126.67</td>
<td>220.15</td>
<td>369</td>
</tr>
<tr>
<td>Low</td>
<td>146.36</td>
<td>220.30</td>
<td>369</td>
</tr>
<tr>
<td>Medium</td>
<td>193.37</td>
<td>273.21</td>
<td>367</td>
</tr>
<tr>
<td>High</td>
<td>217.17</td>
<td>278.24</td>
<td>374</td>
</tr>
<tr>
<td>Very High</td>
<td>264.84</td>
<td>381.56</td>
<td>365</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>185.53</td>
<td>280.22</td>
<td>1081</td>
</tr>
<tr>
<td>Female</td>
<td>195.76</td>
<td>299.99</td>
<td>945</td>
</tr>
<tr>
<td>School Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 8</td>
<td>179.77</td>
<td>280.73</td>
<td>1072</td>
</tr>
<tr>
<td>Year 10</td>
<td>202.15</td>
<td>298.92</td>
<td>954</td>
</tr>
<tr>
<td>Socioeconomic Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>188.69</td>
<td>299.59</td>
<td>695</td>
</tr>
<tr>
<td>Medium</td>
<td>189.24</td>
<td>275.39</td>
<td>688</td>
</tr>
<tr>
<td>High</td>
<td>193.19</td>
<td>293.78</td>
<td>643</td>
</tr>
<tr>
<td>Geographic Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>209.74</td>
<td>321.69</td>
<td>604</td>
</tr>
<tr>
<td>Urban</td>
<td>182.05</td>
<td>274.51</td>
<td>1422</td>
</tr>
</tbody>
</table>
These descriptive statistics did not take into account the relationship between time spent participating in organised sports and games and fundamental motor skill ability controlling for the mediating effects of gender, school year, socioeconomic status, and geographic location. To investigate this relationship, a multiple regression analysis was conducted.

Time spent participating in organised sports and games was then regressed on fundamental motor skill ability, gender, school year, socioeconomic status, and geographic location and the interactions between them. All main effects and interactions with large \( p \) values (> .1, approximately) were omitted (main effects could only be omitted if they were not involved in any statistically-significant interactions) and the model was re-fitted. This procedure continued until only significant interactions and main effects \( (p < .05) \) remained. Table 7 displays the significant main effects and interactions for the relationship between time spent participating in organised sports and games and fundamental motor skill ability controlling for gender, school year, socioeconomic status, and geographic location.
Table 7

Significant Main Effects and Interactions for Research Question One.

<table>
<thead>
<tr>
<th>Significant Main Effect or Interaction</th>
<th>df</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental motor skill ability</td>
<td>4, 1831</td>
<td>14.30***</td>
<td>.03</td>
</tr>
<tr>
<td>Geographic location</td>
<td>1, 1831</td>
<td>7.17**</td>
<td>.004</td>
</tr>
<tr>
<td>Fundamental motor skill ability by gender</td>
<td>4, 1831</td>
<td>3.14*</td>
<td>.007</td>
</tr>
<tr>
<td>Gender by school year</td>
<td>1, 1831</td>
<td>3.95*</td>
<td>.002</td>
</tr>
</tbody>
</table>

*p < .05., **p < .01., ***p ≤ .0001

The amount of variation in time spent participating in organised sports and games for which the full model could account was 6%. Fundamental motor skill ability specifically accounted for only 3% of the total variation in the dependent variable. However, this appeared to be a very large proportion when compared to that accounted for by the other significant main effect in the model, geographic location, which accounted for 0.4%; and the other significant interactions in the model, fundamental motor skill ability by gender and gender by school year, which accounted for 0.7% and 0.2%, respectively, of the total variation.

Results revealed that the main effect of fundamental motor skill ability was statistically significant, $F (4, 1831) = 14.30, p < .0001$. That is, fundamental motor skill ability was an important variable with respect to time spent participating in organised sports and games. As indicated in Chapter III
(page 88), each gender was separately rank ordered into quintiles according to fundamental motor skill ability. The number of males and females in each quintile were then combined, and descriptive statistics for time spent participating in organised sports and games according to fundamental motor skill ability quintiles were presented in Table 6.

Because the interaction between fundamental motor skill ability and gender was statistically significant, $F(4, 1831) = 3.14, p = .014$, an examination of time spent participating in organised sports and games, over the five fundamental motor skill ability quintiles, needed to be carried out separately for each gender. That is, it was not statistically valid to pool the results for the two genders.

A graph of the nature of this interaction (Figure 4) shows that the line for females displayed a steeper angle than the line for males. This suggested that the effect that fundamental motor skill ability had on time spent participating in organised sports and games was stronger for females than for males. That is, among females, for every unit increase in fundamental motor skill ability, there was a greater average increase in time spent participating in organised sports and games than for males. Using the Dunn method of multiple comparisons (which uses the Bonferroni inequality; Glass & Hopkins, 1984), the very low fundamental motor skill ability quintile of males. Males and
females from the low fundamental motor skill ability quintile spent a similar amount of time participating in organised sports and games. From there on, females in the middle, high, and very high fundamental motor skill ability quintiles clearly spent increasingly more time participating in organised sports and games than males, although, using Dunn’s Multiple Comparisons (MC) method, none of these differences were statistically-significant.
Figure 4. Time spent participating in organised sports and games as a function of the interaction between fundamental motor skill ability and gender. Points represent the mean number of minutes per week spent participating in organised sports and games.

To investigate the differences between quintiles of fundamental motor skill ability for each gender, in relation to time spent participating in organised
sports and games, mean scores for time spent participating in organised sports and games were compared according to fundamental motor skill ability quintiles using Tukey’s HSD test. Results of the Tukey multiple comparisons procedure revealed that, for females, each quintile of fundamental motor skill ability did not differ significantly from the one immediately above or below it, but did differ significantly when compared to all other quintiles of fundamental motor skill ability. For example, the very high quintile did not spend significantly more time participating in organised sports and games than the high quintile, but did spend significantly more time participating in organised sports and games than the medium, low, and very low quintiles. The high quintile did not spend significantly more or less time participating in organised sports and games than the medium and very high quintiles, but did spend significantly more time participating in organised sports and games than the low and very low quintiles, and so on.

Results of the Tukey multiple comparisons procedure also revealed that, for males, the only quintiles that were significantly different from each other were the very high and low, and the very high and very low. It was also interesting to note that, using Tukey’s Honest Significant Difference (HSD) test (Glass & Hopkins, 1984), there was no statistically-significant difference between the two lowest fundamental motor skill ability quintiles of males. In other words, there appeared to be a threshold effect with males’ time spent in
organised sports and games not increasing until medium fundamental motor skill ability was reached.

As previously noted, the main effect of geographic location was also statistically significant, $F (1, 1831) = 7.17, p = .008$. A more in-depth analysis for determining how time spent participating in organised sports and games differed according to geographic location was accomplished by a statistical comparison of the effects of the two locations adjusting for all other variables in the model. Results showed that rural students (adjusted $M = 214.15$, $SD = 328.82$) spent significantly more time participating in organised sports and games than urban students (adjusted $M = 178.74$, $SD = 262.29$), $p < .05$.

The interaction of gender and school year was also statistically significant, $F (1, 1831) = 3.95, p = .047$. This suggested that the relationship between school year and time spent participating in organised sports and games differed for males and females.

As a further examination to the statistically significant gender by school year interaction, a graph of the nature of this interaction (Figure 5) shows that the relationship between school year and time spent participating in organised sports and games was relatively strong for males.
Figure 5. Time spent participating in organised sports and games as a function of the interaction between school year and gender. Points represent the mean number of minutes per week spent participating in organised sports and games.

Moving from Year 8 to Year 10 resulted in a significant increase in time spent participating in organised sports and games for males. In contrast, there was no significant difference in time spent participating in organised sports and games between females in Year 8 and in Year 10. Appendix M contains all cell
means, standard deviations, and frequencies for those variables that were involved in significant interactions for this research question.

4.3 Research Question Two

Research question two investigated how time spent participating in nonorganised physical activity was related to adolescents’ fundamental motor skill ability. Data were obtained through the questionnaire that asked respondents to report the amount of time spent participating in nonorganised physical activity during a usual week and through the fundamental motor skills test battery.

In order to investigate this relationship, regression analysis was used with time spent participating in nonorganised physical activity as the dependent variable. Independent variables were fundamental motor skill ability, gender, school year, socioeconomic status, and geographic location. Table 8 shows the means, standard deviations, and frequencies for time spent participating in nonorganised physical activity for each independent variable.
Table 8

Mean Scores for Time Spent Participating in Nonorganised Physical Activity

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>M</th>
<th>SD</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fundamental Motor Skill Ability</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Low</td>
<td>250.35</td>
<td>461.38</td>
<td>369</td>
</tr>
<tr>
<td>Low</td>
<td>246.25</td>
<td>342.53</td>
<td>369</td>
</tr>
<tr>
<td>Medium</td>
<td>272.18</td>
<td>397.25</td>
<td>367</td>
</tr>
<tr>
<td>High</td>
<td>294.15</td>
<td>525.54</td>
<td>374</td>
</tr>
<tr>
<td>Very High</td>
<td>301.88</td>
<td>360.98</td>
<td>365</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>321.02</td>
<td>491.51</td>
<td>1081</td>
</tr>
<tr>
<td>Female</td>
<td>230.77</td>
<td>458.71</td>
<td>945</td>
</tr>
<tr>
<td><strong>School Year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 8</td>
<td>302.13</td>
<td>563.98</td>
<td>1072</td>
</tr>
<tr>
<td>Year 10</td>
<td>252.84</td>
<td>357.45</td>
<td>954</td>
</tr>
<tr>
<td><strong>Socioeconomic Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>302.43</td>
<td>507.13</td>
<td>695</td>
</tr>
<tr>
<td>Medium</td>
<td>250.62</td>
<td>406.99</td>
<td>688</td>
</tr>
<tr>
<td>High</td>
<td>283.80</td>
<td>515.21</td>
<td>643</td>
</tr>
<tr>
<td><strong>Geographic Location</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>335.06</td>
<td>545.47</td>
<td>604</td>
</tr>
<tr>
<td>Urban</td>
<td>255.08</td>
<td>445.10</td>
<td>1422</td>
</tr>
</tbody>
</table>

These descriptive statistics did not take into account the relationship between time spent participating in nonorganised physical activity and fundamental motor skill ability controlling for the mediating effects of gender,
school year, socioeconomic status, and geographic location. To investigate this relationship, a multiple regression analysis was conducted.

