The Effects of Low and Moderate Intensity Physical Activity on Selected Coronary Heart Disease Risk Factors, Functional Ability and Psychological Well-Being in a Senior Population.

by

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DEDICATION

To Heather, my parents Glenn and Shirley and my grandparents, Lizzie, Flo and Les.

Without your wisdom and support I would not be where I am today.

I would also like to dedicate this thesis in the memory of my grandfather George Sitland

who taught me what active living was all about.

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List of Abbreviations

Activities of daily living	ADL
American College of Sports Medicine	ACSM
Blood pressure	BP
Cardiovascular disease	CVD
Center for Disease Control	CDC
Coronary heart disease	CHD
General linear model	GLM
Geriatric Depression Scale	GDS
Groningen Activity Restriction Scale	GDS
Heart rate reserve	HRR
High density lipoprotein	HDL
Instrumental activities of daily living	IADL
Low density lipoprotein	LDL
Physical Activity Scale for the Elderly	PASE
Psychological well-being	PWB
Resting Heart Rate	RHR
Timed 'Up & GO' Test	TUGT
Total cholesterol	TC

ABSTRACT

The CDC and the ACSM recommend accumulating a minimum of 30 minutes of moderate intensity physical activity for most days of the week, preferably everyday to gain health benefits (Lee and Paffenbarger, 1996). However, the operational definition for moderate intensity varies from study to study. The purpose of this study was to determine the effects of low and moderate intensity physical activity on selected coronary heart disease risk factors, functional status and psychological status, with respect to depression. Two males and six females over the age of sixty-five participated in a 16-week walking program (3 sessions per week). The subjects were randomly assigned to one of two experimental walking groups with an intensity of 35-45% heart rate reserve (HRR) and 50-60% HRR for group 1 and group 2, respectively. The kcal expenditure was standardized for each participant and was increased at predetermined intervals. The variables evaluated in this study were systolic & diastolic blood pressure, resting heart rate, weight, waist girth, triglyceride profile, total cholesterol (TC), HDL & LDL profiles, predicted VO_{2max}, timed 'Up & Go' test (TUGT) as well as the scores on the following questionnaires: Groningen Activity Restriction Scale, Geriatric Depression Scale & the Physical Activity Scale for the Elderly. The ANOVA's General Linear Model was used to test the main effects (group, trial, subject(group)) and interactions (group*trial) at an $\alpha = 0.05$ level of significance. The results indicated that VO_{2max} (F 8.61, df 1;7, $p=0.022$) and TC (F 5.77, df 1;7, $p=0.047$) increased significantly and weight (F 3.79, df 2;14, $p=0.049$) and TUGT time (F 6.14, df 1;7, $p=0.042$) decreased significantly. However, no significant difference was observed between the moderate and low intensity exercise groups. The significant increase observed for TC is possibly the result of factors that were not controlled for by this study (e.g. diet). This data suggests that physical activity performed at an intensity of 35-45% HRR can be used to improve VO_{2max}, body composition and TUGT time. As well, it can be inferred that a moderate intensity physical activity program does not result in any greater improvement in the aforementioned variables than the improvements observed when a low intensity physical activity program is used.

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Introduction

Statistics indicate that the numbers of seniors are rapidly increasing in today's society. Currently, 12.3% of the Canadian population is 65 years of age or older and by the year 2016 this number will have increased to approximately 16% (Statistics Canada, 1999). At present, approximately 12% of the U.S. population is aged 65 or older. This number is expected to climb to 20% of the population by the year 2025 (DiPietro, 1996). This growth in the senior population can be attributed, in part, to an increase in life expectancy. This is the direct result of decreases in acute diseases and postponement of chronic diseases. The increasing senior population will also be affected by the 'baby boomer' generation, which will reach the age of 65 between the years 2010 and 2020 (Ostrow, 1989). This generation represents a rapid increase in the birth rate that followed World War II.

As the body ages many physiological changes occur. Research has shown that aerobic power, muscular strength and endurance and flexibility decline with age. It is estimated that aerobic power decreases approximately 10% per decade in sedentary individuals. However, studies have shown that this decrease in aerobic fitness can be slowed through regular exercise (Wilmore & Costill, 1994). Decreases in muscular strength also accompany the aging process. It is estimated that the total decline in strength, during an individual's lifespan, is approximately 16.5% or greater. This process begins to occur toward the end of or just after the third decade of life (McArdle, Katch & Katch, 1991). This decrease observed with aging has been attributed to the decrease in both the size and the number of muscle fibers. It has been suggested that an individual

will lose approximately 10% of their muscle fibers by the age of 50 (Wilmore & Costill, 1994). Flexibility has also been shown to decline with age reducing the range of motion at the joints. This is partially the result of an increase in stiffness in the collagen fibers, which decreases the ability of the tendons and ligaments to stretch (Mazzeo, Cavanagh, Evans, Fiatarone, Hagberg, McAuley & Startzell 1998). Aging is also accompanied by a change in body composition, leading to a reduction in lean body tissue (muscle mass) and an increase in adipose tissue. Possible causes for this change include a reduction of activity (increased inactivity) and or changes in diet.

As these physiological changes occur it becomes more of a challenge to maintain social independence, functional mobility and cognitive abilities. Small declines in functional status associated with aging can result in the inability of an individual to perform the necessary tasks of daily living (Fleming, Evans, Weber & Chutka, 1995). These activities include such things as walking, standing from a chair and performing various household duties. If an individual can no longer perform these tasks it will impact their independence severely. Therefore, if these physiological variables (aerobic capacity, muscular strength and flexibility) could be maintained or improved through regular physical activity it would be highly beneficial and could aid in the maintenance/improvement of the skills and abilities required to perform the necessary activities of daily living and maintain independence.

Along with physiological changes there are also psychological complaints that accompany aging. Depression is the most common psychological complaint among seniors and accounts for 50% of all the mental disorders (Ostrow, 1989). Within this population there is a high suicide rate, especially in older white males. Depression and

depressive symptoms are attributed to such causes as failing health, loss of spouse and or friends and financial problems (Ostrow, 1989). Some research supports the hypothesis that physical activity can be used to help treat or counteract depression and depressive symptoms (Camacho, Roberts, Lazarus, Kaplan & Cohen, 1991; Mobily, Rubenstein, Lemke, O'Hara & Wallace, 1996).

The importance of these physiological, functional and psychological changes cannot be stressed enough since they affect the many facets of seniors' lives as well as their independence. For instance, when a senior changes from being independent to dependent there are financial implications. These include the cost of home care, hospitalization or institutionalization in a long-term care facility. These costs can be shared (individual and health care system) or can be placed entirely upon the health care system. If nothing is done to help seniors maintain their independence it is possible that a large proportion of the senior population will lose their independent status, placing a large financial strain on an already troubled medical system. The impact of this problem along with the health care costs associated with it will grow as the number of seniors within the population continues to increase unless steps are taken now to find a solution to the problem (Denton & Spencer, 1995).

When developing programs aimed at helping seniors maintain their independence it is important to note that a difference exists between physical activity and exercise. There seems to be a popular misconception that physical activity and exercise are synonymous; however, they are not. Physical activity is defined as any movement, produced by the skeletal muscles, that increases energy expenditure. The movements that are produced fall into the category of non-leisure and leisure movements, such as walking

as a mode of transportation or as a form of pleasure. Exercise differs from physical activity in that it is planned, structured and repetitive. Exercise is a leisure activity, but its main function is to improve physical fitness (Canadian Society for Exercise Physiology, 1996). If an individual sets 30 minutes aside 3 to 5 days per week to walk on a treadmill it would be considered exercise.

Health is a multidimensional term that incorporates physical, psychological and social components. These components exist on a continuum and should also be considered when designing senior programs. Good health can be defined, as the ability to enjoy life and withstand challenges, not only the absence of disease, whereas, physical fitness refers to health-related fitness and performance-related fitness. Health-related fitness is made up of those components that exhibit a relationship with the individual's level of health, such as body composition, blood pressure and blood lipoproteins (Canadian Society for Exercise Physiology, 1996). The changes in these variables will not improve an individual's performance-related fitness, but will improve their physical well-being and help reduce their risk of disease. However, performance-related fitness deals with those attributes that are necessary for an individual to optimize their performance at work or in sport, such as reaction time (Canadian Society for Exercise Physiology, 1996). This study focused on health related fitness.

Medical illness can also result in diminished functional status leading to the reduction in an individual's level of independence (Fleming et al., 1995). American studies indicate that cardiovascular disease (CVD) is the leading cause of death in older adults. It is estimated that CVD causes half a million deaths and 3.5 million hospital admissions per year in those individuals 65 years or older (LaCroix, Leveille, Hecht,

Grothaus and Wagner, 1996). In Canada, approximately 23% of all deaths in people aged 65 to 74 years are the result of CVD (Heart and Stroke Foundation of Canada, 1999). Included in the broad category of CVD is coronary heart disease (CHD). Berlin and Colditz (1990) stated that there is a relationship between inactivity and heart disease and that the relationship indicates a sedentary lifestyle, which could result in serious health problems (e.g. CHD). Conversely, research has also shown that regular physical activity, performed at a moderate intensity, can provide health benefits and can improve several CHD risk factors (Young & Steinhardt, 1995). However, further increasing the intensity of physical activity may have a proportionately less significant effect on the reduction of coronary risk factors in comparison to the improvement observed in physical fitness (Young & Steinhardt, 1995). Therefore, lower intensity physical activity may be used to reduce the risk of CHD and help prevent declines in functional status in the older adult.

A study by LaCroix et al. (1996) indicated that walking more than 4 hours per week significantly reduced the risk of CVD hospitalizations and was associated with a reduced risk of death. This reduced risk of disease may help to prevent a decline in functional status. In terms of time spent walking, those individuals walking 1 to 4 hours per week also experienced reductions in the number of CVD events (LaCroix et al., 1996). This reduction was not as great as that observed in individuals that walked 4 hours or more per week, but was greater than that observed in the individuals walking less than an hour per week.

Physical activity has also been shown to positively affect an individual's functional ability by improving aerobic capacity and or muscular strength and endurance. For instance, a 12-week walking program using a self-selected pace was found to

increase walking endurance in nursing home residents (MacRae, Asplund, Schnelle, Ouslander, Abrahamse & Morris, 1996). This study highlights the benefits of regular physical activity on functional mobility, which is very important in maintaining independence in a senior population. Hubley-Kozey, Wall and Hogan (1995) revealed that subjects participating in a general exercise program (elderobics class) showed improved range of motion (ROM) in the joints of the lower limbs. The ability to maintain and or improve ROM helps to prevent injury and allows the subject to complete various activities of daily living thus aiding the individual in maintaining an independent lifestyle.

Psychological benefits can also be realized from physical activity. Research has shown that these benefits are most pronounced in the elderly population. The benefits include decreased depression, anxiety and muscular tension. Together with these reductions and an increased level of physical activity are improvements in overall happiness, higher self-esteem and an overall improvement in the quality of life (Ostrow, 1989). Creating positive changes in one or all of these variables can lead to an improvement in the overall psychological well-being of an individual. Based on this evidence physical activity has been widely prescribed by physicians as a method of treatment for mild depression (Mazzeo et al., 1998). Several studies have indicated that a relationship exists between depression and inactivity and that exercise is a modality that is suitable for counteracting the symptoms of this condition (Camacho et al., 1991, Mobily et al., 1996).

The Center for Disease Control (CDC) and the American College of Sports Medicine (ACSM) recommend accumulating a minimum of 30 minutes of moderate

intensity physical activity most days of the week, preferably everyday (Lee and Paffenbarger, 1996). The 1998 ACSM position states that physical activity may not always increase performance-related fitness, but it does improve health and functional capacity. It is these benefits that contribute to a healthy independent lifestyle for the aging individual (Mazzeo et al., 1998).

The consensus on how much activity an individual should perform is quite clear, but determining the intensity at which this activity should be performed creates a problem. Many of the research studies examining health benefits associated with physical activity in a senior population have used activities such as jogging or cycling. These activities are usually performed at a vigorous intensity and for the most part, are inappropriate for the population in question. For example, a study by Posner, Gorman, Windsor-Lansberg, Larsen, Bleiman, Shaw, Rosenberg and Knebl (1992) had subjects cycling at 70% of VO_{2max}, which they suggested was a moderate intensity. The problem with this is that for many seniors the aforementioned intensity is too strenuous, especially for the oldest old (those greater than 75 years of age). Even if the individual could perform activity at this intensity it would most likely result in muscle soreness and fatigue, which would probably act as a deterrent for future activity. Therefore it is necessary to consider intensities of activity that would be practical, enjoyable and beneficial to this population. It is accepted by most researchers that the moderate intensity activity prescribed by the CDC and ACSM should be at the level of 60-70% of maximal capacity (Lee & Paffenbarger, Jr., 1996). However, even the lower end of this intensity scale may be unrealistic for the seniors who have been sedentary or only perform low levels of activity. Blair and Connelly (1996) have presented the argument

that some activity is better than none and therefore, low to moderate intensity activity is better than remaining sedentary. If this is truly the case, then it is this concept that should initially be used to prescribe physical activity for seniors. Furthermore, in terms of the intensity of activity necessary to incur health benefits, there is no consensus among researchers. Slattery (1996) states that depending on the disease it could be a higher level of intensity that reduces the risk, whereas for other diseases it may be the overall caloric expenditure of the individual. If it is the total amount of calories expended that offers health benefits then there is no reason why this cannot be achieved through low intensity, longer duration activity. Therefore, if activity can be performed at a lower intensity and still provide some health benefits it should help promote increased activity and adherence within the senior population.

As the number of seniors continues to increase in our society the time has come to place the research focus on the problems commonly encountered by this population (declining health, loss of balance, declining functional ability, etc.). If ways are not found to help improve or maintain their independence it could mean that more seniors will have to be institutionalized. As a result, this could place a large financial burden on the medical system with the repercussions felt by society as a whole.

The aim of the present study was to address the question of what can be done in an attempt to offset or delay some of these health concerns encountered as an individual ages. Specifically, the purpose was to compare the effects of low and moderate intensity walking programs, in a senior population, in terms of the effects on selected CHD risk factors, functional status and psychological status with respect to depression. If

improvements can be made in all these areas or even just one, then this could aid the individual in maintaining their independence and improving their health status.