Time spent participating in nonorganised physical activity was then regressed on fundamental motor skill ability, gender, school year, socioeconomic status, and geographic location and the interactions between them. All main effects and interactions with large p values (> .1, approximately) were omitted and the model was re-fitted. This procedure continued until only significant interactions and main effects (p < .05) remained. Table 9 shows the significant main effects and interactions for the relationship between time spent participating in nonorganised physical activity and fundamental motor skill ability controlling for gender, school year, socioeconomic status, and geographic location. Although the main effect of fundamental motor skill ability was not significant, it is included as it was the independent variable of primary concern.
Table 9

Significant Main Effects and Interactions for Research Question Two.

<table>
<thead>
<tr>
<th>Significant Main Effect or Interaction</th>
<th>df</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental motor skill ability</td>
<td>4, 1832</td>
<td>2.18</td>
<td>.005</td>
</tr>
<tr>
<td>Gender</td>
<td>1, 1832</td>
<td>38.33***</td>
<td>.02</td>
</tr>
<tr>
<td>Geographic location</td>
<td>1, 1832</td>
<td>24.59***</td>
<td>.013</td>
</tr>
<tr>
<td>Fundamental motor skill ability by school year</td>
<td>4, 1832</td>
<td>2.75*</td>
<td>.006</td>
</tr>
</tbody>
</table>

*p < .05., ***p ≤ .0001

The amount of variation in time spent participating in nonorganised physical activity for which the full model could account was 5.7%.

Fundamental motor skill ability specifically accounted for only 0.5% of the total variation in the dependent variable. This appeared to be a very small proportion when compared to that accounted for by the other significant main effects in the model, gender and geographic location, which accounted for 2% and 1.3%, respectively; but was of similar proportion to the significant interaction in the model, fundamental motor skill ability by school year, which accounted for 0.6% of the total variation.

Results revealed that the main effect of fundamental motor skill ability was not statistically significant at the .05 level, but was at the less conservative
.1 level, $F(4, 1832) = 2.18, p = .069$. Because the interaction between fundamental motor skill ability and school year was statistically significant, $F(4, 1832) = 2.75, p = .027$, an examination of time spent participating in nonorganised physical activity, over the five fundamental motor skill ability quintiles, needed to be done separately for each school year. That is, it was not statistically valid to pool the results for the two school years.

A graph of the nature of this interaction (Figure 6) shows that, apart from the very high fundamental motor skill ability quintile, the line for Year 10 students displayed a steeper angle than the line for Year 8 students. That is, among Year 10 students, for every unit increase in fundamental motor skill ability, there was a greater average increase in time spent participating in nonorganised physical activity than for Year 10 students for all fundamental motor skill ability quintiles except the very high quintile. The very low fundamental motor skill ability quintile of Year 10 students spent less time participating in nonorganised physical activity than the very low fundamental motor skill ability quintile of Year 8 students. Year 8 and Year 10 students from the low fundamental motor skill ability quintile spent a similar amount of time participating in nonorganised physical activity. From there on, Year 10 students in the middle and high fundamental motor skill ability quintiles clearly spent increasingly more time participating in nonorganised physical activity than Year 8 students, although, using Dunn’s MC Method, none of these aforementioned differences were statistically significant. However, using
Dunn’s MC Method, Year 8 students in the very high fundamental motor skill ability quintile spent significantly more time participating in nonorganised physical activity than Year 10 students.

To investigate the differences between quintiles of fundamental motor skill ability for each school year, in relation to time spent participating in nonorganised physical activity, mean scores for time spent participating in nonorganised physical activity were compared according to fundamental motor skill ability quintiles using Tukey’s HSD test. Results of the Tukey multiple comparisons procedure revealed that, for Year 8 and Year 10 students, none of the quintiles were significantly different from each other.
Figure 6. Time spent participating in nonorganised physical activity as a function of the interaction between fundamental motor skill ability and school year. Points represent the mean number of minutes per week spent participating in nonorganised physical activity.

Figure 6 could be interpreted as meaning that the effect that fundamental motor skill ability had on time spent participating in nonorganised physical activity was stronger for Year 10 students than for Year 8 students. Figure 6 also reveals that the mean for the very high quintile of fundamental motor skill
ability for Year 10 students conspicuously departed from the positive relationship between time spent participating in nonorganised physical activity and fundamental motor skill ability. The severity of this deviation from the trend may have resulted from the fact that 46 of the 214 Year 10 students in the very high fundamental motor skill ability quintile had a score of zero (which equated to spending no time participating in nonorganised physical activity during a usual week). A specific reason why these students spent no time participating in nonorganised physical activity during a usual week could not be identified. Without these scores, the mean value for the very high fundamental motor skill ability quintile for Year 10 students would have been 327.22 (SD = 266.05) providing an extension of the normal positive relationship.

The main effect of gender was statistically significant, $F(1, 1832) = 38.33$, $p < .0001$. Further examination of how males and females differed on time spent participating in nonorganised physical activity was accomplished by a statistical comparison of the effects of the two genders adjusting for all other variables in the model. Results showed that males (adjusted $M = 328.60$, $SD = 499.22$) spent significantly more time participating in nonorganised physical activity than did females (adjusted $M = 208.84$, $SD = 302.52$), $p < .05$.

The main effect of geographic location was also statistically significant, $F(1, 1832) = 24.59$, $p < .0001$. Results showed that rural students (adjusted $M = 342.29$, $SD = 553.32$) spent significantly more time participating in
nonorganised physical activity than did urban students (adjusted $M = 242.32$, $SD = 347.20$). Appendix M contains all cell means, standard deviations, and frequencies for those variables that were involved in significant interactions for this research question.

### 4.4 Research Question Three

Research question three investigated how cardiorespiratory endurance was related to adolescents’ fundamental motor skill ability. Data were obtained through the number of laps completed on the Multistage Fitness Test and through the fundamental motor skills test battery.

In order to investigate this relationship, regression analysis was used with cardiorespiratory endurance as the dependent variable. Independent variables were fundamental motor skill ability, gender, school year, socioeconomic status, and geographic location. Table 10 shows the means, standard deviations, and frequencies for cardiorespiratory endurance for each independent variable.
Table 10

Mean Scores for Cardiorespiratory Endurance

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>M</th>
<th>SD</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiorespiratory Endurance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Number of Laps)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fundamental Motor Skill Ability</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Low</td>
<td>32.38</td>
<td>18.49</td>
<td>368</td>
</tr>
<tr>
<td>Low</td>
<td>41.57</td>
<td>22.30</td>
<td>362</td>
</tr>
<tr>
<td>Medium</td>
<td>44.13</td>
<td>21.61</td>
<td>362</td>
</tr>
<tr>
<td>High</td>
<td>49.63</td>
<td>23.80</td>
<td>369</td>
</tr>
<tr>
<td>Very High</td>
<td>59.47</td>
<td>26.39</td>
<td>358</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>55.19</td>
<td>24.83</td>
<td>1044</td>
</tr>
<tr>
<td>Female</td>
<td>33.41</td>
<td>17.52</td>
<td>898</td>
</tr>
<tr>
<td><strong>School Year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 8</td>
<td>39.40</td>
<td>20.58</td>
<td>1041</td>
</tr>
<tr>
<td>Year 10</td>
<td>51.71</td>
<td>26.54</td>
<td>901</td>
</tr>
<tr>
<td><strong>Socioeconomic Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>42.24</td>
<td>23.13</td>
<td>679</td>
</tr>
<tr>
<td>Medium</td>
<td>46.19</td>
<td>24.79</td>
<td>668</td>
</tr>
<tr>
<td>High</td>
<td>47.19</td>
<td>24.83</td>
<td>595</td>
</tr>
<tr>
<td><strong>Geographic Location</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>47.99</td>
<td>24.62</td>
<td>582</td>
</tr>
<tr>
<td>Urban</td>
<td>43.89</td>
<td>24.09</td>
<td>1360</td>
</tr>
</tbody>
</table>

These descriptive statistics did not take into account the relationship between cardiorespiratory endurance and fundamental motor skill ability controlling for the mediating effects of gender, school year, socioeconomic
status, and geographic location. To investigate this relationship, a multiple regression analysis was conducted.

Cardiorespiratory endurance was then regressed on fundamental motor skill ability, gender, school year, socioeconomic status, and geographic location and the interactions between them. All main effects and interactions with large p values (> .1, approximately) were omitted and the model was re-fitted. This procedure continued until only significant interactions and main effects (p < .05) remained. Table 11 shows the significant main effects and interactions for the relationship between cardiorespiratory endurance and fundamental motor skill ability controlling for gender, school year, socioeconomic status, and geographic location.

Table 11

Significant Main Effects and Interactions for Research Question Three.

<table>
<thead>
<tr>
<th>Significant Main Effect or Interaction</th>
<th>df</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiorespiratory Endurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fundamental motor skill ability</td>
<td>4, 1808</td>
<td>79.05***</td>
<td>.10</td>
</tr>
<tr>
<td>Gender</td>
<td>1, 1808</td>
<td>667.67***</td>
<td>.22</td>
</tr>
<tr>
<td>School Year</td>
<td>1, 1808</td>
<td>108.17***</td>
<td>.03</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>2, 1808</td>
<td>12.43***</td>
<td>.008</td>
</tr>
<tr>
<td>Geographic location</td>
<td>1, 1808</td>
<td>27.37***</td>
<td>.009</td>
</tr>
<tr>
<td>Gender by school year</td>
<td>1, 1808</td>
<td>45.96***</td>
<td>.01</td>
</tr>
</tbody>
</table>

***p ≤ .0001
The amount of variation in cardiorespiratory endurance for which the full model could account was 43%. Fundamental motor skill ability specifically accounted for only 10% of the total variation in the dependent variable. This appeared to be a small proportion when compared to that accounted for by one of the other significant main effects in the model, gender, which accounted for 22% of the total variation. However, it appeared to be a large proportion when compared to that accounted for by the other significant main effects in the model (school year; socioeconomic status; and geographic location), which accounted for 3%, 0.8%, and 0.9%, respectively, and the significant interaction in the model (gender by school year), which accounted for 1% of the total variation in the dependent variable.

Results revealed that the main effect of fundamental motor skill ability was statistically significant, \( F(4, 1808) = 79.05, p < .0001 \). As fundamental motor skill ability did not significantly interact with any of the other independent variables it was possible, in contrast to research questions one and two, to compare the effects of the five fundamental motor skill ability quintiles while ignoring other factors. A graph of mean values for this main effect (see Figure 7) shows that as level of fundamental motor skill ability increased, cardiorespiratory endurance also increased.
Figure 7. Values of cardiorespiratory endurance for very low (n = 369), low (n = 369), medium (n = 367), high (n = 374), and very high (n = 365) quintiles of fundamental motor skill ability. Points represent the mean number of laps completed on the Multistage Fitness Test.

To investigate the differences between quintiles of fundamental motor skill ability in relation to cardiorespiratory endurance, mean scores for cardiorespiratory endurance were compared according to fundamental motor skill ability quintiles using Tukey's HSD test. Results of the Tukey multiple
comparisons procedure illustrated that statistically significant differences existed among all fundamental motor skill ability quintiles except for the medium and low quintiles. For example, the very high quintile had significantly higher levels of cardiorespiratory endurance than the high, medium, low, and very low quintiles. The high quintile had significantly lower levels of cardiorespiratory endurance than the very high quintile, but had significantly higher levels of cardiorespiratory endurance than the medium, low, and very low quintiles. The only exceptions to this trend were the medium and low quintiles, which were not statistically significantly different to each other, but were to all other quintiles.

As noted above, the main effect of gender was also statistically significant, $F (1, 1808) = 667.67, p < .0001$. Follow-up for determining how the genders differed on cardiorespiratory endurance was accomplished by a statistical comparison of the effects of the two genders adjusting for all other variables in the model. Results showed that males (adjusted $M = 55.81$, $SD = 24.70$) had significantly higher levels of cardiorespiratory endurance than did females (adjusted $M = 33.30$, $SD = 17.31$).

The main effect of school year was also statistically significant, $F (1, 1808) = 108.17, p < .0001$. Results showed that Year 10 students (adjusted $M = 52.12$, $SD = 26.52$) had significantly higher levels of cardiorespiratory endurance than did Year 8 students (adjusted $M = 39.59$, $SD = 20.61$).
As previously noted, the main effect of socioeconomic status was also statistically significant, $F (2, 1808) = 12.43, p < .0001$. Results showed that students in the high socioeconomic status tertile (adjusted $M = 47.78$, $SD = 25.16$) and medium socioeconomic status tertile (adjusted $M = 46.36$, $SD = 24.69$) each had significantly higher levels of cardiorespiratory endurance than did students in the low socioeconomic status tertile (adjusted $M = 42.46$, $SD = 23.02$). There were no significant differences between students in the high socioeconomic status tertile and students in the medium socioeconomic status tertile.

As previously indicated, the main effect of geographic location was also statistically significant, $F (1, 1808) = 27.37, p < .0001$. Results showed that rural students (adjusted $M = 48.34$, $SD = 24.49$) had significantly higher levels of cardiorespiratory endurance than did urban students (adjusted $M = 44.05$, $SD = 24.16$).

In addition, the interaction of gender and school year was statistically significant, $F (1, 1808) = 45.96, p < .0001$. This suggested that the relationship between school year and cardiorespiratory endurance was different for males and females.

As a follow-up to the statistically-significant gender by school year interaction, a graph of the nature of this interaction (Figure 8) shows that the
relationship between school year and cardiorespiratory endurance was relatively strong for males.

![Graph showing values of cardiorespiratory endurance as a function of school year and gender.](image)

**Figure 8.** Values of cardiorespiratory endurance as a function of the interaction between school year and gender. Points represent the mean number of laps completed on the Multistage Fitness Test.

Moving from Year 8 to Year 10 resulted in a significant increase in cardiorespiratory endurance for males. In contrast, there was no significant
difference in cardiorespiratory endurance between females in Year 8 and in Year 10. Appendix M contains all cell means, standard deviations, and frequencies for those variables that were involved in significant interactions for this research question.

4.5 Summary

Data from 2026 adolescents were analysed to test the research questions investigating how time spent participating in organised sports and games, time spent participating in nonorganised physical activity, and cardiorespiratory endurance were each related to fundamental motor skill ability among adolescents. Results were reported for each of the research questions which guided the development of this study. A summary of results is shown in Table 12.
Table 12

A Summary of Results

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Was participation in organised sports and games related to adolescents’ fundamental motor skill ability?</td>
<td>• Time spent participating in organised sports and games was significantly related to adolescents’ fundamental motor skill ability.</td>
</tr>
<tr>
<td></td>
<td>• This relationship was significantly different for males and for females. Specifically, the relationship was stronger for males than for females.</td>
</tr>
<tr>
<td>2. Was participation in nonorganised physical activity related to adolescents’ fundamental motor skill ability?</td>
<td>• Time spent participating in nonorganised physical activity was not significantly related to adolescents’ fundamental motor skill ability.</td>
</tr>
<tr>
<td></td>
<td>• The relationship between time spent participating in nonorganised physical activity and fundamental motor skill ability was significantly different for Year 8 and Year 10 students. Specifically, the relationship was stronger for students in Year 10 than for students in Year 8.</td>
</tr>
<tr>
<td>3. Was cardiorespiratory endurance related to adolescents’ fundamental motor skill ability?</td>
<td>• Cardiorespiratory endurance was significantly related to adolescents’ fundamental motor skill ability.</td>
</tr>
</tbody>
</table>
CHAPTER V

SUMMARY, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

The outcomes of this study provided results concerning how participation in two types of physical activity – organised sports and games and nonorganised physical activity – and an objective measure of physical activity – cardiorespiratory endurance – were each related to fundamental motor skill ability among adolescents.

5.1 Summary

In order to obtain information about the possibility of proficiency in motor skills being a determinant of adolescent physical activity, this study examined the relationship between physical activity and fundamental motor skill ability among adolescents with a view to providing information which may better assist the development of interventions and programmes designed to increase adolescent physical activity.

This study investigated the relationship between participation in organised sports and games and fundamental motor skill ability; participation in nonorganised physical activity and fundamental motor skill ability; and
cardiorespiratory endurance and fundamental motor skill ability, taking into account any effect that gender, age, socioeconomic status, and geographic location may have had on the potential relationships.

5.2 Conclusions

On the basis of analyses of the available data the following conclusions, specific to the research questions regarding the adolescents in this study, were made:

1. Participation in organised sports and games was significantly related to fundamental motor skill ability.
2. Participation in nonorganised physical activity was not significantly related to fundamental motor skill ability.
3. Cardiorespiratory endurance was significantly related to fundamental motor skill ability.

Tangential to the specific research questions, but embedded in the data analyses, were the following conclusions regarding the adolescents in the study:

1. The relationship between participation in organised sports and games and fundamental motor skill ability was significantly different for males and for females; specifically, the relationship was stronger for females than for males. That is, among females, for every unit increase in fundamental motor skill ability, there was a significantly greater increase in participation in organised
1. greater increase in participation in organised sports and games than for males.
2. Rural students participated in significantly more organised sports and games than did urban students.
3. From Year 8 to Year 10, there was a significantly greater increase in participation in organised sports and games for males than for females.
4. Males participated in significantly more nonorganised physical activity than did females.
5. Rural students participated in significantly more nonorganised physical activity than did urban students.
6. The relationship between participation in nonorganised physical activity and fundamental motor skill ability was significantly different for Year 8 and for Year 10 students; specifically, the relationship was stronger for Year 10 students than for Year 8 students. That is, generally among Year 10 students, for every unit increase in fundamental motor skill ability, there was a significantly greater increase in participation in nonorganised physical activity than for Year 8 students.
7. Males had significantly higher levels of cardiorespiratory endurance than did females.
8. Year 10 students had significantly higher levels of cardiorespiratory endurance than did Year 8 students.

9. There was a significant relationship between cardiorespiratory endurance and socioeconomic status. That is, cardiorespiratory endurance increased with increasing socioeconomic status.

10. Rural students had a significantly higher levels of cardiorespiratory endurance than did urban students.

11. As school year increased, there was a significantly greater increase in cardiorespiratory endurance for males than for females.

5.3 Discussion

Three hypotheses were central to this investigation; two were supported by the data collected, one was not supported. The first hypothesis, that there is a positive relationship between participation in organised sports and games and fundamental motor skill ability among adolescents, was supported by the results of this study. Specifically, adolescents who spent more time participating in organised sports and games during a usual week performed better on the selected fundamental motor skills test battery. While causality cannot be inferred from the data collected in this study, these results suggested that skill proficiency may have had a significant and positive effect on participation in organised sports and games.
The results of this investigation agree in part with the only other known published study in this area. Ulrich (1987) investigated the relationship between participation motivation and demonstrated motor performance (called actual competence) in Kindergarten through Year 4 children. Her results suggested that children who were participants in organised sports performed selected motor ability tasks better than nonparticipants. The differences between Ulrich’s study and this study are twofold. First, her definition of participant was a parent-answered “yes” or “no” regarding completion of a season in at least one organised sport during the previous year whereas this study investigated self-reported participation in organised sports and games among adolescents. Second, her motor ability tasks were a combination of quantitative, product-measured tasks and health- and skill-related fitness tests in young children. This study used qualitative, process- or technique-based fundamental motor skills tests among adolescents.

The significance of the results was not surprising considering that the advanced forms of the fundamental motor skills assessed in this study may be clearly seen in most of the preferred organised sports and games reported by the students. Although not specifically mentioned in the results, the seven most popular organised sports and games in descending order were: basketball, tennis, swimming, cricket, soccer, dancing, and touch football. The skills integral to all these sports, except swimming and to a lesser extent dancing, are clearly more advanced forms of the specific fundamental motor skills tested in
advanced forms of the specific fundamental motor skills tested in this study (run, vertical jump, catch, overarm throw, kick, and forehand strike). It is well accepted that fundamental motor skills are prerequisites or “building blocks” for participation in popular forms of sports and games (Gallahue & Ozmun, 1995; Payne & Isaacs, 1995; Ulrich, 1985); therefore, it is feasible to presume that those students who spent more time participating in these organised sports and games would have had a higher fundamental motor skill ability.