Hypothesis

It was hypothesized that both low and moderate intensity physical would improve health related fitness over a 16-week period, as measured by: resting heart rate, systolic & diastolic blood pressure, weight, waist girth, Groningen Activity Restriction Scale score, Geriatric Depression Scale score, triglyceride level, total cholesterol, high density lipoprotein profile, low density lipoprotein profile, Physical Activity Scale for the Elderly score, predicted VO_{2max} and timed 'Up & Go' time. It was also hypothesized that a greater increase in health benefits would be observed in group 1 (moderate intensity) than group 2 (low intensity).

The expected outcomes for these measures are detailed in the following section.

Expected Experimental Outcomes

Time Effects

The following changes were expected when comparing the pre and post data sets for the two experimental groups:

1. Selected cardiovascular risk factors:

Blood Lipid Profile

Group 1: Cholesterol, triglycerides and LDL levels will decrease significantly from T1 to T3.

Group 2: Cholesterol, triglycerides and LDL levels will decrease significantly from T1 to T3.

Group 1: HDL levels will increase significantly from T1 to T3.

Group 2: HDL levels will increase significantly from T1 to T3.

Systolic & Diastolic Blood Pressure

Group 1: Systolic blood pressure will decrease significantly from T1 to T3.

Group 2: Systolic blood pressure will decrease significantly from T1 to T3.

Group 1: Diastolic blood pressure will decrease significantly from T1 to T3.

Group 2: Diastolic blood pressure will decrease significantly from T1 to T3.

Resting Heart Rate

Group 1: Resting heart rate will decrease significantly from T1 to T3.

Group 2: Resting heart rate will decrease significantly from T1 to T3.

Waist Girth

Group 1: Waist girth will decrease significantly from T1 to T3.

Group 2: Waist girth will decrease significantly from T1 to T3.

2. Predicted VO_{2max}

Group 1: Predicted VO_{2max} will increase significantly from T1 to T3.

Group 2: Predicted VO_{2max} will increase significantly from T1 to T3.

3. Functional ability:

Timed Up & Go Test

Group 1: Time required to complete the TUGT will decrease significantly from T1 to T3.

Group 2: Time required to complete the TUGT will decrease significantly from T1 to T3.

Groningen Activity Restriction Scale

Group 1: Scores on the GARS will decrease significantly from T1 to T3.

Group 2: Scores on the GARS will decrease significantly from T1 to T3.

4. Psychological well-being will improve significantly.

Geriatric Depression Scale
Group1: Scores on the GDS will decrease significantly from T1 to T3.

Group 2: Scores on the GDS will decrease significantly from T1 to T3.

Group Effects

It was expected that the changes observed for group 1 (moderate intensity physical activity) would have been significantly greater than those observed for group 2 (low intensity physical activity).

Literature Review

A common goal among researchers is to determine various ways to increase life expectancy. However, it may be time to shift the focus from quantity of life to quality of life. Rejeski, Bawley & Shumaker (1996) define quality of life as those attributes that are valued by the individual. These include general level of comfort, sense of well-being, ability to maintain reasonable physical, emotional and intellectual function and their ability to participate in activities that they enjoy. Wagner, Grothaus, Hecht and LaCroix (1991) believe in the idea of successful aging. This theory suggests that seniors can prevent declines in functional status or at least reduce the size of these declines through health promotion strategies, such as promoting regular exercise or physical activity. If physical activity can improve functional ability and selected health related variables, then it is reasonable to suggest that increasing physical activity may help maintain or improve independence and health status in the older adult. This maintenance/improvement may then positively change the individual's perception in regards to their quality of life.

The Senior Lifecycle

According to Ostrow, (1989) with increasing age a major change in behavior occurs, specifically the level of physical activity tends to decrease for most individuals as they age. This decrease in physical activity helps contribute to the decreases in physiological variables (aerobic capacity, muscular strength & endurance, flexibility) that also occur with age. These decreases often have a negative impact on an individual's

ability to perform the activities of daily living required to maintain an independent state of living. These declines in functional ability and independence often result in decreased social interaction and increases in depression or depressive symptoms. As this occurs it may result in a further decrease in physical activity, which can then multiply the severity of the situation. As well, decreases in physical activity also increase the risks of certain diseases such as cardiovascular disease. These diseases can also affect the circle by decreasing physical activity, functional ability or increasing the number of depressive symptoms. Figure 1 clearly shows that this process is a never-ending loop unless steps are taken to prevent the initial behavior change or to increase the senior's level of physical activity.

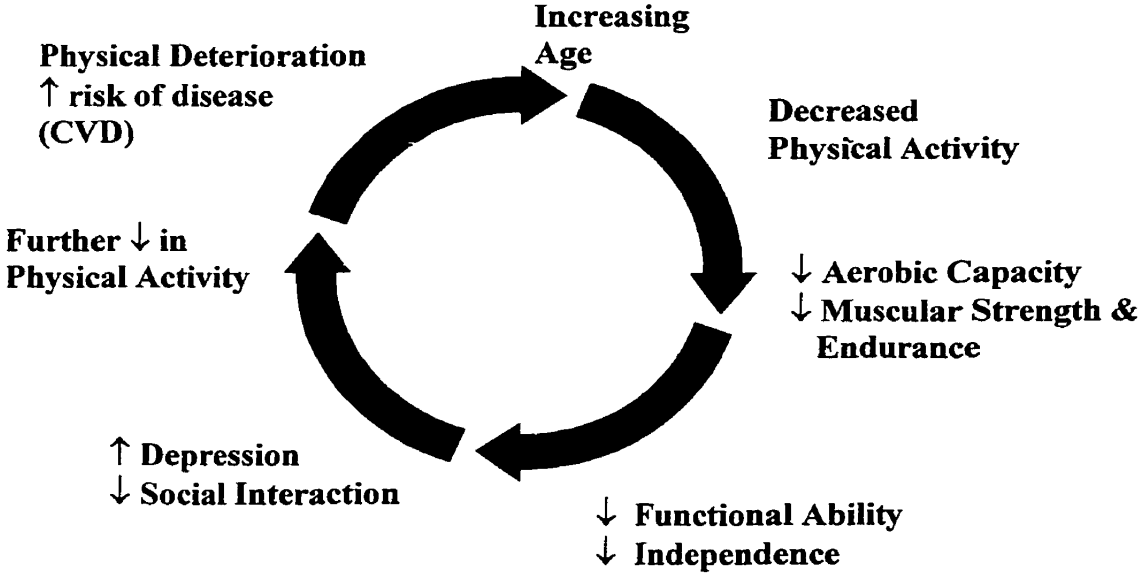


Figure 1: The elderly lifecycle (Ostrow, 1989)

Benefits of Physical Activity

In today's technologically advanced society the trend has been to move away from physical activity. For example, with the development of the Internet it has become easier for individuals to complete more and more tasks from home, such as banking and shopping. This reduction in daily activities that need to be completed outside of the household could be seen as a contributing factor to the low levels of physical activity that can be observed across ages within the population.

It is generally realized that there are benefits associated with physical activity, however the question is not how much activity should be performed, but rather what is the minimum amount of time that is required to receive health benefits (Slattery, 1996). This time requirement is often determined by the intensity of the activity. Therefore, it is important to determine the minimum intensity of physical activity required to improve health status. Health benefits are defined as those changes that improve the well being of the individual. The main health benefits that are derived from physical activity include improvements in triglycerides, blood pressure, body composition and high-density lipoproteins. Other health benefits include reduced risk of disease (CHD, stroke, non-insulin dependent diabetes and certain cancers) and the prevention of osteoporosis. Health benefits can also be observed in the psychological domain. These include stress management, reduced anxiety and relief from depression (Canadian Society for Exercise Physiology, 1996)

Inactivity is one of the primary risk factors for cardiovascular disease and is considered as an equivalent of smoking a package of cigarettes per day (ACSM, 1998). Research indicates that physical activity can provide some protection against CHD

(Morris, 1996). The protective mechanisms include reduction of atherosclerosis and thrombosis, reduced risk of ventricular arrhythmias and decreased peripheral vascular resistance (Slattery, 1996). A recent study involving senior (64-84 years of age) Dutch men revealed that mortality risks associated with cardiovascular disease (CVD) decrease with increasing physical activity. The study also indicated that walking at least 3 times per week for 20 minutes was associated with reduced mortality rates from CVD (Bijnen, Caspersen, Feskens, Saris, Mosterd & Kromhout, 1998).

Obesity can be a contributing factor in many chronic diseases. It is the result of an energy imbalance, caused by consuming more calories than expended. As a result the excess calories are stored as fat resulting in the above condition. Physical activity helps to increase energy expenditure and create a balance between energy in and energy out. Physical activity also helps to maintain fat free mass, mobilize fat, increase resting metabolic rate and increase the amount of fat metabolized (Slattery, 1996).

Psychological surveys have indicated that one out of every two adults has experienced a mental disorder within their lifetime and the most common disorder is a depressive episode (Slattery, 1996). Statistics indicate that 15% of the elderly population suffers from depressive symptoms (Mazzeo et al., 1998). Research has shown that inactive individuals are more likely to experience depressive episodes and the symptoms associated with this condition. It is believed that physical activity improves mental health and reduces the chance of depression by reducing muscle tension and creating biochemical changes within the brain (Slattery, 1996).

In terms of this study the primary concerns are how physical activity effects 1) cardiovascular health (blood lipoproteins and body composition); 2) mental health (depression); and 3) functional ability (mobility and ADL).

How much physical activity is enough?

The traditional exercise guidelines put forth by the American College of Sports Medicine (ACSM) stated that an individual should train at 60-90% of their maximum heart rate or at 50-85% of their maximum oxygen uptake for 15 to 60 minutes per session, 3 to 5 days per week. However, these guidelines were designed to increase aerobic capacity and improve body composition (Haskell, 1994). Recently, the Center for Disease Control (CDC) and the American College of Sports Medicine recommended accumulating a minimum of 30 minutes of moderate intensity physical activity for most days of the week, preferably everyday (Lee and Paffenbarger, 1996). Moderate activity has been defined as 3-6 MET's or walking at a pace of 3-4 mph (4.8-6.4 km/hr) (Pate, Pratt, Blair et al., 1995).

Research has shown that low to moderate intensity physical activity can provide health benefits. Specifically, these include improvements in bone health, reductions in serum cholesterol, blood pressure and relative weight as well as a reduction in relative risk for coronary artery disease. These benefits are more apparent in sedentary individuals that begin a regular low to moderate intensity physical activity program than in those individual that are already active and increase intensity to the next level, e.g. increase from moderate to vigorous (Blair and Connelly, 1996). These findings highlight

the health benefits that could be realized by a sedentary senior population if they incorporated regular physical activity into their lives. Even more important is the fact that the physical activity does not have to be strenuous, but can be of low or moderate intensity. This allows for programs of low-moderate intensity physical activity to be designed, which would be more comfortable for the sedentary senior to follow.

Based on the research it is clear that physical activity provides health benefits as well as decreases the risk of disease. As mentioned above this relationship also exists for low and moderate intensity and not just vigorous activity. However, the terms low and moderate intensity physical activity are not clearly defined within the literature. For example, a recent study by Cress, Buchner, Questad, Esselman, deLateur and Schwartz (1999) examined the effects of exercise on physical functional performance. The results indicated that exercise did have a positive effect on functional ability, however, the exercise intensity (75%-80% heart rate reserve) used by the study may not be appropriate for a large proportion of the senior community. More specifically, another study examined the effects of low impact, moderate intensity activity (50-70% of maximum heart rate) on functional capacity and mood states in a senior population. The study concluded that the physical activity intervention improved aerobic capacity, lower extremity muscle strength and psychological vigor (Engels, Drouin, Zhu & Kazmierski, 1998). These are just a few of the definitions of low and moderate intensity physical activity that can be found in the literature. The problem with the discrepancy in the definitions is that it cannot be determined what the minimum intensity level required to obtain health benefits is. Furthermore, most data is collected on independent seniors (Cress et al., 1999; Engels et al., 1998), which in turn may have an effect on the relative

intensity required to receive health benefits in comparison to dependent seniors. Those seniors classified as dependent may have a lower fitness level and/or health status, which would require a less intense activity to improve health related variables. For example, an individual with a good total cholesterol profile has to exercise at a much higher intensity to continue to improve this variable whereas an individual with a bad profile can initially exercise at a much low intensity to create improvements.

Dose-Response

The general thought has been that an individual can improve their health through physical activity. Traditionally, the improvements observed in health are thought to have been the result of an increase in physical fitness (Bouchard, Shephard & Stephens, 1994). However, a new school of thought is now emerging and this traditional relationship may not be the only relationship present. It is possible that many relationships exist between physical activity, physical fitness and health. Physical fitness can be defined as a set of attributes necessary to improve performance (e.g. anaerobic power) whereas health related fitness includes variables representative of improved health status such as total cholesterol, body composition. One possible relationship may be that physical activity can improve both fitness and health at the same time, but not separately as seen in Figure 2a. Another view is that activity may increase fitness, but does not improve a specific health outcome (Figure 2b). For example, resistance training increases an individual's strength, but does not directly affect the level of blood lipoproteins. Of particular interest to this study is the final relationship where physical activity improves various areas of

health, but does not significantly affect an individual's fitness as seen in Figure 2c (Bouchard et al., 1994). For example, moderate intensity walking decreases low-density lipoproteins, but may not improve overall strength or VO_{2max}. These are the main theories that are believed to exist under the dose-response of physical activity and health benefits.

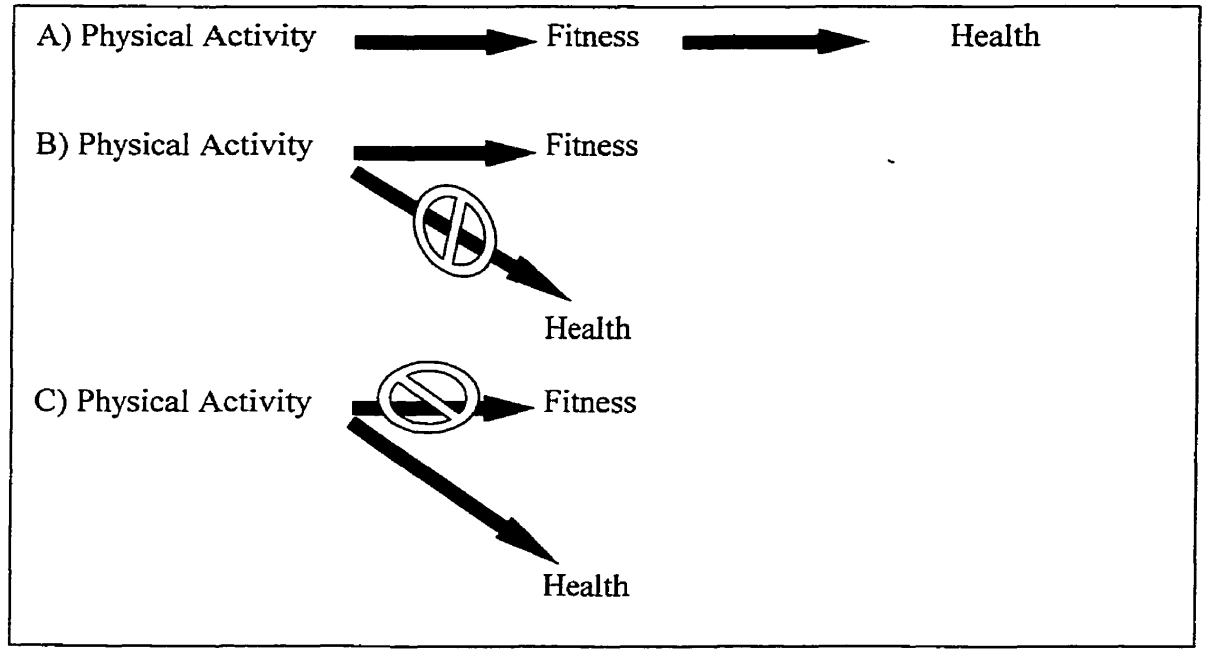


Figure 2: Possible relationships between physical activity and fitness and health.

Dose-response is defined as the different aspects of physical activity such as type, intensity, the number of sessions (frequency) and the time period over which the sessions were completed (duration). The response is identified as the effects that are the result of the activity such as improvements in health, enhanced performance, biological, psychological and physical changes (Bouchard et al., 1994).

The dose-response relationship is primarily viewed as a way to improve an individual's health-related fitness rather than improve their performance-related fitness.

The theory is based on increasing kilocalorie expenditure through physical activity. As activity levels rise, kilocalorie (kcal) expenditure increases and the individual experiences more health benefits until a certain point. Research indicates this point occurs when an individual exceeds approximately 3000 kcal per week (Canadian Society for Exercise Physiology, 1996). Therefore, it is very important that physical activity prescription is not solely based on traditional positions or even the current positions held by ACSM and the CDC, whose recommendations are primarily aimed at improving physical performance (e.g. aerobic fitness, strength, etc.). The characteristics of the physical activity dose required to cause the biological changes necessary to improve health are not necessarily the same as those required to improve physical performance (Bouchard et al., 1994). Based on the dose-response theory an individual could improve their health related fitness by expending 100 kcal/week above normal baseline energy expenditure (approximately a 10% improvement in selected health variables). According to ACSM and the CDC's guidelines, physical activity at this level would not result in any health benefits for the individual. Therefore, it is important to keep kcal expenditure in mind when determining the volume and the intensity of the physical activity to be performed.

The dose-response relationship is influenced by personal and environmental characteristics. These characteristics include age, gender, clinical status, nutritional status, medication use, smoking status, baseline differences in the levels of physical activity and the level of fitness. The effects of these characteristics on the above relationship are all superseded by an individual's heredity. How heredity and the above characteristics will influence each biological response will vary between responses and between individuals (Bouchard et al., 1994). Self-perceptions of physical activity may

also influence this relationship. A study by Shephard and Bouchard (1995) found that an individual's perception of their activity frequency was associated with markers of health-related fitness, such as body composition and cardiovascular function. Those that considered themselves habitually active exhibited an inverse relationship between fat accumulation and activity frequency. In terms of cardiovascular function high physical activity frequency was associated with lower resting heart rates and higher physical working capacities.

Traditionally, it was thought that the dose-response relationship worked by creating a training response. This response was thought to produce a temporary or long-term change in either the structure or function of the individual. This was the result of performing repeated bouts of exercise and the response was considered to be independent of a single bout of exercise (Bouchard et al., 1994). In other words the activity has created some type of semi-permanent change within the body. However, research now suggests that the health-related changes that are observed may be the result of an acute response. This acute response is the result of the short term or a single bout of activity that is being performed. The effects tend to be short lasting, but as the frequency of the activity being performed is increased, it may produce a greater response for some biological characteristics (Bouchard et al., 1994). For, example, one study found that after 45 minutes of cycling at 70% VO_{2max} there was a significant reduction in systolic blood pressure in moderately hypertensive males and females. This change in blood pressure was present for at least 3 hours post exercise (Bouchard et al., 1994).

Typically there are four different dose-response curves that can occur (Figure 3). These curves are 1) an acute response; 2) rapid response; 3) linear response; and 4) delayed response (Bouchard et al., 1994).

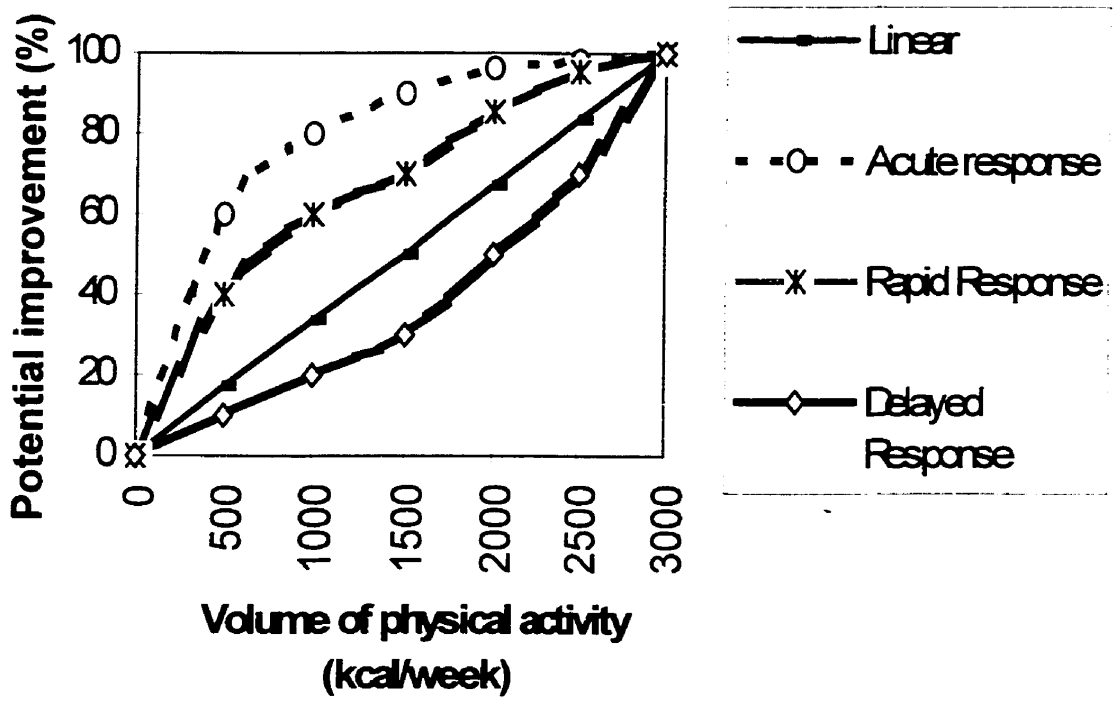


Figure 3: Dose-Response relationships (Canadian Society for Exercise Physiology, 1996, Haskell, 1994)

With an acute response an improvement is observed after several exercise sessions, but the improvement plateaus even though exercise continues (e.g. triglycerides) (Bouchard et al., 1994). This curve is initially characterized by a rapid improvement for a small

increase in calorie expenditure during the early phase of the curve. However, by the time an individual has increased calorie expenditure to approximately 1000 kcal/week they have already experienced an 80% improvement. With a rapid response the greatest benefits occur as small changes in kcal expenditure are made, but then the improvements begin to level off and finally plateau even though kcal expenditure continues to increase (e.g. blood pressure). The main difference between the rapid and acute response is the rate at which improvement occurs. On average, variables that fall in the rapid response category improve 20% faster than those in the acute category. In a linear response, for every increase in kcal expenditure there is an equal increase in improvement (e.g. body composition). The last curve that can be observed is a delayed response. This response is the opposite of the rapid response. Here, little or no change is observed initially, but as time progresses improvements become apparent with the greatest gains being made later on in the program (e.g. HDL-C) (Bouchard et al., 1994). With this type of response an individual must increase caloric expenditure substantially, by either increasing the intensity or duration of the physical activity, before observing a significant improvement the health variable. For example, increasing caloric expenditure by 2000 kcal/week only results in a 50% improvement, whereas a caloric expenditure of 2800 kcal/wk would result in a 90% improvement.

Risk Factors

Within a person's lifespan there are many factors that increase the likelihood that the individual will experience some cardiac. These factors have been divided into two

categories, primary and secondary risk factors. Primary risk factors are those that are directly related to the development of coronary heart disease (CHD) and are thought to be controllable. These risk factors include high blood pressure, high blood lipid level, cigarette smoking and physical inactivity. Secondary risk factors also contribute to the development of coronary heart disease, but are not linked as strongly as the primary factors. These factors are subdivided into controllable (obesity, stress, emotional behavior and diabetes mellitus) and uncontrollable (age, gender, race and heredity) (Robbins, Powers and Burgess, 1994). The risk associated with these factors are outlined below in Table 1.

Table 1: Patient's Risk Profile (Frohlich, Fodor, McPherson, Genest & Langer, 1998).

Patient's Risk Category		
Risk Factors	**Risk Level**	**10-year CAD risk (%)**
≥ 4 or CAD	Very High	≥ 40%
≤ 3	High	20-39
≤ 2	Moderate	10-19
≤ 1	Low	< 10

The purpose of the present study was to compare the effects of low and moderate intensity physical activity on selected risk factors for CHD. The importance of incorporating physical activity in an individual's life is critical and its value should not be underestimated. If the risk of CHD in an individual can be reduced it could improve the duration and the quality of life.

Lipoproteins

It has been determined that critical levels of lipoproteins within the blood can increase the risk for CHD. To help reduce the risk of CHD it has been recommended that an individual should decrease the low-density lipoprotein level (LDL-C) and increase the high-density lipoprotein level (HDL-C) (Stein, Michielli, Glantz, Sardy, Cohen, Goldberg & Brown, 1990). It is believed that LDL-C helps to transport fat to the smooth muscle cells where it is deposited and forms atherosclerotic plaques (McArdle, Katch and Katch, 1991). These plaques begin to clog the arteries and can eventually block the artery off which can result in a heart attack or stroke (Robbins et al., 1994). HDL-C acts in an opposite manner transporting cholesterol from the peripheral tissues to the liver where it can then be excreted (McArdle et al., 1991). Studies indicate that an inverse relationship exists between LDL-C and HDL-C (Stein et al., 1990). Normative values for cholesterol and LDL-C levels and the associated CHD risk are shown in Table 2. As well, normative values for the ratio of total cholesterol (TC) to HDL-C levels and the CHD risk associated with them are presented in Table 3.

Table 2: Total blood cholesterol and LDL for men and women (Robbins et al., 1994).

Risk	Total Cholesterol (mmol/l)	LDL (mmol/l)
Desirable	under 5.2	< 3.4
Borderline High	5.2 – 6.17	3.4 – 4.1
High	6.2 or more	4.13 and above

Table 3: Ratio of total cholesterol and HDL- cholesterol to risk of CHD (Robbins et al., 1994).

Risk	Ratio TC/ HDL-C men	Ratio TC/HDL-C women
Very low	< 3.43	< 3.27
Low	4.97	4.44
Moderate	9.55	7.05
High	more than 23.39	more than 11.04

Research has shown that LDL-C levels usually increase in young to middle-aged adults. However, other studies have indicated that this is not what happens in those individuals 65 years of age or older. This research has shown that LDL-C and HDL-C levels actually decrease with age in both men and women. The Rancho Bernardo Study (Ferrara, Barrett-Connor and Shan, 1997) examined this trend and confirmed this finding. The results indicated that in both men and women (age≥65) LDL-C and HDL-C levels decreased approximately 1% per year (Ferrara et al., 1997). This finding is very important in helping to prevent CHD since HDL-C plays an important role in helping to remove cholesterol from the body. If an elderly individual has a low HDL-C level as the result of physical inactivity, the aging process will then further reduce it. This could facilitate a build up of LDL-C levels resulting in an increased risk for CHD.

Stein et al. (1990) indicated that a 12-week exercise program affected the levels of lipoproteins present in the blood of middle-aged men. The study used three groups, exercising at 65%, 75% and 85% of the subject's measured maximal heart rate. Based on these exercise intensities a significant change in HDL-C was observed for the 75 and

85% groups and a significant decrease in LDL-C was observed in the 75% group. It is interesting to note that there were no significant changes observed in the 65% exercise group. This result indicates that intensity may play an important role in the improvement of lipoprotein profile as well as questions the benefit of less vigorous physical activity. However, Stein et al. (1990) did not accurately describe the physical activity level of the population being used. The study did indicate the pre-intervention VO_{2max} differed significantly between groups, which may have affected the results. It is also interesting to note that 85% intensity group had the lowest mean VO_{2max} prior to the intervention and showed the greatest improvements in VO_{2max} and HDL-C.