Fundamental motor skill ability may be considered as either a cause or effect of participation in organised sports and games. That is, having higher fundamental motor skill ability may increase the options for participation in popular organised sports and games – such as those self-reported by the students – particularly when there appears to be a high degree of carry over from the fundamental motor skill to the sport-specific skill (for example, from the overhand throw to the tennis serve or cricket throw). However, simply participating in organised sports and games may increase fundamental motor skill ability through greater time spent practising the skill and through a greater exposure to coaching. This seems plausible, given the fact that a most frequently cited reason for participating in organised sports and games is to develop new skills (Gould & Horn, 1984; Gould & Petlichkoff, 1988; Sale, 1991). However, while the latter may seem to offer an explanation, research suggests that this would only occur in the presence of specific instruction,
feedback, practice, and encouragement (Gallahue, 1996) which, due to the
definition of organised sports and games as detailed earlier in the study (see
page 10) – and in particular the part of the definition regarding the involvement
of a coach or teacher – would be likely to be occurring.

This finding highlighted the importance that fundamental motor skill
ability plays in the organised sport patterns of adolescents. From an educational
perspective, it reinforced how critical it is that adequate time and resources be
devoted to fundamental motor skill development, especially during the period
of early childhood, where a “window of opportunity” exists that maximises the
speed and ease of learning new motor skills (Gallahue, 1996).

This importance is even more salient when the effect of gender is
considered. This study found that gender mediated the relationship between
organised sports and games and fundamental motor skill ability. Specifically,
time spent participating in organised sports and games was more strongly
related to fundamental motor skill ability in females than males (see Figure 4,
page 104). The fact that such a relationship existed for females suggested that
progressing one quintile in fundamental motor skill ability would have a
significant impact on the time they spent participating in organised sports and
games per week. In fact, movement to the next highest quintile was associated
with approximately an extra 50 minutes per week spent participating in
organised sports and games. For males, the relationship was not as strong and
suggested that, while an increase in fundamental motor skill ability would increase the time spent in organised physical activity, it would not be as great.

In other words, females were more likely to participate in organised sports and games if they had higher levels of fundamental motor skill ability; whereas for males, this did not appear to be as important a factor. This may contribute to the precipitous decline in physical activity during adolescence for females; if they are not in the higher fundamental motor skill ability quintiles they tend to participate in less physical activity.

Another consideration with regard to this finding may be differences in the socialisation of male and female adolescents regarding organised sports and games. For males, playing organised sport is more socially acceptable as it provides an outlet for them to reinforce their masculinity (Scully & Clarke, 1997). Level of fundamental motor skill ability is not as important as the act of participation. In fact, it may be considered more of a risk not to participate. On the other hand, for females, participation in some forms of organised sports and games, particularly team sports is considered more socially unacceptable (Petersen & Taylor, 1980; Scully & Clarke, 1997). Therefore, only those females who are more highly skilled will continue to participate during adolescence. Others who are less skilled may opt out of participation or decrease their participation levels.
This notion of skill level being important in initial and continuing participation in organised sports and games has been previously suggested (Orlick & Botterill, 1975; Sale, 1991). It appears that males and females will seek out organised sports and games in which they perceive they are competent to demonstrate this competency. Males had higher levels of fundamental motor skill ability compared to females, and there is a high degree of carry over from the fundamental motor skills tested to the popular organised sports and games. This may explain the gender differences in the relationship between organised sports and games and fundamental motor skill ability.

The ramifications of this finding for adolescent sport and physical activity are important. It suggests that efforts to increase organised sport participation among adolescent girls could be greatly enhanced through improving their fundamental motor skills and could provide a greater payoff than for boys. Even very small increases in fundamental motor skill ability (progressing only one quintile) could greatly increase their organised sport participation.

Perhaps of more importance in terms of promoting physical activity is that the time spent in organised sports and games for the very low ability girls was only just above the recommended guidelines for moderate-to-vigorous physical activity for adolescents established by Sallis and Patrick (1994). It is known that physical activity declines precipitously during adolescence,
especially for girls (Pate et al., 1994). Therefore, there is a need to ensure that this quintile is well above the recommendation at this stage of adolescence.

In developing the analyses for the research hypotheses, other significant results were found. Although these were not specifically related to the research hypotheses under investigation, they are worth some consideration here.

The first is that rural adolescents spent significantly more time participating in organised sports and games than urban adolescents. This finding is consistent in part with a past international study which indicated that adolescents from more rural areas in the U.S. State of West Virginia were less likely to engage in a range of high-risk health behaviours, one of which was physical inactivity (Meehan, 1993). However, the findings of the present study are inconsistent with other past research which has cited no significant relationship between geographic location and physical activity among adolescents (Vilhjalmssson & Thorlindsson, 1998).

The finding that rural adolescents participated in more organised sports and games than urban adolescents has several possible explanations. The first of these is that safe and open rural environments may be more conducive to physical activity participation than the higher-crime and more densely-populated urban areas (Sallis, 1995). With respect to crime, safety has been reported as the most important factor parents consider in selecting play spaces for their children (Sallis et al., 1997). The second is that rural adolescents may
have less competing demands on their leisure time in terms of computer and arcade games and the internet, albeit that this is rapidly changing as communication links throughout rural areas expand. A third possible explanation is that organised sports play a big part in the social culture or fabric of small towns and rural areas, often being the catalyst for drawing people together. Although there may not be the range of organised sports and games available compared with urban areas, those that are available may have higher levels of participation because it is part of a long and strong tradition. More research is certainly needed in this area to make more tangible some of these explanations.

The results also revealed that the interaction between school year and gender was significant. Specifically, the relationship between time spent participating in organised sports and games and school year was stronger for males than for females. There was a significant increase in participation in organised sports and games from Year 8 to Year 10 for males and a decrease – which was not significant – in participation in organised sports and games from Year 8 to Year 10 for females. This finding for males differs from some studies conducted in Australia (Pyke, 1987) and overseas (Fuchs et al., 1988; Janz & Mahoney, 1997a), however, it is consistent with others in Australia (Australian Bureau of Statistics, 1997b) and overseas (Sallis et al., 1993a). The reasons for this inconsistency are unclear, but it could be explained by differences in the
self-report instruments used to assess organised sports and games. Australian studies (Australian Bureau of Statistics, 1997b; Sale, 1991) that have separated participation in organised sports and games into *during school hours* and *organised by a club or association* have revealed that participation in the former decreased from Year 8 to Year 10, but participation in the latter increased over the same school-year span. The fact that this study did not ask adolescents to make a distinction between participation avenues for organised sports and games could explain why this finding differed from previous studies. In hindsight, perhaps a more compartmentalised question should be considered in future studies as it may provide richer participation data.

That there was a slight decrease in participation in organised sports and games for females was consistent with other findings (Australian Bureau of Statistics, 1997b; Pyke, 1987; Ross et al., 1985a) and may be partly explained by girls’ previous negative experiences which have resulted in a self-fulfilling prophecy of low perceived competence (Sale, 1991) and socialisation factors regarding organised sports and games among female adolescents that have already been discussed.

Fundamental motor skill ability, geographic location, the interaction between fundamental motor skill ability and gender, and the interaction between gender and school year were significantly associated with adolescents’ participation in organised sports and games. However, in no case did the entire
regression equation account for large proportions of variance in participation in organised sports and games. Similar to previous studies (Bungum & Vincent, 1997; Sallis et al., 1992a), the model explained 6% of the variance in participation in organised sports and games. There were two conditions that possibly contributed to the small reported $R^2$ values. First, the measure of participation in organised sports and games was self-report, so it was not exact. Second, there were limitations to the range of fundamental motor skills in the test battery. Both of these limitations may be expected to make it more difficult to demonstrate meaningful relationships, and this conservative bias tends to increase confidence in the significant findings that were observed. However, it should be emphasised that the modesty of their meaningfulness highlights the need for further studies of the relationship between participation in organised sports and games and fundamental motor skill ability.

The results of research question one suggest that interventions to increase participation in organised sports and games among adolescents should involve fundamental motor skills education and support prior to adolescence. Considering that organised sports and games make a substantial contribution to the total energy expenditure of adolescents (Katzmarzyk & Malina, 1998; Ross et al., 1985a), promoting and maximising participation in them may provide benefits to most adolescents in NSW.
The second hypothesis was not supported by the results of this study. A significant relationship was not found between participation in nonorganised physical activity and fundamental motor skill ability. Specifically, adolescents who spent more time in nonorganised physical activity during a usual week did not perform better on the selected fundamental motor skill tasks.

This finding is different from the only other similar published study by Butcher and Eaton (1989), in which the authors found a significant relationship between physical activity and running speed and agility. However, the differences between the studies make it impossible to draw conclusions as Butcher and Eaton assessed preschoolers, using free play behaviour as the measure of physical activity, and used quantitative tests to measure running speed and agility.

It is interesting to note that while the relationship for research question one (between participation in organised sports and games and fundamental motor skill ability) was significant, no relationship was found for research question two (between participation in nonorganised physical activity and fundamental motor skill ability). A plausible explanation for this finding is that the fundamental motor skills tested in this study may be less relevant to nonorganised physical activities than to organised sports and games. Although not specifically mentioned in the results, this study revealed that the seven most preferred nonorganised physical activities in descending order were:
walking for transport, swimming, cycling for fun, walking for pleasure, basketball, surfing, and rollerblading. The fundamental motor skills that may be considered prerequisites for the majority of these activities (except basketball) include walking, static and dynamic balance, side gallop, ball bounce, and skip. By comparison, the most popular organised sports and games were: basketball, tennis, swimming, cricket, soccer, dancing, and touch football. The fundamental motor skills for the majority of these (except swimming and to a lesser extent dancing) include the sprint run, vertical jump, overarm throw, catch, kick, forehand strike, side gallop, skip, and ball bounce, all of which except the last three were assessed in this study.

Since behavioural skills are suggested as being related to adolescent physical activity (Parcel et al., 1989; Perry et al., 1985; Simons-Morton et al., 1991), perhaps educational programmes aimed at increasing physical activity should look beyond the fundamental motor skills used in this study to those that may be more closely related to popular forms of nonorganised physical activity. However, the closeness of the relationship to significance suggests that further research should be conducted between the variables.