It was also observed that all the individuals in the exercise groups experienced a significant increase in VO_{2max} with no significant change in lipid profiles. This suggests that there is a poor correlation between improvement in aerobic fitness and plasma lipoproteins (Stein et al., 1990). This suggests that if an individual increases their aerobic fitness it does not necessarily mean that a decrease in LDL-C levels or an increase in HDL-C levels will occur. This directly conflicts with the dose-response theory, which suggests that these variables should improve with any energy expenditure above baseline values. However, it is possible that the duration of the study conducted by Stein et al. (1990) was too short to observe any significant changes in the variables of interest. Therefore, if the duration was increased it is possible changes would have been observed that would support the dose-response theory.

A study conducted by Wei, Macera, Hornung and Blair (1997) over a one-year period investigated lipoprotein profiles in men 25 to 65 years of age who routinely engaged in mild to moderate physical activity, but the study did not define moderate

intensity. The study used questionnaires to examine activity patterns over a 10 to 14 month period. The results indicated that each individual on average expended 1522±1712 kcal/week as well as that increasing energy expenditure through increased physical activity did have an effect on blood lipoprotein profiles. Specifically, the study revealed that by increasing physical activity from baseline to 920 kcal/week significantly increased HDL-C levels on average by 0.12 mmol/l and reduced the ratio of total cholesterol to HDL-C by 0.72 (Wei et al., 1997). It is interesting to note that when the kcal/week expenditure increase (920) is added to the baseline expenditure (1522 kcal/wk) the total kcal/week expenditure is now almost 2500 kcal. In reference to the senior population, this kcal expenditure per week may be too high for the sedentary senior to achieve. This calls into question the applicability of these results to an older population.

There have been very few studies that have examined the effects of exercise on lipid profiles in a senior population. It is well known that this group is at high risk for CHD, yet little research is being conducted to examine this specific risk factor. Most of the information has been gathered on a younger population, primarily men, using higher intensities of exercise than would normally be used with a senior population. These finding are then applied to the elderly even though they may not pertain to them. It is very important that data be collected on this specific population using exercise intensities that will accommodate their lifestyle. As well, few studies have used low and moderate intensity activity as their intervention. For most studies the intensity of the activity would be classified as vigorous. Some studies have used moderate intensity activity as their intervention, but the definition of moderate is dependent on the researcher. A goal of this

study was to determine an intensity of activity that is both beneficial and enjoyable for the elderly.

Blood Pressure

Another primary risk factor for CHD is hypertension. Several studies have examined the effects of different intensities of exercise on hypertension. These studies have concluded that hypertension can be reduced using exercise (Hagberg, Montain, Martin & Ehsani, 1989; Seals & Reiling, 1991). One study found that low intensity training might reduce blood pressure more than moderate intensity training. The low intensity exercise intervention resulted in significant reductions in both systolic and diastolic blood pressure. The moderate exercise intensity also resulted in decreases in systolic and diastolic blood pressure, but the improvement was only significant for diastolic pressure. It should be noted that even though blood pressure significantly improved with low intensity activity there was no significant change in VO_{2max} over time. This could indicate that the mechanisms required to reduce blood pressure are different than those required to increase VO_{2max} (Hagberg et al., 1989). This may imply that an individual does not have to increase their VO_{2max} in order to reduce their blood pressure. This would allow for the reduction in physical activity intensity to a level that was more suitable for seniors (low intensity).

The Hagberg et al. (1989) methodology was of particular special interest for the reason that it had several similarities with this study, specifically; the population of interest, seniors aged 60 to 69, as well as the physical activity intensity (low and

moderate). However, low and moderate intensity were defined as 53% and 73% of maximal oxygen consumption respectively (Hagberg et al., 1989). These intensities may be too high for some of the elderly individuals. Therefore, it is necessary to redefine these terms and examine different intensities to determine if they can significantly improve blood pressure.

Body Composition

Body composition was identified as a secondary controllable risk factor for CHD. There is an abundance of literature indicating that the problem and risk of obesity can be treated using physical activity and proper nutrition.

For this study, it was decided to use waist girth as a measure of body composition. This decision was made based on the population that was going to be used, seniors, and recent research findings. Using more specific methods of body composition analysis, such as skinfolds or hydrostatic weighing, could cause several problems. The first problem was the distress that these protocols could have caused the subjects. For a younger generation, exposing various parts of the body for skinfolds may seem acceptable, however for seniors this could create an uncomfortable situation. Using hydrostatic weighing was not an option because of the difficulty associated with getting in and out of the tank as well as problems that may have occurred when asking the subjects to hold their breath or place their head under the water for the test. Another problem with the hydrostatic weighing was that it could not be done on site (Northwood) and that may have created transportation problems for the seniors involved.

The results of a study by Lemieux, Prud'homme, Bouchard, Tremblay and Després, (1996) revealed that waist girth was strongly related to elevated systolic blood pressure, increased diastolic blood pressure and an elevated ratio of high density lipoprotein cholesterol. However, the study also found that waist girth was not a good predictor of visceral adipose tissue accumulation, but was good at indicating the degree of obesity. When waist girth is used in conjunction with the body mass index it should provide a suitable indicator of body composition. However, it is the risk of disease that is of primary interest and not overall body composition. Després (1992) reported that the regional distribution of body fat is more highly correlated with chronic disease than total excess body fat. Computer tomography studies have shown that visceral fat is highly correlated with HDL-C levels and is associated with a deterioration of glucose tolerance and dyslipoproteinemias. Therefore, it is very important that visceral adiposity be assessed as a first step in trying to identify an individual's risk for disease. However, it should be noted that a high waist girth measurement could indicate either a high level of subcutaneous adipose tissue or a high level of visceral adipose tissue. Therefore, caution must be used when interpreting waist girth measurements as an indicator for visceral adiposity when no other measurements of body composition have been taken.

Functional Ability

Research indicates that physiological function decreases as aging occurs. Since, functional ability is dependant on physiological function it can be assumed that functional ability also decreases during the aging process. This functional decline in the senior population can seriously comprise an individual's ability to perform many daily physical

tasks and activities (Chandler & Hadley, 1996). As a result, this loss of independence may lead to decreased self-esteem, increased levels of hopelessness and a decrease in the perceived quality of life (Kempen Miedema, Ormel & Molenarr, 1996). However, it is possible that these changes can be averted or at least decrease the rate at which they progress. An individual must maintain their ability to complete activities of daily living (ADL) and instrumental activities of daily living (IADL) for continued independence. ADLs include those activities such as washing and dressing and IADLs refer to activities such as shopping, preparing meals and cleaning (Kempen et al., 1996). To perform ADLs and IADLs it is essential that the individual be functionally mobile, which Tinetti (1986) defined as the ability to move around in one's environment.

As mentioned before, research has shown that physiological function decreases with age, often as a result of physical inactivity. The decrease in activity level can be attributed to chronic disease, decrease in cardiovascular fitness and musculoskeletal limitations (Chandler & Hadley, 1996). These reductions in physiological ability can decrease an individual's tolerance for exercise (Young, 1986). For example, among those aged 75 and older 30% report difficulty with stairs, 40% could not walk 0.8 km and 7% needed help to walk. This difficulty observed in basic mobility can also lead to falls. It is estimated that approximately 30% of non-institutionalized elderly fall each year (Fleming et al., 1995). Recuperation from a fall can also cause problems. Specifically, the period of reduced physical activity that usually follows a fall can lead to a more rapid decline in physiological function. This decline may increase the severity of the impairment past the level that would be associated with the fall itself. However, problems such as these could be averted if functional status was improved, and functional mobility was maintained.

Young (1986) states that many seniors are living near the threshold of their physical ability and that even a minor illness could significantly impact upon their physiological state as well as their functional capacity, changing their lifestyle status from independent to dependent. Therefore, it is necessary to design and implement intervention programs, such as physical activity, aimed at helping seniors improve and maintain their functional status.

Before intervention strategies are designed it is first necessary to assess and understand functional ability within the senior population. The assessment of physical mobility is considered essential when evaluating a senior's functional status (MacKnight & Rockwood, 1995). For the individual to be classified as independent they must possess 'basic mobility skills'. These skills are necessary for everyday activity, such as getting oneself in and out of bed, on and off the toilet and walking a few meters. Traditionally, neuromuscular examinations were used to diagnose any problems and the severity of them; however, it was found that these examinations were a poor representative of functional capacity. Activities of daily living questionnaires have also been used to assess functional mobility, but there are some concerns regarding the accuracy of and consistency these questionnaires. Finally, specific tests that assess motor abilities, such as gait speed and sway, are used, but are often impractical in clinical settings since they require specialized equipment such as force platforms and treadmills (MacKnight & Rockwood, 1995).

One method that is commonly used to assess functional mobility in a senior population is the timed 'up & go' test (TUGT). This protocol requires the subject to sit in a chair and upon hearing the command 'go' the individual rises from the chair, walks a

distance of 3 m, turns, returns to the chair and sits back down with whole process being timed. This simple protocol indirectly assesses balance and gait maneuvers that are required in every day life (Podsiadlo & Richardson, 1991). The protocol can also be used to assess walking speed and lower body strength. Lower body strength can be studied by observing the amount of time required for the individual to stand from the chair without using any of the musculature of the upper body. According to Okumiya, Matsubayashi, Nakamura, Fujisawa, Yasushi, Doi and Ozawa, (1999) the test can also be used as an independent predictor of declines in both basic and instrumental ADLs.

Mathias, Nayak and Issacs (1986) found that the 'get up and go' test was a satisfactory measure of balance in the elderly. It is important to note that the researchers were scoring performance on a 5-point scale instead of using overall time. Results from Podsiadlo and Richardson (1991) support the findings of Mathias et al (1986). Their results indicate that the individual's score in seconds was highly correlated with balance ($r = -0.72$). They also found that gait speed was correlated with the time required to complete the test ($r = -0.78$). These correlations become even stronger when a log transformation is used. The researchers concluded that the test was reliable, showing little variation in score (seconds) over time, and that it had content validity.

The TUGT has demonstrated high intrarater and interrater reliability with intraclass correlation coefficients of 0.99 for both (Whitney, Poole and Cass, 1998). The TUGT measure has also been highly correlated with scores from the Berg Balance Scale and the Barthel Index of Activities of Daily Living (Thompson & Medley, 1995). It has been determined that the TUGT is more sensitive in detecting change over time than

other assessment techniques such as the Berg Balance scale and the Tinetti Balance Test of Performance-Oriented Assessment of Mobility Problems (Whitney et al., 1998).

A study by Tinetti and Ginter (1988) compared the ability of a standard neuromuscular examination (vision, hearing, frontal reflexes, position sense, tone, coordination and manual muscle testing) to a direct assessment technique to determine which was more sensitive in identifying mobility dysfunctions in seniors. The direct assessment examined mobility maneuvers such as rising from a chair, sitting down and turning while walking, maneuvers that are also observed in the TUGT. The study revealed that poor mobility performance, observed in the direct assessment, did not translate into corresponding neuromuscular abnormalities. Therefore, it was determined that the relationship between neuromuscular findings and functional mobility was not reliable for identifying mobility problems.

The TUGT is a dynamic multitask test that may be representative of the person's functional ability since many ADLs can be classified into a dynamic multitask category. Read, Crouse & Hubley-Kozey (1998) developed an electrical circuitry system to measure the time requirement of each phase of the overall TUGT task and established the consistency of the measurements between trials and days in a senior population. The study also indicated that the reliability of total time was dependent on consistently performing each phase of the test.

To determine functional status also requires assessing the ability of an individual to perform certain activities of daily living. If individuals cannot care for themselves or their place of residence, it becomes increasingly difficult to maintain their independence. One questionnaire specifically developed to assess the areas of personal care and

domestic ability is the Groningen Activity Restriction Scale (GARS) (Appendix E) (Kempen et al., 1996). It is important to note that the GARS measures actual disability, specifically the difficulty encountered in performing activities with personal or equipment assistance. It does not assess intrinsic assistance, which assesses the level of difficulty independent in performing tasks without the use of personal or equipment assistance.

The GARS has been recognized as a comprehensive, valid and reliable (coefficient of reliability of 0.93) as well as an easy to administer tool for assessing both ADLs and IADLs. Concurrent validity has been established by comparing the GARS with Medical Outcomes Study Short Form-20 (SF-20) physical functioning and Organization for Economic Co-operation and Development (OECD) indicator of freedom measures, with reported Pearson correlation coefficients of 0.79 and 0.82 respectively (Kempen et al., 1996). In reference to sensitivity to change over time, the GARS is more sensitive to change with respect to improvement in contrast to worsening. Furthermore, it is more sensitive to improvement than the Health Assessment Questionnaire (Doeglas, Krol, Guillemin, Suurmeijer, Sanderman, Smedstad, Briancon & van den Heuvel, 1995). Suurmeijer, Doeglas, Moum, Briancon, Krol, Sanderman, Guillemin, Bjelle and van den Heuvel, (1994) stated that since the scales reported high reliability and validity as well as that it is community based rather than disease specific, the GARS is extremely useful for both comparative and longitudinal research studies.

Psychological Well-Being

Most researchers, along with health professionals, believe that physical activity is related or even causally related to psychological well-being (PWB). Psychological well-being is comprised of emotional function and satisfaction with life. It can be specifically defined as the absence of anxiety, depression, high levels of self-esteem, ability to deal with daily stress, reports of physical symptoms and satisfaction of personal life circumstances (Gauvin & Spence, 1996). Within the literature there are very few reports suggesting that physical activity could have a negative effect of PWB. The 1990 Campbell's Survey on Well-being (Stephens & Craig, 1990) indicated that 50% of the population believes that physical activity can improve mental health. These feelings were especially strong in female and elderly populations (Gauvin & Spence, 1996). This data suggests that mental health or PWB is important to the senior population. The review by Gauvin & Spence (1996) revealed that physical activity is the preferred method of self-regulating depressive episodes, increasing levels of energy and vigor by both individuals and psychotherapists.

The majority of the studies examining the effects of physical activity on PWB have used moderate to high intensity continuous activity for a duration of 20 to 30 minutes. In terms of depression, research has indicated that physical activity is a more effective treatment for those suffering clinical depression than those suffering depressive symptoms (Gauvin & Spence, 1996). A large portion of the research that has been conducted has used an adult population (e.g. 20-55 years of age), but very few studies have been conducted using a senior population. For example a study conducted by

Blumenthal, Babyak, Moore, Craighead, Herman, Khatri, Waugh, Napolitano, Forman, Applebaum, Doraiswamy and Krishnan (1999) found that exercise could be used as an alternative for antidepressants in treating clinical depression in a senior population. However, the participants in the study ranged from 50 to 77 years of age with a mean age of 57 years. As well, the exercise intensity employed was 70-85% heart rate reserve. Once again, the exercise intensity is quite high and the population examined is not truly representative of the range or ages within a senior population. Therefore, there is little experimental evidence to indicate that a causal relationship exists between physical activity and PWB in a senior population. Therefore, it is premature to conclude that physical activity can enhance PWB in the elderly (Brown, 1992). Therefore, there is a need for more research in this area to determine whether a relationship truly exists.

Depression in the Elderly

The DSM-IV defines depression as an emotional state characterized by sadness and lethargy. The signs and symptoms include persistent sadness, lethargy, mental and physical withdrawal from enjoyed activities, as well as thoughts of suicide (Gauvin & Spence, 1996).

Research findings suggest that a paradox exists when examining the prevalence of depression in the elderly. Clinical studies reveal that the prevalence of depression increases with age, but epidemiological studies support the exact opposite findings, the prevalence of depression decreases with age (Gallo, Reichel & Anderson, 1995). These findings place the clinicians and the epidemiologists in direct conflict. Other research

indicates that even though depression decreases with age, according to epidemiologists, the number of suicides increases with age (Gallo et al., 1995). The question now becomes which group is correct in terms of the prevalence of depression in reference to aging? As well, if depression does decrease with age what is the cause of the elevated suicide rate in the elderly?

One possible explanation for the above conflict is that the elderly may see a psychological problem as a sign of weakness or may feel that it is something to be ashamed of. Therefore, seniors would be unwilling to discuss the problem with their physician (Gallo et al., 1995). Also, the possibility exists that depression presents differently in a senior population making questionnaires designed on younger adults less sensitive. Therefore, it would appear the prevalence of depression in a senior population is less. Furthermore, feelings such as hopelessness may mask the signs of depression. Research has shown that hopelessness increases with age and that it may be this increase that results in suicide more so than depression (Gallo et al., 1995).

Depression in a senior population has been attributed to a variety of factors including life events, loss of special senses and as the result of physical illness (Bennett & Ebrahim, 1995). As a person ages several major losses occur within their life. These include loss of employment (retirement), loss of status, loss of physical abilities and loss of friends and loved ones as a result of death. These losses are considered life events that can result in depression. There is considerable research evidence supporting the existence of a relationship between these events and the onset of depression. As an individual increases in age a decline in the special senses and sensory perceptions can be observed (e.g. vision, hearing). It is hypothesized that the loss of these senses may cause a person

to withdraw from their social network. As a result of this withdrawal the individual becomes more vulnerable to the onset of depression. Finally, depression has been linked to physical illness. This is especially true for illnesses such as heart disease, stroke, Parkinson's disease and severe arthritis. The depressive symptoms associated with illness are usually mild if the disease can be controlled and treated. However, in cases where the individual does not respond to treatment or rehabilitation the symptoms can be much more severe (Bennett & Ebrahim, 1995).

Measuring Depression

Depression is commonly measured using validated self-report depression inventories or through psychiatric interview. These inventories include the Beck Depression Inventory (BDI) (McDowell & Newell, 1996), Zung's self-rating Depression Scale (McDowell & Newell, 1996) and the Hamilton Rating Scale for Depression (HAM-D) (McDowell & Newell, 1996) to name a few. However, the Geriatric Depression Scale is considered to the most appropriate for assessing depression in a senior population (Nordhus, VandenBos, Berg & Fromholt, 1998).

The Geriatric Depression Scale (McDowell & Newell, 1996) was designed to be a simple and clear self –administered scale that did not rely on somatic symptoms for diagnosis (Appendix F). The questions used in the scale were chosen specifically to identify the cognitive and behavioral aspects of depression in a senior population. The GDS exists in both a short form (15 questions) and a long form (30 questions) and can be used to indicate an individual's degree of depression. For example, the short form, scores

between 0 and 4 are considered normal, scores of 5 to 9 indicate mild depression and scores of 10 to 15 indicate moderate to severe depression.

The GDS has been widely used in studies of depression in older adults (Nordhus et al., 1998) and has undergone vigorous scrutiny in regards to reliability and validity. A study by Burke, Nitcher, Roccaforte and Wengel (1992) showed good agreement between clinical diagnosis and the GDS in both cognitively intact and impaired seniors. Validity has also been addressed by comparing the GDS with other validated self-report depression inventories. For example, correlations of 0.78 and 0.81 are the result of multiple comparisons between the GDS and the HRS-D; as well, comparisons of the GDS with the BDI resulted in correlations of 0.85 and 0.91 (McDowell & Newell, 1996; Nordhus et al., 1998).

In reference to sensitivity, the GDS is significantly better than the HRS-D, with sensitivity and specificity levels of 84% and 95% respectively (McDowell & Newell, 1996). In direct comparison to the BDI, the GDS exhibited greater sensitivity and a higher hit rate (i.e. positive predictive value), but was slightly less specific (4%). The GDS also exhibits high internal consistency and split-half reliability with identical alpha coefficients of 0.94 (Nordhus et al., 1998).

Most of the information that exists pertaining to the reliability and validity of the GDS is in reference to the long form questionnaire. However, the short form is often used to try to prevent fatigue, decreases in concentration and focus that may have an effect on the outcome when completing longer questionnaires. The validity of the short form has been established by comparing it to the longer version resulting in a correlation of 0.84, $p < 0.001$ (Brink, 1986). More recently, the short GDS was validated in the United

Kingdom using community dwelling seniors. This study found that the GDS had sensitivity and specificity levels of 100% and 72% respectively, for detecting depression and levels of 79% and 78% for detecting depressive symptoms (Arthur, Jagger, Lindesay, Graham and Clarke, 1999). Overall, these results suggest that the short GDS has the ability to detect changes in depression and depressive symptoms over time.

Treating Depression

It has been reported that 1% to 4% of community dwelling seniors suffer from major depression, whereas 9% to 30% suffer significant levels of depression even though they are categorized as subclinical (Nordhus et al., 1998). Many physicians believe that exercise can be used to treat mild depression, but researchers are still split on the effects of exercise on depression in the older adult.

Cooper-Patrick, Ford, Mead, Chang and Klag (1997) found that exercise did not reduce the risk of depression in medical students. The study used questionnaires to examine self-reported physical activity levels and incidence of depression in former medical school students over a 5-year period. The results indicated that the risk of depression was similar for both exercisers and nonexercisers. This is an interesting finding, but is hardly conclusive, since this was not an intervention study and was based solely on a questionnaire. It is possible that the subjects may have underestimated their levels of activity. This underestimation may have resulted in the above findings of no difference in risk between exercisers and non-exercisers. As well, any activity that resulted in 'a sweat' was considered an exercise and subjects were only asked if they had

exercised to 'a sweat' on a weekly basis (Cooper-Patrick et al., 1997). The study results do not provide any information regarding the intensity or frequency of the activity and without this information it is difficult to interpret these findings.

The Alameda County study provided convincing data of a relationship between physical activity and depression. The study found that baseline depressive symptoms were associated with inactivity and as subjects increased their activity level their risk of depression dropped to a level similar to that of active individuals (Mazzeo et al., 1998). A study conducted in Iowa (Mobily et al., 1996) supports the findings of the Alameda County study. The study indicated that exercise could be used to treat depressive symptoms. The authors reported that a major improvement in depressive symptoms could be obtained through activity, especially for those individuals moving from a sedentary lifestyle to a lifestyle involving minimal physical activity (Mazzeo et al, 1998).

These last two studies provide evidence that exercise can be used to decrease the risk of depression and depressive symptoms. However, the research in this area is conflicting in regards to the relationship between physical activity and depression. Therefore, there is a need to conduct further studies to clarify this association. If activity and depression are truly linked then activity could be used as a primary treatment to improve the quality of an individual's life.

Measuring Physical Activity

Inactivity is considered a modifiable primary risk factor for chronic diseases, such as coronary heart disease. In the senior population a greater amount of attention is now being focused on how to prevent these diseases in order to maintain functional capacity

and a healthy life expectancy (Bijnen et al., 1996). To determine the current risk for disease or a decrease in risk it is necessary to evaluate either the level of physical activity or the fitness level of the individual. However, in a senior population it is not always safe or accurate to assess fitness since it usually involves some form of stressful physical testing. Therefore, it becomes necessary to evaluate the current level of physical activity. In the literature there are many questionnaires specifically developed for this task. One such questionnaire is the Physical Activity Scale for the Elderly (PASE).

The PASE was developed as an age-specific physical activity questionnaire that would aid in epidemiological research and provide an accurate assessment of physical activity levels in seniors. The PASE has been validated by comparing the questionnaire scores with measures known to change with physical activity (e.g. heart rate, body mass index) and health status. The physiological variables and health status were determined at the same time the questionnaires were administered. The test-retest reliability coefficient was 0.75 and was determined by examining the extent to which the scores were stable over repeated administrations (Washburn, Smith, Jette & Janney, 1993). More specifically, the validity of the PASE has also been established through comparison of questionnaire scores with energy expenditure determined using the doubly labeled water method (Schuit, Schouten, Westerterp & Saris, 1997). A more recent study once again established validity by comparing physiological and performance variables with PASE scores (Washburn, McAuley, Katula, Mihalko & Boileau, 1999). Based on these studies it is suggested that the PASE is a valid and reliable method for classifying seniors into categories of physical activity levels.

Maximal Oxygen Consumption (VO_{2max})

Most training studies use VO_{2max} to determine the intensities that will be used in their training programs. For example, Foster, Hume, Byrnes, Dickinson and Chatfield, (1989) used the subject's VO_{2max} to establish the calorie expenditure (100 calories) for low and moderate intensity groups. However, performing a direct or indirect maximal test on an elderly population presents several problems. One of these problems is that exhaustive exercise places the subjects at risk for some type of coronary event. Also, it is necessary to use an electrocardiogram to monitor heart rate and to have a physician present for safety precautions. Another possible drawback to maximal testing in a senior population is that it is difficult to recruit volunteers willing to participate in studies employing these types of techniques since it is often difficult to perform these types of tests.

If a maximal test cannot be performed, then the obvious choice is to use a submaximal test. However, many of the submaximal protocols have not been validated on a population over the age of 70. For example, the modified Canadian Aerobic Fitness Test has only been validated for individuals 69 years of age or less (Canadian Society for Exercise Physiology, 1996). Several of the cycle ergometer tests have been validated for an older population, but are not test specific if the intervention is walking. The cycle ergometer also presents a problem in that it is very difficult to mount and dismount as well as being an activity that most seniors are neither familiar nor comfortable with.

One of the only walking tests that has been validated in an older population is the Rockport Fitness Walking Test (Fenstermaker, Plowman & Looney, 1992). However,

this test requires the individual to walk a mile as quick as possible, which may not be feasible for some sedentary elderly individuals. The Cooper 12 minute walk run (Cooper, 1968) has also been validated for an older population, individuals up to and including those 83 years old. This is a more feasible alternative when testing the elderly since it only requires them to walk for a period of time and not a distance. An individual may be able to walk 12 minutes, but may not be able to walk a single mile. In terms of error, the prediction equations for this test have a coefficient of variation of 10% for males and 16% for females (Sidney & Shephard, 1977). This variation may seem unacceptable, but in comparison to other submaximal alternatives is acceptable. To employ a protocol that has not been validated on a specific population could introduce a large amount of error into the study. Also, cycle ergometer tests focus on specific musculature, quadriceps, which can result in underestimating VO_{2max} by at least 15 to 20%.

Additional Benefits

Osteoporosis is a major concern in a senior population. Osteoporotic fractures can lead to falls that can further injure the individual (Slattery, 1996). These falls and injuries can severely affect the independent lifestyle of a senior individual. Physical activity helps to maintain the strength and the structure of the bone and may even increase bone mineral density (Slattery, 1996). Maintenance of bone density helps to prevent injuries and thus allows the individual to maintain an independent lifestyle.

Krall and Dawson-Hughes (1994) found that walking is an effective mode for decreasing the rate of bone loss in the legs. The study found that postmenopausal women

who walked 1 mile (1.6 km) per day had a higher leg bone density than those who walked shorter distances. These results provide evidence that walking can be beneficial to the maintenance of bone density in the lower limbs.

Although this study does not examine the effect of regular activity on bone density it is plausible to suggest that increases may occur. If this is the case then a walking program should help maintain, if not improve the bone density of the lower limbs. This possible improvement could reduce the risk of falls decreasing the risk of potential injury as a result of osteoporotic fractures. This reduction of injury and falls associated with osteoporosis could be seen as an improvement in the quality of an individual's life.

Summary

From this literature review several conclusions can be drawn. The first being that physical activity is an important factor in maintaining a healthy life. This suggests that performing regular physical activity can reduce the risk of CHD by decreasing selected risk factors. It can also help maintain and or improve functional status, allowing the individual to live an independent lifestyle and reduce the risk of depression and can help treat depressive symptoms. The second conclusion that can be made is that there is no consensus on the intensity of activity necessary to derive these benefits. Most of the studies reviewed indicated that moderate intensity activity was used for the intervention, however upon further examination there are problems with the definition of moderate intensity. It seems that the definition of moderate intensity is dependent on the researcher and the study being conducted. This review has found that moderate intensity has been

defined anywhere from 60% to 73% of maximal oxygen consumption. Other studies suggest that any activity that creates a sweat is considered to be moderate intensity. Without a clear concise definition of intensity levels it is difficult to determine where these health benefits occur. However, based on the dose response relationship (Haskell, 1994) it would be expected that any increase in caloric expenditure, no matter how low, would result in some degree in improvement in selected health related variables.