Although there was no relationship between participation in nonorganised physical activity and fundamental motor skill ability, the interaction between fundamental motor skill ability and school year was significant. This meant that the relationship between participation in
nonorganised physical activity and fundamental motor skill ability was significantly different for Year 8 and for Year 10 students. Specifically, participation in nonorganised physical activity was more strongly related to fundamental motor skill ability in Year 10 than in Year 8. A tenable explanation for this finding is that as students get older their fundamental motor skill ability tends to improve (Gallahue, 1996; Payne & Isaacs, 1995), thus opening up more options for participation in nonorganised physical activity. Conversely, if improvement in fundamental motor skill ability does not occur – through lack of practice, encouragement, or instruction – students may tend to opt out of physical activity. The fact that this relationship was significant may suggest that perceived competence in fundamental motor skill ability may not just be related to those sports and games specifically related to the fundamental motor skills tested, but may be more generic in nature and carry over to all forms of physical activity.

The other significant findings for research hypothesis two were not specifically related to the relationship between participation in nonorganised physical activity and fundamental motor skill ability; however, they were of tangential relevance and a brief discussion is merited.

Consistent with other findings (Katzmarzyk & Malina, 1998; Ross et al., 1985a) male adolescents participated in more nonorganised physical activity than did female adolescents. While it has been consistently shown that males
participate in more overall physical activity than females (Aaron et al., 1993; Anderssen & Wold, 1992; Armstrong et al., 1990; Fuchs et al., 1988; Janz & Mahoney, 1997a; Ross et al., 1985a; Sallis et al., 1996; Saris, 1986; Sunnegardh & Bratteby, 1987; Tell & Vellar, 1988; Trost et al., 1996; Trost et al., 1997; Zakarian et al., 1994), that there was a significant gender difference for nonorganised physical activity was slightly surprising. What made this result slightly surprising was that previous studies in Australia (Australian Bureau of Statistics, 1997b; Pyke, 1987) and the United States (Myers et al., 1996; Ross et al., 1985a), have suggested that nonorganised physical activities such as walking and swimming are more popular for females than for males (Australian Bureau of Statistics, 1997b; Katzmarzyk & Malina, 1998; Pyke, 1987; Sallis et al., 1996). In addition, the majority of the most preferred nonorganised physical activities in this study were individual in nature, which the literature suggests are preferred by females because there are less rules and competition and more emphasis on enjoyment (Scully & Clarke, 1997). A possible explanation for this finding is that, while nonorganised physical activities may be more preferred by females than males, participation rates are still higher for males because they participate in more overall physical activity than females.

Similar to research question one, rural adolescents participated in more nonorganised physical activity than urban adolescents. A discussion of this finding was examined previously (pages 135-136) and since the studies drawn
upon did not differentiate between organised sports and games and nonorganised physical activity, further discussion would be inappropriate.

Therefore, while it may be speculated that gender and geographic location will have an association with participation in nonorganised physical activity, further research should include descriptive studies to confirm or otherwise their relationship to participation in nonorganised physical activity among adolescents.

The implications of these findings are that there may be a need to widen the base of fundamental motor skills assessed in the test battery and that are taught in schools to incorporate the fundamental movements that are common to more nonorganised physical activities. Since the mean time spent participating in nonorganised physical activity was significantly greater than the mean time spent participating in organised sports and games, it appears that nonorganised physical activity is the more popular of the two. Other evidence suggests that this is the type most participated in by adolescents (Pate et al., 1994; Ross et al., 1985a; Saris et al., 1986), and that they have a higher carry over potential into adulthood (Armstrong et al., 1990; Sallis et al., 1996). Therefore, it makes sense to provide students with the skills needed for participation in nonorganised physical activity.

Since it has been consistently shown that female adolescents participate in less nonorganised physical activity than male adolescents, there is a need to
specifically tailor interventions and programmes to suit their needs. This need is even more important when it is considered that evidence also suggests that nonorganised physical activities contribute far more to the total energy expenditure of females than for males (Ross et al., 1985a).

The third hypothesis was supported by the results of this study. A significant relationship was found between cardiorespiratory endurance and fundamental motor skill ability. Specifically, adolescents who had higher levels of cardiorespiratory endurance performed better on the selected fundamental motor skills. While causality cannot be inferred from the data collected in this study, this result suggested that skill proficiency may have had a significant and positive effect on cardiorespiratory endurance. This study agreed in part with the only other published study which investigated this relationship in children of a similar age range. Mahon, Del Corral, Howe, Duncan, and Ray (1996) examined the relationship of physiological determinants to cardiorespiratory endurance among boys. Their results suggested that sprint run time and vertical jump height were significantly related to three kilometre run times. However, the authors only investigated a small sample (N = 21) of boys and used quantitative assessments for the sprint run and vertical jump.

That the results were significant was not surprising considering that participation in the sports, games, and physical activities that comprised advanced forms of the fundamental motor skills assessed in this study were
generally of an intensity that would increase cardiorespiratory endurance (that is, vigorous in terms of estimated rates of energy expenditure).

Because cardiorespiratory endurance is an excellent indicator of adolescent health (Krahenbuhl, Skinner, & Kohrt, 1985) and is associated with more favourable cardiovascular disease risk profiles (Sallis et al., 1988; Tell & Vellar, 1988) among adolescents, this result highlighted the importance that fundamental motor skill ability may have had in the cardiorespiratory endurance levels of adolescents. From an educational perspective, it once again reinforced how critical it is that adequate time and resources continue to be set aside for development of fundamental motor skills during early childhood and childhood.

While the other significant findings for research hypothesis three were not specifically related to the association between cardiorespiratory endurance and fundamental motor skill ability, they are worth some consideration.

The first was that males had significantly higher levels of cardiorespiratory endurance than did females. These results agreed with previous studies which have investigated this relationship in adolescents (Halfon & Bronner, 1989; Janz & Mahoney, 1997b; Pyke, 1987; Ross, Dotson, Gilbert, & Katz, 1985b; Sunnegardh & Bratteby, 1987) and can be explained by three mechanisms: first, males have a higher fat-free mass per unit stature and also have a lower percentage of body fat than females; second, males have a
higher haemoglobin concentration than females; and third, males have a higher level of habitual physical activity than females (Rowland, 1996).

The results also indicated that Year 10 students had higher levels of cardiorespiratory endurance than Year 8 students. In other words, there was a significant relationship between cardiorespiratory endurance and age. This result agreed with previous studies which have investigated this relationship among adolescents (Janz & Mahoney, 1997b; Pyke, 1987; Ross et al., 1985b; van Mechelen & Kemper, 1995a) and is largely the result of increases in the size of the organs that contribute to cardiorespiratory endurance (Rowland, 1996) and an improved mechanical efficiency or economy during locomotion (Docherty, 1996b).

In addition, the results indicated that socioeconomic status was significantly related to cardiorespiratory endurance. Precisely, cardiorespiratory endurance increased with increasing socioeconomic status. The findings of this study were consistent with past studies which have shown that children and adolescents from lower socioeconomic status families have lower levels of cardiorespiratory endurance than children and adolescents from higher socioeconomic status families (Lehnhard, Lehnhard, Butterfield, Parker, & Young, 1995; Renson et al., 1978). However, the findings of the present study were inconsistent with past research which has found an inverse relationship between cardiorespiratory endurance and socioeconomic status (Ponthieux &
Barker, 1965). The possibility that cardiorespiratory endurance may be positively related to socioeconomic status has several possible explanations. First, students from low-socioeconomic status families may have less physical access to appropriate environments and safe places (Taylor, Baranowski, & Sallis, 1994). Second, students from high-socioeconomic status families may have more ability to pay the costs of cardiorespiratory endurance-enhancing activities (Sallis et al., 1996). Third, students from low-socioeconomic status families may have fewer opportunities to participate in physical activities that influence cardiorespiratory endurance due to limited financial resources (Shropshire & Carroll, 1997). Fourth, girls from low-socioeconomic status families may receive less encouragement and support to participate in activities that improve cardiorespiratory endurance (Yang, Telama, & Laakso, 1996). Fifth, students from low-socioeconomic status families may have fewer programmes available that promote and maintain cardiorespiratory endurance and physical activity (Sallis et al., 1992b; Sallis et al., 1996).

The results also indicated that rural adolescents had significantly higher levels of cardiorespiratory endurance than urban adolescents. This finding replicated other previous studies among children and adolescents (Panterbrick, Todd, Baker, & Worthman, 1996; Renson et al., 1978). Some possible explanations for this finding parallel those for research question one and have been discussed in detail on pages 135-136.
In addition, the results indicated that the interaction between school year and gender was significant. That is, the relationship between cardiorespiratory endurance and school year was significantly different for both males and females. Specifically, the relationship was stronger for males than for females. There was a significant increase in cardiorespiratory endurance from Year 8 to Year 10 for males and no difference in cardiorespiratory endurance from Year 8 to Year 10 for females. This finding was consistent with that of Armstrong and Welsman (1994) who collated and plotted, from worldwide literature, over 10 thousand cardiorespiratory endurance data points from students aged 8-16 years. This progressive widening of the gender difference in cardiorespiratory endurance during adolescence may be explained physiologically by the concomitant increase in fat-free mass per unit stature for males and increase in body fat for females. It may, however, be more a result of the sociological influences considered in the discussion of the similar result for research question one rather than biological factors. The increases with age for both sexes is consistent with other studies that have reported absolute VO₂ max values (van Mechelen & Kemper, 1995a) and can be explained by increases in the size of the heart and lungs (Rowland, 1996) and by the ability to move more efficiently or economically (Docherty, 1996b).

The regression equation for this question accounted for a much larger proportion of the total variation in the dependent variable than for the previous
two questions. A possible factor that may have contributed to the larger reported $R^2$ value was that the measure of cardiorespiratory endurance was objective, so it was more exact than the self-report used in research questions one and two.

5.4 Recommendations

On the basis of results achieved in this study, the following recommendations are made:

1. A further study should be undertaken using a fundamental motor skills test battery that includes a wider range of fundamental motor skills that may be more pertinent both to the popular types of organised sports and games and nonorganised physical activities participated in by adolescents.

2. Provide increased professional development in assessment and pedagogy of fundamental motor skills for staff and in fundamental motor skills education for students to increase the proficiency of students’ fundamental motor skill ability, which is significantly related to their participation in organised sports and games and cardiorespiratory endurance. This should be focused on during early childhood (two to eight years of age) which is considered the optimal
period for learning new skills and fine-tuned during childhood (eight to eleven years of age).