This study will focus on improving the lifestyle of senior individuals by using low and moderate intensity physical activity programs. Once again, the researcher will set the values for intensity, but the definitions for these intensities will be more realistic, and better suited for an elderly population. This study hypothesizes that activity at a moderate intensity of 50% to 60% or less of heart rate reserve will result in the accumulation/improvement of health benefits that have been observed in other studies. When a senior population performs regular low intensity activity, 35% to 45% of heart rate reserve it is hypothesized at least some if not all the above health benefits will be realized.

Methods

This study was conducted at Northwood Incorporated in Halifax, Nova Scotia from May 1999 to September 1999.

Sample Size and Recruitment

To determine the sample size required to meet the statistical needs of the present experiment the standard deviations of the 'Up & Go Test' total time, from a study conducted by Okumiya, Matsubayashi, Wada, Kimura, Doi and Ozawa (1996), were used. For the calculation alpha and beta were set at 0.05 and 0.9 respectively. Based on the above-mentioned study a sample size of n=25 was calculated.

Prescreening

Inclusion/Exclusion Criteria

To participate in the study the subject had to be classified as living independently or semi-independently. Anyone that required total assistance in completing the necessary activities of daily living was classified as dependent and was not suitable for this study. As well, subjects were required to walk freely with or without the use of walking aids (walkers, canes) as well as have the ability to walk twelve consecutive minutes without stopping.

Any individual that was currently using common beta-blockers (atenolol, metoprolol, propranolol, timolol, pindolol, nadolol), calcium channel blockers (verapamil, diltiazem) and/or digoxin was not permitted to participate in the study unless

their heart rate responded to exercise. Also, individuals with pacemakers or insulin dependent diabetes were excluded from the study. It should be noted that no individuals were disqualified from the study based on the exclusion criteria.

Cognitive Capacity

All subjects underwent an initial assessment where they were required to complete the Mini Mental State (MMS) questionnaire (Appendix B). This questionnaire was used to screen potential subjects by assessing the cognitive aspects of mental function (Folstein, Folstein & McHugh, 1975) and identifying those who had a diminished cognitive capacity. Assessment of mental function was necessary since the inability to complete a functional task or the length of time required to complete the task may be the result of an inability to process information rather than a decreased physiological capacity. If a diminished mental capacity were the cause of decreased functional ability, then the intervention being used (physical activity) would not be expected to have any effect.

The researcher administered the MMS orally, with the questions presented in the order in which they appeared on the questionnaire. Based on the recommendations from Folstein et al. (1975) the subjects were allowed to take as long as necessary to answer the questions (no time limit) and were not pressed for answers on any questions that they found difficult (Folstein et al., 1975). A more detailed set of instructions is provided in appendix B. The exam was scored out of 30 (Folstein et al., 1975) with a score of less than 24 representing an abnormal score, signaling a diminished cognitive capacity

(Fleming et al., 1995). Any subject that scored less than 24 on the MMS was thanked for their time and excused from the study.

Medical Screening

As a final precaution, all subjects underwent a medical evaluation conducted by a physician to determine their suitability to participate in a physical activity program. It was not deemed necessary to conduct stress testing since the intensity of the activity being used was relatively low, 60% heart rate reserve or less.

Consent

All subjects that met the inclusion criteria and wished to participate in the study were required to sign a consent form (Appendix C) that had previously been approved by both the Faculty of Graduate Studies Ethics Committee and the Medical Ethics Committee at Dalhousie University.

Experimental Group Design

The Physical Activity Scale for the Elderly (PASE) (New England Research Institute, Inc., 1991) (Appendix D) was used to determine the subject's activity patterns prior to taking part in the study. This information was used to classify the subject's frequency of activity as low or high. The subjects were randomly assigned, based on their activity classification and using a random numbers table, to one of the two experimental groups. By assigning the subjects in this manner it ensured that there was a normal distribution of activity frequency within the two study groups. It can be suggested that the subjects who were more physically active would have a higher level of health-related

fitness than those that were not. Young & Steinhardt (1995) stated that the greatest health benefits are realized when moving from a low activity level to a moderate activity level. Therefore, if an experimental group contained only highly active subjects it would be expected that the health benefits incurred may not be significant, whereas, if the group contained only sedentary individuals a significant change in health benefits would be expected. Creating the groups in the above manner should ensure that any changes in the dependent variables observed are the result of the intervention and not the construction of the groups.

The present study consisted of a 16-week exercise program and was conducted over an 18-week period. Week 0, week 9 and week 17 were used to assess and retest functional and psychological variables as well as selected coronary heart disease (CHD) risk factors and the exercise program ran from the beginning of week 1 until the end of week 16.

During week 17 the subjects completed the PASE questionnaire once again to determine if their activity patterns had significantly increased over the 16-week intervention.

Testing Procedures

Maximal Oxygen Consumption

The 12 minute walk/run test was used determine the maximal oxygen consumption for each subject. The test was administered at the beginning (week 0) and at the end (week17) of the training period. This was a submaximal, self-paced walking test that predicted VO_{2max} (L/min or ml/kg/minute) using the regression equations found in Table 4.

Table 4: Male and female regression equations for the 12 minute walk test (Sidney & Shephard, 1977).

Males
$\mathbf{VO_{2max} = 1.552X + 2.11}$ **L/min or** $\mathbf{= 19.9X + 21.5}$ **ml/kg/min**
Females
$\mathbf{VO_{2max} = 0.662X + 1.04}$ **L/min or** $\mathbf{= 18.3X + 11.9}$ **ml/kg/min**
Where: X = distance covered in miles

The 12-minute walk test required the subject to walk as far as possible during a 12-minute period (Sidney and Shephard, 1977; American College of Sports Medicine, 1995). The distance walked was then calculated by multiplying each complete lap by the total distance of one lap. Next, the distance for an incomplete lap was measured from the starting point of the course to the point where the individual stopped at the 12-minute mark. This distance was then added to the distance calculated from the completed laps. This distance, in miles, was then used in the respective regression equation to predict VO_{2max}. For this study the subjects were required to walk laps around a clearly marked course to complete the test, where each lap measured 0.03 miles. The subjects were instructed to walk as many laps as possible during the timed period in accordance with Sidney and Shephard, 1977 and the American College of Sports Medicine, 1995. During this period the subjects were not permitted to stop and rest and were asked to try and maintain a constant movement speed. The time was monitored using a standard stopwatch and the incomplete lap was measured to the nearest inch using a standard 50-foot measuring tape. As a safety precaution the subjects were permitted to use walking

aids if they required them. As well, the researcher remained in close proximity to the subject in case any assistance was required. However, none of the participants required assistance from the researcher or used walking aids.

Prior to the test the subject completed a short warm-up followed by a series of lower body stretches. Upon completion of the test, the subject actively cooled down and post exercise heart rate (HR) and blood pressure (BP) were taken. This was done to ensure that HR and BP had returned to resting levels before the subject left the testing area. The researcher or a research assistant took these measurements using a standard stethoscope and sphygmomanometer. Both the researcher and the assistant were certified Professional Fitness and Lifestyle Consultants by the Canadian Society for exercise Physiology and were experienced with taking blood pressure and heart rate.

Functional Ability

Functional status was determined using physical performance test and using a questionnaire to measure the ability to complete activities of daily living (ADL) and instrumental activities of daily living (IADL).

The Timed 'Up & Go' (TUGT) test was used to assess physical performance. The test utilized a standard armless chair with a seat height of 46 cm. The subject began the test seated in the chair with their back against the chair back, arms resting at their sides and hands folded in their lap. Upon the command 'Go' the subject rose from the chair, walked a distance of 3 meters to a marked line, pivoted on the line and then returned to a seated position on the chair (Podsiadlo & Richardson, 1991). When rising from the chair the subjects were instructed not to use their arms to aid in the standing process and to

ensure that the muscles of the legs alone would be used for this movement. The subjects were also instructed to walk at a safe and comfortable pace and were permitted one practice trial before performing the actual test (Podsiadlo & Richardson, 1991). The subjects were not allowed to use any walking aids for this assessment. Prior to testing the subjects were informed to wear comfortable footwear with a flat sole to the session.

The TUGT was timed using an IBM compatible computer and the GEN93 software program. The setup of the actual test involved placing metal tape on the soles of the subject's shoes as well as their buttocks and back. The tape created an electric circuit with the chair back, chair seat and the floor. The specific circuits created were located between the subject's back and the chair back, the subject's buttocks and the chair seat and the soles of the subject's feet and the floor. As the subject began to move the circuits were broken in sequence resulting in changes in voltage (Read, 1998). The program was then used to graph and display the changes in voltage against time on the computer monitor. A more detailed account of this system and its instrumentation can be found in Read, 1998. In the present study, the program was used to calculate the total time of the TUGT task. Using this system provided a more accurate and consistent method for recording subject times than using a manual stopwatch.

ADLs and IADLs were assessed using the Groningen Activity Restriction Scale (GARS) (Appendix E). The subjects had the choice of four possible responses: 1) yes, I can do it fully independently without any difficulty; 2) yes, I can do it fully independently, but with some difficulty; 3) yes, I can do it fully independently, but with great difficulty; and 4) no, I cannot do it fully independently, I can only do it with someone's help. The individuals themselves completed the questionnaires with the

exception of one subject to whom it was administered orally. For the oral administration the response options were printed in a large font on a cue card, which was visible and available for the subject to use. It is important to note, that if a subject did not perform an activity addressed by one of the questions they were instructed to imagine performing the activity and then rate their perceived performance (Kempen, Miedema, Ormel and Molenarr, 1996).

The GARS was scored by totaling the score from each of the subject's responses to the eighteen questions. The point values for the responses were 1 point for response 1, 2 points for response 2, 3 points for response 3 and 4 points for response 4.

Depression

The effects of the exercise programs on psychological status (depression) were determined using the Geriatric Depression Scale (GDS) (Yesavage, Brink, Rose, Lum, Huang, Adey & Otto, 1983) (Appendix F). This scale was scored using a yes/no response whereby a point was given for every question where the subject's response matched the response given in the answer key. Any individual that scored five or higher were classified as depressed (Gallo et al., 1995). The subjects completed the questionnaire on their own with the exception of one subject where it was necessary to administer the questionnaire orally. In all cases no explanation or insight into any of the questions was offered to any of the subjects.

Selected CHD Risk Factors

Finally, the study examined the effect of the exercise programs on selected cardiovascular risk factors. The factors that were examined included blood lipoproteins (total triglycerides, high density lipoprotein and low density lipoprotein), total cholesterol, resting blood pressure and body composition (waist girth).

Body composition was assessed using overall body weight and the waist girth measurement. These measurements were taken during week 0 (pre), week 9 (mid) and week 17 (post). Weight was measured to the nearest 0.1 kilograms. Waist girth was determined using the protocol detailed in The Canadian Physical Activity, Fitness & Lifestyle Manual (Canadian Society for Exercise Physiology, 1996). Waist girth was chosen over skinfolds as an indication of body composition and health status since it was a less invasive technique and less likely to cause distress to the subjects. As well, research indicates that those individuals with a high concentration of adipose tissue in the abdominal region are at greater risk for developing cardiovascular disease (Lemieux et al., 1996).

Post exercise blood pressure was measured during all the exercise sessions as a safety precaution, but was not included as part of the analyzed data. The resting BP values that were used for analysis were collected during the pre, mid and post assessment weeks. These values were recorded 5 minutes after the questionnaires had been completed and prior to the functional testing. This was done to ensure that the subjects blood pressure and heart rate were at a resting level.

Blood samples were collected during week 0 and week 17 and were analyzed at the Queen Elizabeth II Health Sciences Center. Each sample was analyzed for total

triglycerides, total cholesterol, high-density lipoprotein (HDL) and low-density lipoprotein (LDL). In order for the lab to determine HDL and LDL it was necessary for the subjects to fast for 12 hours prior to having the blood sample drawn. It is important to note that the first blood sample was drawn as part of prescreening procedure and was therefore controlled by the subject's family physician. As a result, an incomplete data set exists for subject number 7.

Physical Activity Intervention

The subjects were randomly assigned to either the group 1 or the group 2. Group 1 walked at an intensity of 50% to 60% of their predicted VO_{2max} while group 2 walked at 35% to 45% of their predicted VO_{2max}.

The exercise mode that was used for the study was walking. This activity was chosen based on a 'needs assessment' survey conducted at the Northwood facility. The report indicated that walking was the primary physical activity for 65% of the respondents and also indicated that 35% of the respondents would be interested in participating in a walking club (Northwood, 1998). Also, walking was an easy activity to implement, monitor and required no special equipment. As well, the low intensity of the exercise allowed the individuals to talk with one another as they walked, facilitating social interaction.

The primary focus of this study was to examine the effects of different exercise intensities on selected variables (selected CHD risk factors, functional ability and depression). As previously mentioned, the group 1 walked at an intensity of 50% to 60% of their predicted VO_{2max} while the group 2 walked at an intensity of 35% to 45% of their

predicted VO_{2max}. Since the subjects were in a gymnasium and not on a treadmill, speed and oxygen cost could not be consistently controlled. Therefore, it was necessary to calculate target HR zones to ensure the subjects were exercising at the correct intensity

When using exercise interventions it is often hard to differentiate whether the observed effects are the result of intensity or duration. Therefore, it was necessary that the duration remain constant between the groups, so that only exercise intensity differed. However, a problem occurs when trying to control for duration. If duration is fixed between groups, but intensity is different, then one group will expend more energy than the other. When this happens it is not clear what has caused the observed effects, intensity or differences in caloric expenditure. Nonetheless, the problem can be overcome if each group performs the same amount of work. In this study work was calculated as the total number of calories expended per exercise session. Therefore, every subject independent of the intensity, attended the same number of sessions per week and expended the exact same amount of calories per session regardless of duration.

The amount of work to be completed per exercise session was set at 100 calories. This value was based on a study conducted by Foster et al. (1989) where low and moderate intensity walking programs were created for elderly women. However, 100 calories was too intense for this study during the first several weeks making it necessary to start at a lower work level and progress up to 100 calories per session (Table 5).

Table 5: Exercise progression for the 16-week intervention program.