3. Increase the skill level of females in skills used, first, in their most preferred organised sports and games and, second, in other popular sports and games in which girls may like to participate.

4. Broaden the range of fundamental motor skills taught in the physical education curriculum to include those which relate to popular female sports, games, and other physical activities.

5. Make it more socially acceptable for adolescent girls to participate in organised sports and games despite their skill level.

6. Encourage State Governments and Local Councils to examine ways in which they can promote more organised sports and games and nonorganised physical activities. This may be through advertising what facilities and programmes are available for adolescents, through building appropriate facilities, and through increasing the safety of areas.

7. Implement a further study examining the possibility of a cause-and-effect relationship existing between participation in organised sports and games and fundamental motor skill ability.

This research was undertaken to investigate how participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance were each related to
fundamental motor skill ability among adolescents. Issues and theories identified and developed through this study are in line with and build upon the theories and findings of previous research in the areas of adolescent health, physical activity, and motor development. Answers and explanations for two of the research questions have been provided and this has helped further the understanding of adolescent health and physical activity. However, one of the research questions and other significant related findings highlight the importance of further investigation. The issues raised throughout this study, therefore, could be used to give direction to future research aimed at better understanding and promoting physical activity among adolescents, which is such an integral physical and health education, and adolescent health issue.
APPENDIX A

Design Effect Values

### Table A1

**Design Effect Values**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 8</td>
<td>Year 10</td>
</tr>
<tr>
<td>Self-report recall questionnaire of participation in physical activity</td>
<td>2.35</td>
<td>1.49</td>
</tr>
<tr>
<td><strong>Fundamental motor skills test battery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run</td>
<td>1.84</td>
<td>2.16</td>
</tr>
<tr>
<td>Vertical jump</td>
<td>2.27</td>
<td>3.09</td>
</tr>
<tr>
<td>Catch</td>
<td>1.75</td>
<td>2.51</td>
</tr>
<tr>
<td>Overhand throw</td>
<td>2.75</td>
<td>1.89</td>
</tr>
<tr>
<td>Kick</td>
<td>1.47</td>
<td>1.14</td>
</tr>
<tr>
<td>Forehand strike</td>
<td>2.89</td>
<td>2.57</td>
</tr>
<tr>
<td>Multistage Fitness Test</td>
<td>3.05</td>
<td>3.71</td>
</tr>
</tbody>
</table>
APPENDIX B

Self-report Recall Questionnaire of Participation in Physical Activity
You are one of many students all over New South Wales who are helping us by completing this questionnaire. By answering these questions you will give us important information about the health of young people.

Your answers are confidential and will be looked at by the survey team and no one else. No one at your school will see your answers.

Take your time to read each question in turn and answer it as best you can.

Thank you for taking part in this survey.

IMPORTANT: HOW TO COMPLETE THIS FORM

Most questions can be answered by colouring in a box or writing your answer on a line.

* Read each question carefully.
* Completely colour in the box.
* Use only the 2B pencil provided.
* Fully erase any mistakes.
* Do not make stray marks on this form.
* Do not fold this form.
* Ask one of the staff if you need help.
What year are you in? (Please fill one box).
- Year 8
- Year 10

Are you male or female? (Please fill one box).
- Male
- Female

In what month were you born? (Please fill one box).
- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December

In what year were you born? (Please fill one box).
- 1979
- 1980
- 1981
- 1982
- 1983
- 1984
- 1985
- 1986
- 1987

In what country were you born? (Please fill one box).
- Australia
- Another country
- (Please specify): ________________

What language do you speak most at home? (Please fill one box only).
- English
- Another language
- (please specify): ________________

Are you an Aboriginal or Torres Strait Islander? (Please fill one box only).
- Yes
- No

What suburb do you live in?

What is the postcode where you live?

POSTCODE

EXAMPLE:
If your postcode is 2203, then you would fill the boxes like this:

2 2 0 3

How much do you weigh? (in kilograms)

KILOGRAMS

If you only know your weight in stones or pounds please call the supervisor.

I don’t know my weight

How tall are you? (in centimetres)

CENTIMETRES

If you only know your height in feet or inches please call the supervisor.

I don’t know how tall I am
The following questions are about ORGANISED sports and games that you do at school, before and after school and on weekends during school terms. DO NOT INCLUDE SCHOOL HOLIDAYS.

Please think about a NORMAL week and write in the table below:

a. Sports, games and organised activities that you usually do (including training),
b. How many times each week you usually do them, and
c. The usual amount of time you spend doing them.

In the middle of this page is a list of common activities to help remind you. If you do sports or games that are not on the list, please write them in the table anyway.

If you do not do any organised activities, please write 'zero' next to Sport/game 1.

### SUMMER SCHOOL TERMS (terms 1 and 4)

<table>
<thead>
<tr>
<th>Sport/game 1:</th>
<th>Number of times PER WEEK you usually do this sport or game, including training:</th>
<th>The usual amount of time (hours and minutes) you spend doing this activity EACH TIME you do it:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Athletics</th>
<th>Golf</th>
<th>Rugby League</th>
<th>Swimming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Rules</td>
<td>Gymnastics</td>
<td>Rugby Union</td>
<td>Tennis</td>
</tr>
<tr>
<td>Baseball</td>
<td>Hockey</td>
<td>Running</td>
<td>Touch Football</td>
</tr>
<tr>
<td>Basketball</td>
<td>Inline Hockey</td>
<td>Soccer</td>
<td>Volleyball</td>
</tr>
<tr>
<td>Cricket</td>
<td>Martial Arts</td>
<td>Softball</td>
<td>Water Polo</td>
</tr>
<tr>
<td>Cycling (competitive)</td>
<td>Rowing</td>
<td>Squash</td>
<td></td>
</tr>
</tbody>
</table>

### WINTER SCHOOL TERMS (terms 2 and 3)

<table>
<thead>
<tr>
<th>Sport/game 1:</th>
<th>Number of times PER WEEK you usually do this sport or game, including training:</th>
<th>The usual amount of time (hours and minutes) you spend doing this activity EACH TIME you do it:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Athletics</th>
<th>Golf</th>
<th>Rugby League</th>
<th>Swimming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Rules</td>
<td>Gymnastics</td>
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<tr>
<td>Baseball</td>
<td>Hockey</td>
<td>Running</td>
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<tr>
<td>Basketball</td>
<td>Inline Hockey</td>
<td>Soccer</td>
<td>Volleyball</td>
</tr>
<tr>
<td>Cricket</td>
<td>Martial Arts</td>
<td>Softball</td>
<td>Water Polo</td>
</tr>
<tr>
<td>Cycling (competitive)</td>
<td>Rowing</td>
<td>Squash</td>
<td></td>
</tr>
</tbody>
</table>
The following questions are about your participation in NON-ORGANISED physical activities at school, before and after school, and on weekends during school terms (such as walking or cycling to and from school). DO NOT INCLUDE SCHOOL HOLIDAYS. Please think about a NORMAL week and write in the table below:

- Activities that you usually do,
- How many times you usually do them, and
- The usual amount of time you spend doing them.

In the middle of this page is a list of common activities to help remind you. If you do physical activities that are not on the list, please write them in the table anyway.

If you do activities that are not on the list, please write them in the table anyway.

### SUMMER SCHOOL TERMS (terms 1 and 4)

<table>
<thead>
<tr>
<th>Activity 1:</th>
<th>Number of times PER WEEK you usually do this activity, including training:</th>
<th>The usual amount of time (hours and minutes) you spend doing this activity EACH TIME you do it:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 2:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 3:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 4:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 5:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 6:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 7:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Aerobics</td>
<td>Fishing</td>
<td>Sailing (dinghies)</td>
</tr>
<tr>
<td>Basketball</td>
<td>Golf</td>
<td>Skateboard</td>
</tr>
<tr>
<td>Bushwalking</td>
<td>Gym Workout</td>
<td>Soccer</td>
</tr>
<tr>
<td>Canoeing/Kayaking</td>
<td>Martial Arts</td>
<td>Squash</td>
</tr>
<tr>
<td>Cricket</td>
<td>Mountain Biking</td>
<td>Surfing (board)</td>
</tr>
<tr>
<td>Cycling for transport</td>
<td>Netball</td>
<td>Surfing (body)</td>
</tr>
<tr>
<td>Cycling for fun</td>
<td>Rollerblading</td>
<td>Swimming</td>
</tr>
<tr>
<td>Dancing</td>
<td>Sailing (sailboard)</td>
<td>Table Tennis</td>
</tr>
</tbody>
</table>

### WINTER SCHOOL TERMS (terms 2 and 3)

<table>
<thead>
<tr>
<th>Activity 1:</th>
<th>Number of times PER WEEK you usually do this activity, including training:</th>
<th>The usual amount of time (hours and minutes) you spend doing this activity EACH TIME you do it:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 2:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 3:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 4:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 5:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 6:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
<tr>
<td>Activity 7:</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
<td>over 21</td>
</tr>
</tbody>
</table>
APPENDIX C

Qualitative Components for Each Fundamental Motor Skill

QUALITATIVE COMPONENTS FOR EACH FUNDAMENTAL MOTOR SKILL IN THE FUNDAMENTAL MOTOR SKILLS TEST BATTERY

Run
1. Eyes focused forward throughout the run.
2. Knees bend at right angles during recovery phase.
3. Arms bend at elbows and move in opposition to legs.
4. Contact ground with front part of foot.
5. Body leans slightly forward.

Vertical Jump
1. Eyes focused forwards or upwards throughout the jump.
2. Crouch with knees bent with arms behind body.
3. Forceful upward thrust of arms as legs straighten to take off.
4. Contact ground with front part of feet and bend knees to absorb landing.
5. Balanced landing with no more than one step in any direction.

Catch
1. Eyes are focused on ball throughout the catch.
2. Preparatory position with elbows bent and hands in front of body.
3. Hands move to meet the ball.
4. Hands and fingers positioned correctly to catch the ball.
5. Catch and control of the ball with hands only.
6. Elbows bend to absorb the force of the ball.
Overhand Throw
1. Eyes are focused on the target throughout the throw.
2. Stand side-on to the target.
3. Throwing arm nearly straightened behind the body.
4. Step toward the target with foot opposite throwing arm during the throw.
5. Marked sequential hip-to-shoulder rotation during the throw.
6. Throwing arm follows through down and across the body.

Kick
1. Eyes are focused on the ball throughout the kick.
2. Step forward with nonkicking foot placed near the ball.
3. Bend knee of kicking leg during the backswing for the kick.
4. Hip extension and knee flexion of at least 90° during preparatory phase.
5. Contact the ball with the top of the foot.
6. Forward and sideway swing of the arm opposite to the kicking leg.
7. Kicking leg follows through towards the target after ball contact.

Forehand Strike
1. Eyes are focused on ball throughout the strike.
2. Stand side-on to target with bat held in one hand.
3. Striking arm nearly straightened behind shoulder at the end of the swing.
4. Step towards the target with foot opposite to the striking arm during the strike.
5. Marked sequential hip-to-shoulder rotation during the strike.
6. Ball contact made opposite to front foot with a straight arm.
7. Follow through towards the target then around the body.
APPENDIX D

Fundamental Motor Skills Test Battery Score Sheet

### Flexibility

<table>
<thead>
<tr>
<th>Sit-and-reach (millimetres)</th>
<th>1</th>
<th>2</th>
<th>srrbest</th>
<th>srlbest</th>
<th>srbbest</th>
<th>tidsr:______</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right leg:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left leg:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both legs:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Shoulder stretch**

- Right shoulder (Yes = 1, No = 2) ssr
- Left shoulder (Yes = 1, No = 2) ssl tids:

### Muscular Strength

<table>
<thead>
<tr>
<th>Basketball throw (metres)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>msbest</th>
<th>tidms:______</th>
</tr>
</thead>
</table>

### Muscular Endurance

| Curl-up | msbest | tidme:______ |

### Locomotor Skills

<table>
<thead>
<tr>
<th>Run</th>
<th>1</th>
<th>2</th>
<th>rubest</th>
<th>tidru:______</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical jump</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

### Ball Skills

<table>
<thead>
<tr>
<th>Throw</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>thbest</th>
<th>tidth:______</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>cabest tidca:______</td>
</tr>
<tr>
<td>Kick</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>kibest tidki:______</td>
</tr>
<tr>
<td>Strike</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sbest</td>
<td>tidst:______</td>
</tr>
</tbody>
</table>
APPENDIX E

University of Wollongong Human Research Ethics Committee Authorisation
University of Wollongong

CONDITIONAL APPROVAL
In reply please quote: SD:KM HE97/05
Further Information: Karen McRae (Ext 4457)

20 February 1997

Mr Tony Okely
Faculty of Education
University of Wollongong

Dear Mr Okely,

I am pleased to advise that the following Human Research Ethics application has been conditionally approved:

- **Ethics Number:** HE97/05
- **Project Title:** The relationship between physical fitness, skill level and physical activity in children and adolescents
- **Name of Researcher:** Tony Okely
- **Clearance Date:** 18 February 1997
- **Duration of Clearance:** 17 February 1998

This approval is granted subject to the following conditions:

(i) the Consent Forms and Information Sheets for children and parents being sent to the Committee before proceeding with the research

(ii) written approval from the Department of Education and Independent and Catholic School Principles to conduct the research should be forwarded to the Committee

Please provide written confirmation to the Secretary of the Committee before continuing your research, or approval will be withdrawn.
This certificate relates to the research protocol submitted in your original application of 4 February 1997. It will be necessary to inform the Committee of any changes to the research protocol and seek clearance in such an event.

Please note that experiments of long duration must be reviewed annually by the Committee and it will be necessary for you to apply for renewal of this application if experimentation is to continue beyond one year.

Dr S. Dodds  
Chairperson  
Human Research Ethics Committee  

cc. Dean, Education
4 March 1997

Mr Tony Okely
Faculty of Education
University of Wollongong

Dear Mr Okely,

I am pleased to advise that following our discussion on 27/2/97, the amendments to your Human Research Ethics application has been conditionally approved:

Ethics Number: HE97/05

Project Title: The relationship between physical fitness, skill level and physical activity in children and adolescents.

Name of Researchers: Tony Okely

Approval Date: 27 February 1997

Duration of Approval: 26 February 1998

Approval is subject to receipt of a revised letter (including contact at Sydney University) and a letter of agreement between T. Okely, Department of Schools Education and Sydney University concerning ownership and use of data.

It will be necessary to inform the Committee of any changes to the research protocol and seek clearance in such an event.

Please note that experiments of long duration must be reviewed annually by the Committee and it will be necessary for you to apply for renewal of this application if experimentation is to continue beyond one year.

Dr S. Dodds
Chairperson
Human Research Ethics Committee

cc: Dean, Education
26 March 1997

Mr Tony Okely
Faculty of Education
University of Wollongong

Dear Mr Okely,

Thank you for your response and amendments to the Committee's requirements for your Human Research Ethics Application HE97/05 "The relationship between physical fitness, skill level, and physical activity in children and adolescents"

Your response and amendments meet with the requirements of the Committee and your application is now formally approved.

Yours Sincerely,

Chairperson
Human Research Ethics Committee
12 February 1998

Mr Tony Okely,
Faculty of Education
University of Wollongong

Dear Mr Okely,

I am pleased to advise that renewal of the following Human Research Ethics application has been approved:

Ethics Number: HE97/005

Project Title: The relationship between physical fitness, skill level and physical activity in children and adolescents

Name of Researchers: Tony Okely

Approval Date: 5 February 1998

Duration of Approval: 4 February 1999

This certificate relates to the research protocol submitted in your original application and the renewal application of 2 February 1998. It will be necessary to inform the Committee of any changes to the research protocol and seek clearance in such an event.

Please note that experiments of long duration must be reviewed annually by the Committee and it will be necessary for you to apply for renewal of this application if experimentation is to continue beyond one year.

Dr S. Dodds
Chairperson
Human Research Ethics Committee
APPENDIX F

Information Sheets for Education Sectors and Principals of Selected Schools

NSW SCHOOLS FITNESS AND PHYSICAL ACTIVITY SURVEY
INFORMATION SHEET

Background
In May 1995 the Minister for Education announced four steps to improving the fitness of NSW school students. This study, the purposes of which are to determine the prevalence of adequate levels of fitness and physical activity participation and the main factors associated with physical activity participation, is one of those four steps. Part of the strategy has also been to make physical activity a 1997 priority area. Your school is being approached as it was selected on the basis of a random sampling procedure of all NSW schools.

The study
The study has been funded jointly by the NSW Dept of School Education, the NSW Dept of Health and the National Professional Development Program and is being conducted by a research group with representatives from the University of Sydney, University of NSW, Wollongong University and the Australian Catholic University. The project will be overseen by the National Professional Development Program K-6 PDHPE Coordinating Group. Forty-five NSW high schools and forty-five NSW primary schools from all three education sectors and from rural and metropolitan NSW will be invited to participate in the study.

The purpose of the study is threefold. First, we wish to develop an understanding of the physical fitness and physical activity habits of NSW students aged 7 to 15 years. (The measures are listed below.) The most recent survey of this size and type was conducted in 1985 and is now out of date. The second component of the study will involve the provision of professional development opportunities to teachers and information to interested parents and other members of the school community. Finally, the results of the survey will be used to inform the development of a professional development package being prepared by the National Professional Development Program. The study has been approved by the appropriate ethics committees.

What are the benefits of the study?
The study will provide valuable information on the physical fitness of NSW children and adolescents and will provide opportunities to offer support to teachers and parents involved in the physical education of NSW school children. The study will provide benchmark data for tracking changes in the physical fitness of children and adolescents in NSW and will contribute to our understanding of the factors which influence physical activity participation.
NSW SCHOOLS FITNESS AND PHYSICAL ACTIVITY SURVEY

What tests and measures will be used and how long will it take?

A team of three or four field research officers will conduct the tests at the school after thorough training and practice. Most of the field work will be carried out by teachers voluntarily seconded for the term of the project. We wish to administer the following tests:

- aerobic capacity (Shuttle Run test)
- strength (basketball throw)
- muscular endurance (curl-ups)
- flexibility (sit-and-reach and shoulder stretch)
- locomotor skills (run, vertical jump)
- ball skills (catch, kick, throw, strike)
- body composition (height, weight, waist and hip girths, skinfold thicknesses)
- a brief questionnaire (see attached draft).

We estimate that the objective measures will require approximately one and a half hours per Year group and that the questionnaire will require approximately 10 minutes to complete.

When will the study be conducted?

The study will be conducted during weeks three to eight of Term 1, 1997. The date for the visit will be negotiated with each school and we will do our best to accommodate the first preference of the school.

What is required of schools?

Conduct of the tests requires an open space approximately 30 metres in length. Access to a power point would be helpful, but is not essential. It is preferable to conduct the tests in-doors to avoid exposure to the sun and rain, but an outdoor space is also acceptable. At co-educational schools, separate rooms (or a visually partitioned area) for conducting body composition measures (to provide privacy) is also required. A room or space which can sit 30 students is required to allow completion of the questionnaire.

As soon as participating schools have been identified, we will talk with the liaison officer about the random selection of one class in each of Years 2, 4 and 6 in 1997. Students will need to wear their usual sports clothes.

Professional development opportunities for schools

We invite schools to send as many teachers as they wish to observe and participate in the measurement process. We will be sending handbooks on measurement (for most of the measures) to participating schools prior to our visit. We will also offer each participating school the opportunity for a professional development session at the end of the day of the visit.

Confidentiality

Only research staff at the University of Sydney will have access to the completed questionnaires. Any information that identifies the responses of a particular student or school will be stored securely and held in confidence. The results will be published in aggregate form, from which the responses of any student or school will not be identifiable. A one-page description of the study will be prepared to inform parents.
NSW SCHOOLS FITNESS AND PHYSICAL ACTIVITY SURVEY

Well-being of students

Every effort will be made to protect the safety, privacy and self-esteem of students. All anthropometric measures will be conducted by field researchers of the same sex as the students. Wherever possible measurements will be taken in the absence of members of the opposite sex, but particularly in the case of post-pubertal students.

If you have any questions regarding the study please call Dr Michael Booth on (02) 9351-5121. If you wish to talk with the representative of your education sector who is involved with this study, a list of contacts is provided below. Your cooperation would be greatly appreciated.