Weeks	Calories per session	Total Number of Weeks
1-5	50	5
6-11	75	6
12-16	100	5

Using the subject's predicted $VO_{2max,}$ exercise intensities were calculated as the appropriate percentage of this value. The corresponding MET values were then determined for each subject based on 1 MET equals 1.5 kcal/minute (Ainsworth, Haskell, Leon, Jacobs, Montoye, Sallis & Paffenbarger, Jr., 1993). MET's were then used to calculate how long each subject had to exercise to expend the appropriate number of calories per session. Microsoft Excel 5.0 was used to perform these calculations. A sample calculation can be found in Appendix G. Since VO_{2max} differed between subjects each subject walked for a slightly different amount of time. However, this difference in duration was not important since the amount of work being done by the subjects was equated.

Each subject attended 3 sessions per week, Monday, Wednesday and Thursday, with each session lasting approximately 40 minutes, including warm-up, cool-down and social time. Any subject that missed 6 consecutive sessions (2 week period) was dismissed from the study. However, as a result of the time of year (summer) it was necessary to make special arrangements for vacations. These arrangements consisted of a logbook to record their walking and a detailed explanation of how to continue with the walking program while on vacation.

The subjects were required to maintain an activity diary (Appendix H) while participating in the study. They were instructed to use their diary to record their walking on days that they missed the group walks as well as record any other physical activity performed. Along with the activity diaries the subjects were given a copy of Borg's scale of perceived exertion (Appendix I) to monitor the intensity of their activities (Borg, 1998). The diaries and RPE scales were explained on several occasions, but many of the subjects did not understand how to use them. Most subjects only recorded walking activities or activities that may be classed as exercise. The researcher examined these diaries on a regular basis throughout the intervention period and continually offered further instruction to try and improve compliance.

At the beginning of each walking session the subjects were required to take part in a warm-up, which lasted approximately 5 minutes. This consisted of walking 2 slow laps of the marked course and completing a series of lower body stretches. The stretches were taught to the subjects during the first week of the program. After completing their prescribed physical activity all subjects completed an active cool-down consisting of 2 slow laps of the marked course. As well, HR and BP were checked before the subjects left the testing area to ensure the subject left to ensure they had returned to resting values.

During the exercise session the subjects were required to monitor their pulse in order to maintain the proper exercise intensity. All the subjects were taught how to take their radial pulse during week 0. The researcher also monitored HR on a regular basis using radial palpation and a digital finger pulse-meter. This was done to help make certain that the individuals were working at the proper intensity.

In an attempt to maximize exercise adherence it was necessary to design the activity in a manner that was appealing to the subjects. This study used the theme of, "Walk Across Canada." The goal was to walk as far across the country, in essence, as possible. Since the subjects were walking a circuit of known distance the total distance walked during each session was calculated and charted on a series of provincial maps. This activity was done as a combined effort to increase the social interaction of the group as well as help maintain a high level of adherence.

Statistical Analysis

This study utilized an unbalanced two-stage nested factorial design with repeated measures. The main effects were group, trial and subject within group. A two-sample t-test was used to test for group differences for each measured variable at an alpha of 0.05 level of significance.

The ANOVA's General Linear Model (GLM) was used to test the main effects of the experiment. All interactive effects were tested prior to testing for any main effects. An alpha of 0.05 was used to test for all main effects and interactions. The full model can be represented by;

$$\mathbf{y = \mu + Group + Trial + Subject(Group) + Group*Trial + error} \quad \begin{matrix} i = 1,2 \\ j = 1,2 \\ k = 1,2,3,4,5,6,7,8 \end{matrix}$$

A reduced model was fitted since there was no significant interaction. The reduced model can be represented by;

$$\mathbf{y = \mu + Group + Trial + Subject(Group) + error} \quad \begin{matrix} i = 1,2 \\ j = 1,2 \\ k = 1,2,3,4,5,6,7,8 \end{matrix}$$

The reduced model was used to test the main effects of the experiment and its results used for the interpretation of the data.

Prior to any interpretation, the usual diagnostic checks were performed including the normal probability plots, checking for outliers and residual plots. These plots were used to determine if the assumptions associated with the model had been violated.

Comparisons of significant treatment means were tested using the Tukey Test at an alpha of 0.05 level of significance. All of these statistical analyses were performed using Minitab 12.

Results

Sample Population

Subjects were recruited through Northwood Inc. by means of flyers, information seminars and in-house television and radio broadcasts. Subjects were also recruited from the metro population through flyers (Appendix A) distributed to all senior homes in the Halifax area, Cable 10 advertisement and radio advertisements on CBC radio.

Six weeks of recruitment resulted in 12 volunteers, representing a sample of convenience. It was decided to end the active recruitment phase of the study well short of the predicted sample size because of the length of intervention program (16 weeks) and the time and space availability at the facility.

The final gender distribution for the sample population was 25% males (n=2) and 75% females (n=6). Group1 (low intensity) consisted of one male and two females, whereas group 2 (moderate intensity) consisted of one male and four females. The mean ages and standard deviations for the subjects were 74.3±2.3 and 76±8.5 years for group 1 and group 2, respectively. The complete raw data set can be found in Appendix J.

Sample Size and Adherence

The study began (week 0) with twelve volunteers, eight females and four males, participating in the physical activity intervention. However, after five weeks of the program the sample size had decreased to eight subjects due to attrition. Two subjects were forced to leave the study as a result of medical problems (1 male and 1 female) and the other two subjects left as the result of prior commitments (1 male and 1 female). In

total, four subjects, two males and two females, dropped out of the study prior to the mid point testing date (week 9).

The total number of physical activity sessions held over the 16-week intervention period was 44. Of the eight subjects who remained in the study the average compliance was 85%. The compliance rate for each subject can be found below in Figure 4. Subjects four and five had compliance rates that fell below the 85% average. This lower compliance rate was the direct result of a three-week vacation, which accounted for a large proportion of the sessions missed. Subject six was the only other participant whose attendance fell below the average (85%). This decreased compliance was the result of a medical problem.

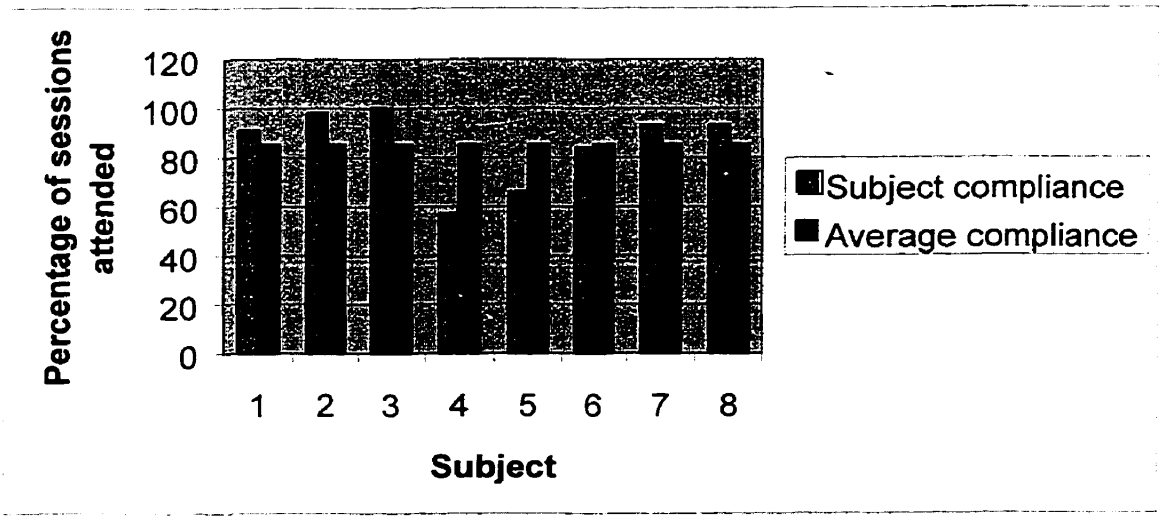


Figure 4: Subject compliance rate for physical activity sessions.

Group Differences

To determine if the effects observed during week 17 of the study were the result of the intervention it was necessary to determine if group 1 and group 2 were statistically different at the beginning of the study (week 0). Two sample t-tests were conducted at α

= 0.05 level of significance, for each of the 14 variables of interest. The results indicated that there was no significant difference at the beginning of the study between group 1 and group 2 for any of the variables (See Appendix K).

Model and Model Adequacy

As stated in the statistical analysis section, it was necessary to determine if there was any significant interaction between the main effects trial and group before any further analysis and interpretation of the results could be done. The results revealed that there was no significant interaction ($\alpha = 0.05$ level of significance) between the two main effects for any of the 14 variables (See Appendix L). As well, model adequacy checks (See Appendix M) revealed that none of the assumptions associated with the analysis had been violated. Based on these findings the *group*trial* interaction term was removed and the reduced model was fitted.

Prior to reviewing the results of the statistical analysis of the reduced model (See Appendix N) an adequacy check was performed to confirm that the assumptions associated with the analysis of variance had not been violated. Specifically, normal probability plots were used to ensure that the errors were normally distributed with a mean of zero and residual plots were examined to ensure the variance assumption had not been violated.

Figure 5, shows the normal probability plot for predicted VO_{2max}, and is representative of the normal probability plots for the other 12 of the 14 variables (systolic BP, diastolic BP, RHR, weight, waist girth, GARS score, GDS score, PASE score, HDL

level, LDL level, cholesterol level and TUGT time). The normal probability plots for these variables can be found in Appendix O.

The normal probability plot (Figure 5) for predicted $V0_{2max}$ revealed a linear relationship between the residuals and the normal scores. This indicated that the residuals were normally distributed and that the assumption of normality had not been violated.

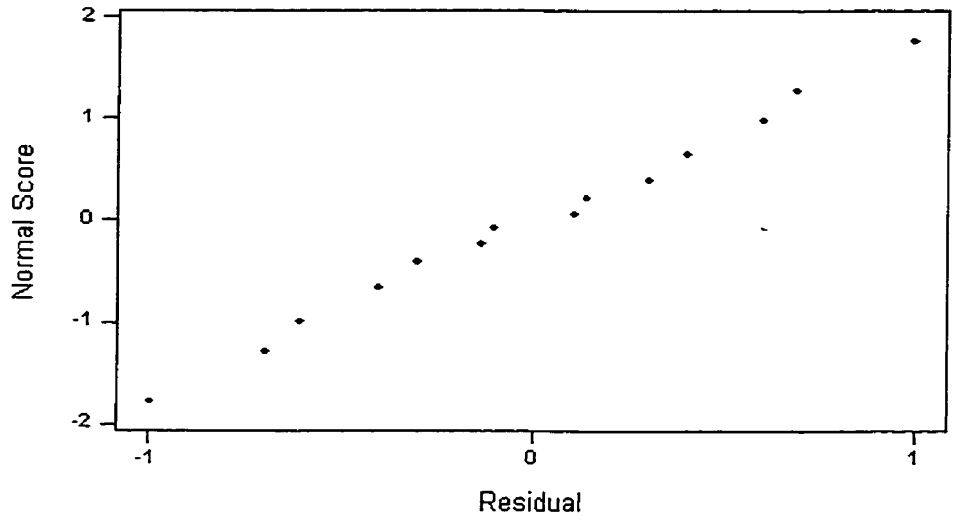


Figure 5: Normal probability plot of the residuals for the response predicted $V0_{2max}$.

The residuals versus fitted value plot for VO_{2max} (Figure 6) shows that the residuals are random and have no obvious pattern. This plot indicates that the assumption of a constant, but unknown variance σ^2 has not been violated. Figure 6 is representative of the residual plots for the other 12 variables (systolic BP, diastolic BP, RHR, weight, waist girth, GARS score, GDS score, PASE score, HDL level, LDL level, cholesterol level and TUGT time), which can be found in Appendix O.

It is important to note that in Figure 6 a gap in the residuals can be observed approximately between the fitted values of 25 and 30. This gap is a direct result of the small sample size and its associated smaller variance. As a result, not enough variance was present within the sample group to completely fill-in the graph. Therefore, when the residuals were calculated and plotted against the fitted values large gaps were formed. Consequently, a larger sample size might have resulted in a greater degree of variance whereby decreasing the likelihood of gaps within these plots would have been observed.

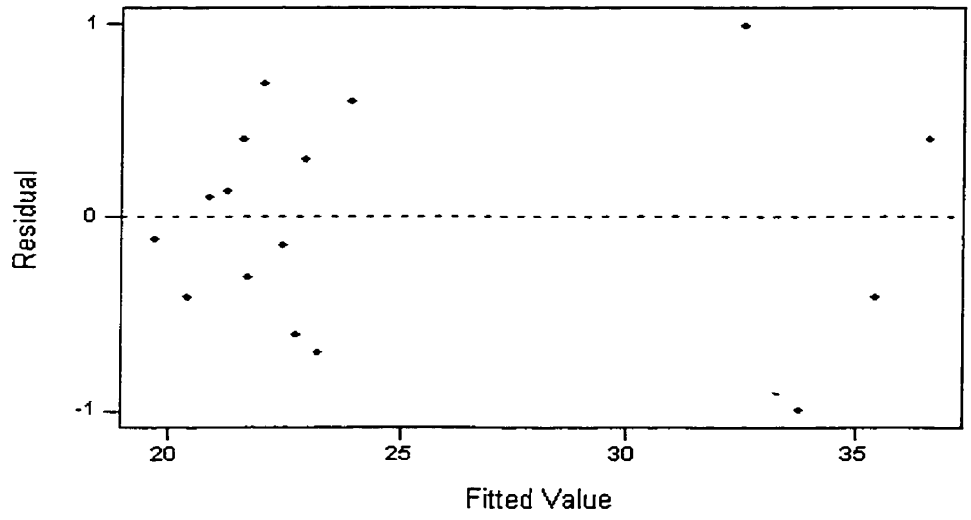


Figure 6: Residuals versus the fitted values for the response predicted $V0_{2max}$.

Figure 7, indicates that the normal probability plot for the response triglycerides, deviates from the linear relationship that would be expected if the assumptions associated with the analysis of variance were correct. However, Montgomery (1997) states that there is considerably more fluctuation in the plot when the sample size is small and in these

cases a moderate departure from normality does not indicate a serious violation of the assumption.