Education Sector Contacts

Department of School Education
Janet Davy
Phone (02) 9886-7444

Catholic Education Commission
Margaret Sykes
Phone (02) 9287-1583

Association of Independent Schools
Linda Fairbairn
Phone (02) 9299-2845

If you wish to make a complaint about the conduct of the survey in your school you may contact:

Ms Gail Briody
University of Sydney Ethics Committee
Phone (02) 9351-4811
APPENDIX G

School Participation Confirmation Sheet

Thank you for agreeing to participate in this exciting project. Students in Years 2, 4, 6, 8 and 10 from throughout NSW will be tested and surveyed during term 1. Prior to one of our field teams visiting your school on ________, classes will be selected at random from these years. In order to do this I will need to discuss the following points with you:

- does your school have home roll groups and if so how are these groups arranged
- approximate size of roll groups (if applicable)
- are classes streamed or mixed ability (size of classes)
- do classes include both boys and girls (in coed schools)
- approximately, how many students are in each of the selected years
- approximately, how many classes are in each of the selected years.

My intention is to contact you by phone within the next two days, or if more convenient you could ring me on ____________________.

It is important for the validity of the study that classes are selected at random so that the results are not biased when the data for all schools are combined. After we establish the above information on classes, a class in each of the years being tested will be selected using a statistically valid process. Confirmation of selected classes and other details will then be forwarded to you.

Thank you again for your cooperation. I look forward to speaking with you soon,

NSWSFPAS Project Officer
NSW SCHOOLS FITNESS AND PHYSICAL ACTIVITY SURVEY 1997
CLASS SELECTION CONFIRMATION TO SCHOOL

School: ________________________________
Contact teacher: ________________________________
Date of scheduled visit: ________________________________ Time of scheduled visit: ________________________________
Confirmation date: ________________________________

Selected classes:

<table>
<thead>
<tr>
<th>Year</th>
<th>Time</th>
<th>Year</th>
<th>Time</th>
<th>Year</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>Size/info</td>
<td>Class</td>
<td>Size/info</td>
<td>Class</td>
<td>Size/info</td>
</tr>
</tbody>
</table>

Professional development workshop: No [ ] Yes [ ] Time: ________________________________

IMPORTANT REMINDERS

A. Time requirements
- The time required for questionnaire completion will vary among different classes and students. But, it is expected to take between 20-40 minutes.
- The objective physical measurements will take approximately one and a half hours to complete. These measurements will be conducted after questionnaire completion.

B. Space requirements

For questionnaire completion:
- A class room which can seat 30 students, tables set up examination style to allow completion of the questionnaire.

For objective physical measurements:
- A hall/gym (or open space if not available) approximately 30 metres in length, access to a power point (helpful, but not essential), separate rooms (or visually partitioned area) for conducting body composition measures (to provide privacy) are also required.

C. Students requirements
- The students of the selected classes must return their permission notes prior to the field team visiting your school to permit participation in the study.
- Students are required to wear a pair of shorts, T-shirt and sport shoes during the fitness assessment.
D. Staff

- Staff are welcomed to observe the fitness assessment and participate in the professional development workshop of the study.
- Assistance in completing a School Environment Survey is requested, which is anticipated to take approximately 10-15 minutes to complete, any questions will be welcomed on the day of the visit.
- On the day, please provide to the field staff a copy of the class list for each of the selected classes so that a check on those who might be absent or refused to participate can be done.

Should you have any further questions or issues you would like clarified, please do not hesitate to contact a member of the NSWSFPAS management team.

Government Schools
Diane Trist
Phone (042) 213308

Catholic and Independent Schools
PH Phongsavan or Lyndall McLellan
Phone (02) 9351-6499
APPENDIX H

Proforma for Selection of Classes

NSW FITNESS AND PHYSICAL ACTIVITY SURVEY 1997
SELECTION OF CLASSES PROTOCOL

SCHOOL: ____________________________________________

CONTACT TEACHER: ____________________________ DATE: __________

INTRODUCTION:
"As you are aware, one class from each of Years 2, 4 and 6 (or 8 and 10) will be selected to participate in the study. It is important for the validity of the study that these classes are selected at random so that the results are not biased when the data for all schools are combined. To allow me to select the classes, I will need some information from you about how classes in your school are formed and how many classes there are in each year group."

1. Ascertain how students are assigned to classes to select appropriate groupings to sample

NOTE: For sampling purposes, in order of preference use:
• mixed ability roll classes
• mixed ability subject classes
• streamed classes
• check that average class sizes are at least 25-30 and that classes include boys and girls in co-educational schools.

Repeat this section for each year group:

2. Ascertain how many classes there are in each year to be sampled (2/4/6 or 8/10).

3. Identify the classes (e.g. 2GW etc), and ascertain whether they are composite classes and approximately how many children are in each class.

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<th>size/info</th>
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</table>

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4. Check whether any of the classes are:

"special" in any way (e.g. all children in the class have learning difficulties OR most/all have major problems with English etc)

or not available on the day of the survey (e.g. excursion)

Cross out any classes which would not be able to participate (not avail / special)

Combine composite classes to form a new "class(es)" of size 30 (APPROX)

Repeat this process for the remaining year group(s)

Once the eligible "classes" have been identified for each year group, assign the number "1" to the first on the list, "2" to the second and so on. Open the attached envelope to select the "random class" for each year, circle it on the table above and let the contact teacher know which it is.
APPENDIX I

Information Sheet and Permission Notes for Parents
Dear Parent,

During this term approximately 6,000 students across NSW will participate in a survey of student fitness and physical activity. Our school has been randomly selected to take part in this survey.

The study will help us to better understand how we can encourage our students to be physically active. It will also inform the development of a teacher and parent resource to support the improvement of student fitness.

Your child’s class has been selected to take part in this survey. It will take place on __________. The survey includes a series of tests which will measure aerobic fitness, strength, body composition, flexibility, ball skills and locomotor skills. Students will also be asked to complete a questionnaire on attitudes to physical activity. These tests are often conducted in schools as part of PD/Health/PE programs. A team of four research officers, who are teachers, will conduct the tests.

The results of your child’s tests will be confidential. The survey will not report on any individual student’s results. Students will need to bring their PE/Sports uniform or a pair of shorts and t-shirt on the day of the test for accurate measurements to be obtained.

This project is an exciting step in helping us improve the health of our students. I encourage you to support your child’s involvement.

Please complete the details below and return to _________________ by ____________.

Principal

NSW Schools Fitness and Physical Activity Survey 1997

Student’s Name: ________________________________

Class: ________________________________

I hereby consent to my child participating in the NSW Schools Fitness and Physical Activity Survey.

Signature of Parent/Carer ___________________________ Date ___________________________

Does your child have any medical conditions we need to be aware of during the conduct of the survey?

☐ No ☐ Yes, Please describe:

________________________________________

________________________________________

________________________________________

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APPENDIX J

Self-report Recall Questionnaire of Participation in Physical Activity:
Verbal Instructions
Survey Introduction Guideline
Year 8 and Year 10

Thank you for taking part in the 1997 NSW Schools Fitness and Physical Activity Survey. Three thousand high school students from across NSW will be taking part. The purpose of the survey is to find out about the fitness and skills of young people and to find out what you think and feel about being physically active.

*(Read through instructions on cover sheet). Emphasise and explain confidentiality.*

First, write your name here *(hold up chart or questionnaire)*. Point out to students that we only need their names on both forms because we will first separate the forms and later would need to match them up again. The names will not be used for anything else.

Next, write the name of your school here *(hold up chart or questionnaire)*.

Next, write these numbers (school code and year code - see Appendix A) in the boxes here and fill in the boxes like this *(demonstrate)*.

For the rest of the questions, you would colour in the boxes that best describe the answer that is right for you.

*Year 8/Year 10 to do the first page on sociodemographics by themselves, under supervision.*

*Instruction for height and weight here.*
If you don’t know you height/weight please fill in the box next to ‘I don’t know how tall I am’ or ‘I don’t know what my weight is’.
If you only know your height in feet and inches, and weight in pounds or stones, please put your hand up.

*Field staff to use conversion chart to assist students.*
If you don't know your height/weight please do not write anything on the line. If you only know your height in feet and inches, and weight in pounds or stones, please put your hand up. Students can complete the height and weight boxes also.

Field staff to use conversion chart to assist students.

(Stop and wait for class to catch up).

The next questions are about sports, games and other activities that you do. The first questions are about ORGANISED sports and games. The next questions (the next page) are about NON-ORGANISED activities that you do.

Organised sports, games and other activities are ones in which you compete, have training or coaching sessions, and which adults organise. They include things like football, gymnastics or dance. NON-ORGANISED activities are things like skateboarding, surfing, riding a bike, walking or playing a sport with friends for fun. There may be activities that you do in an organised way and a non-organised way.

For example, you might play in a touch football team which competes regularly and which have regular training sessions. You would write that under organised activities. You might also play a game of touch football with friends once a week. That would go under NON-ORGANISED activities. (Read through instructions).
APPENDIX K

Physical Activity Codes

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</tr>
<tr>
<td>03 Australian Rules</td>
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<td>06 Bushwalking</td>
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<td>07 Canoeing/Kayaking</td>
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<tr>
<td>08 Cricket</td>
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<td>09 Cycling for Transport</td>
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<td>10 Cycling for Fun</td>
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<td>26 Running/Jogging</td>
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APPENDIX L

Equivalence Between Level and Shuttle (L.S.) and Number of Laps for the Multistage Fitness Test

Equivalence between level.shuttle (L.S) and number of laps for the Multistage Fitness Test.

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APPENDIX M

Tables Showing Results of Regression Analyses

for Research Questions One, Two, and Three
## Table M1

Time Spent Participating in Organised Sports and Games: Cell Means, Standard Deviations, and Frequencies for Fundamental Motor Skill Ability Quintiles by Gender and School Year

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<td>SD</td>
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Table M2

**Time Spent Participating in Nonorganised Physical Activity: Cell Means, Standard Deviations, and Frequencies for Fundamental Motor Skill Ability Quintiles by School Year**

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### Table M3

Cardiorespiratory Endurance: Cell Means, Standard Deviations, and Frequencies for Fundamental Motor Skill Ability Quintiles by Gender and School Year

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REFERENCES


Board of Studies NSW. (1991). Personal development, health and physical education syllabus: Years 7-10. Sydney: Board of Studies, NSW.

Board of Studies NSW. (1992). Personal development, health and physical education: K-6 syllabus and support document, formal consultation draft. Sydney: Board of Studies, NSW.

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