However, the residual versus fitted plot for the response triglycerides (Figure 8) also indicates that there may be a problem with the assumptions made with the model. Analysis of the plot reveals an outward coning distribution, indicating nonconstant variance, a violation of one of the assumptions (Montgomery, 1997).

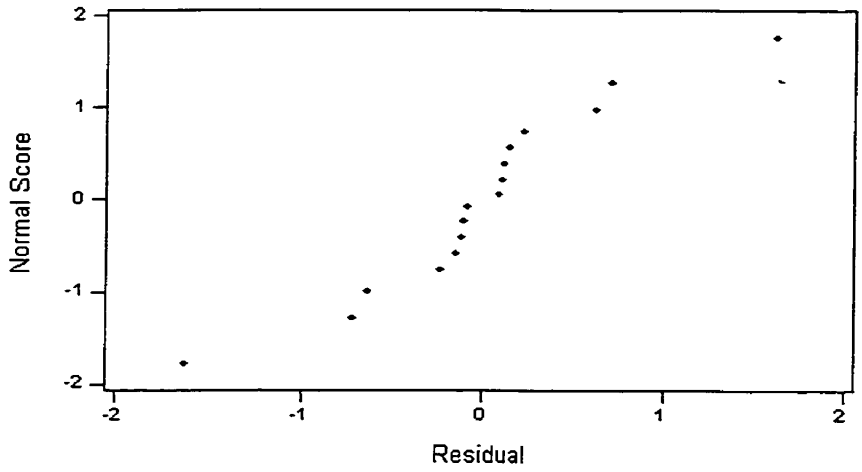


Figure 7: Normal probability plot of the residuals for the response triglycerides.

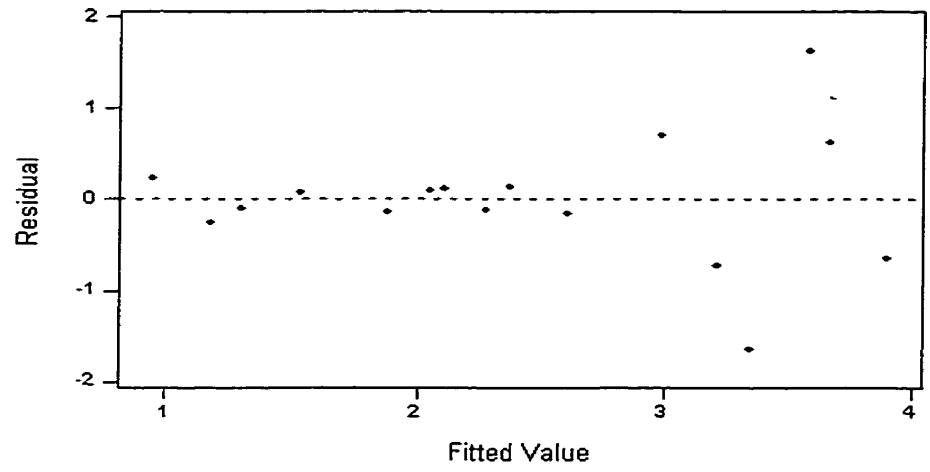


Figure 8: Residuals versus the fitted values for the response predicted triglycerides.

Based on the analysis of Figure 7 and 8 it was very possible that one or more of the assumptions associated with the analysis of variance had been violated for the variable triglycerides. Therefore, it was necessary to try a variance stabilizing transformation on the data for this variable so that the proper analysis could be done. These transformations included square-root(y_{ij}) and square-root($1+y_{ij}$) However, the transformation failed to stabilize the variance. As a result the only other options were to remove potential outliers and reanalyze the data or leave the outlier in and explain why they acted as a pivot point for the rest of data. Based on the small sample size and the lack of a suitable reason to remove the potential outlier the data point remained in the model. The potential influence of this point will be explained in the results. It should be noted that the variable triglycerides was the only variable that appeared to violate the assumptions associated with the analysis of variance.

Descriptive statistics

The descriptive statistics including means and standard deviations, for the fourteen variables can be found in Tables 6 though 9. The tables have been subdivided into descriptive statistics for group 1 (moderate intensity) and group 2 (low intensity).

Table 6: Descriptive statistics for selected cardiovascular risk factors for group 1 and group 2.

Variable	Week	Group 1 Moderate Intensity		Group 2 Low Intensity	
		Mean	Standard deviation	Mean	Standard deviation
RHR (bpm)	Week 0	64.0	14.4	80.0	18.3
	Week 9	64.0	6.9	71.2	13.4
	Week 17	73.3	14.0	68.0	13.9
Systolic BP (mm of Hg)	Week 0	126.7	25.2	142.8	19.8
	Week 9	143.3	43.9	129.6	5.5
	Week 17	121.3	5.8	136.4	10.4
Diastolic BP (mm of Hg)	Week 0	71.3	10.3	80.0	1.6
	Week 9	77.3	9.0	73.2	11.4
	Week 17	73.3	7.6	73.2	5.2
Weight (kg)	Week 0	71.7	8.3	68.0	14.6
	Week 9	71.8	7.0	66.0	13.3
	Week 17	70.7	7.6	65.1	12.0
Waist girth (cm)	Week 0	88.9	12.1	94.7	7.7
	Week 9	88.8	8.4	96.9	4.3
	Week 17	98.3	5.5	96.1	3.8

Table 7: Descriptive statistics for blood lipid analysis for group 1 and group 2.

Variable	Test Week	Group 1		Group 2	
		Mean	Standard deviation	Mean	Standard deviation
Triglycerides (mmol/L)	Week 0	2.1	0.4	2.8	1.6
	Week 17	2.0	0.7	2.5	1.4
Cholesterol (mmol/L)	Week 0	6.2	0.9	5.2	1.9
	Week 17	6.5	1.4	5.5	1.8
HDL (mmol/L)	Week 0	1.8	0.5	1.1	0.4
	Week 17	1.6	0.8	1.1	0.3
LDL (mmol/L)	Week 0	3.7	1.0	3.6	1.1
	Week 17	4.0	1.0	3.3	1.2

Table 8: Descriptive statistics for the questionnaire results for group 1 and group 2.

Variable	Week	Group 1		Group 2	
		Mean	Standard deviation	Mean	Standard deviation
PASE*	Week 0	129.9	49.4	68.4	27.2
	Week 17	137.3	35.2	94.8	40.3
GARS**	Week 0	18.0	0	19.4	2.6
	Week 9	18.3	0.6	19.6	1.8
	Week 17	18	0	19.4	2.2
GDS***	Week 0	2.3	2.1	2.2	1.8
	Week 9	1.0	1.0	2.4	1.3
	Week 17	0.7	1.2	1.8	1.6

* Physical Activity Scale for the Elderly

** Groningen Activity Restriction Scale

*** Geriatric Depression Scale

Table 9: Descriptive statistics for performance variables for group 1 and group 2.

Variable	Week	Group 1		Group 2	
		Mean	Standard deviation	Mean	Standard deviation
Predicted VO_{2max} (ml/kg/min)	Week 0	25.9	6.7	23.6	6.5
	Week 17	26.2	5.5	25.4	6.6
TUGT time (sec)	Week 0	11.4	1.9	13.7	3.7
	Week 17	10.0	1.2	10.7	2.8

The General Linear Model

The general linear model was used to determine if any significant differences existed between the two experimental groups. The results of this analysis indicate that there were no significant differences between the groups for any of the 14 variables examined. A summary of the results can be found in Table 10.

Table 10: General linear model results for comparisons between group 1 and group 2.

FACTOR	GROUP		
Variable	**DF**	**F**	**P**
RHR	1;14	0.44	0.530
Systolic BP	1;14	0.31	0.599
Diastolic BP	1;12	0.00	0.969
Weight	1;14	0.14	0.723
Waist girth	1;14	0.80	0.407
GARS	1;14	1.21	0.314
GDS	1;14	1.28	0.310
PASE	1;7	4.32	0.083
Predicted VO_{2max}	1;7	0.11	0.753
TUGT time	1;7	0.74	0.424
Triglycerides	1;7	0.84	0.396
Cholesterol	1;7	0.73	0.424
LDL	1;6	4.87	0.078
HDL	1;6	0.18	0.691

The results of the analysis of the trial effect on the 14 variables can be found in Tables 11 and 12. The results for the variables that were assessed at week 0, week 9 and

week 17 are found in Table 11 whereas those variables assessed only during week 0 and week 17 are found in Table 12.

Main effects plots (variable versus time) were also created for each of the 14 variables (Appendix P). The plots indicate that both systolic and diastolic pressure decreased between week 0 and week 9 and then again between week 9 and week 17. Both resting heart rate and weight decreased between week 0 and week 9, but increased from week 9 to week 17. The plot for waist girth indicates that the measure steadily increased between week 0 and week 9 and then again between week 9 and week 17. The plots for the questionnaire scores show that the GARS score increased between week 0 and week 9, but decreased between week 9 and week 17 whereas GDS scores decreased fairly linearly over the three evaluation periods. Both triglycerides and LDL show a decreasing trend between week 0 and week 17. However, both cholesterol and HDL show an increasing trend over the same time period. The main effect plots for the PASE scores and predicted VO_{2max} indicate an increasing trend between week 0 and 17 whereas TUGT time decreased during this time.

Table 11: General linear model results for comparisons between trials (pre, mid and post).

FACTOR	TRIAL		
Variable	**DF**	**F**	**P**
RHR	2;14	0.62	0.554
Systolic BP	2;14	0.22	0.803
Diastolic BP	2;12	0.58	0.574
Weight	2;14	3.79	0.049*
Waist girth	2;14	1.71	0.217
GARS	2;14	0.26	0.775
GDS	2;14	1.28	0.310

*significance at $\alpha = 0.05$.

Table 12: General linear model results for comparisons between trails (pre and post).

FACTOR	TRIAL		
Variable	**DF**	**F**	**P**
PASE	1;7	3.37	0.109
Predicted VO_{2max}	1;7	8.61	0.022*
TUGT time	1;7	6.14	0.042*
Triglycerides	1;7	0.20	0.665
Cholesterol	1;7	5.77	0.047*
LDL	1;6	0.36	0.572
HDL	1;6	0.31	0.596

*significance at $\alpha = 0.05$.

The results indicate a significant difference existed between week 0 and week 17 for the variables weight (Figure 9), total cholesterol level (Figure 10), predicted VO_{2max} (Figure 11) and TUGT time (Figure 12).

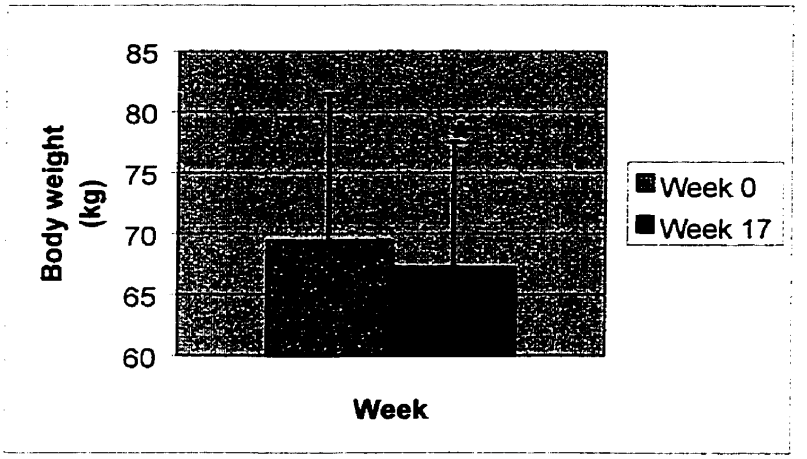


Figure 9: Changes in body weight over time (* $\propto = 0.05$, $p = 0.049$)

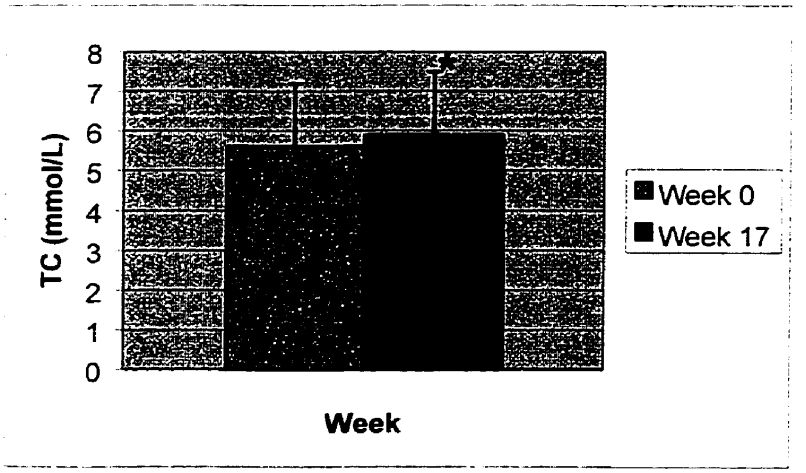


Figure 10: Changes in total cholesterol (TC) level over time (* $\propto = 0.05$, $p = 0.047$)

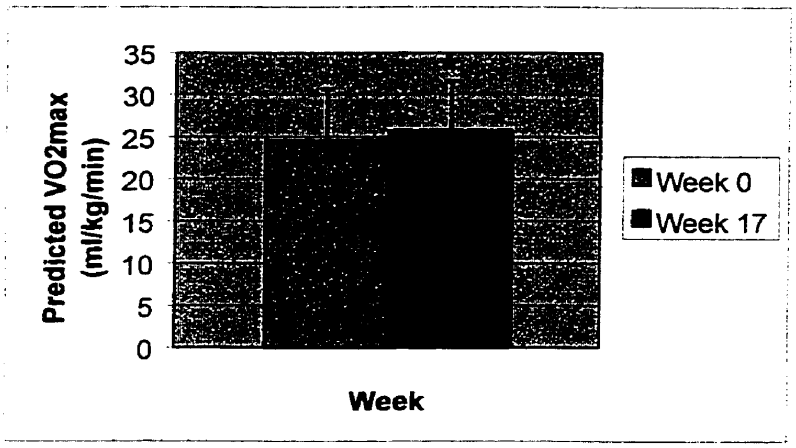


Figure 11: Changes in predicted VO_{2max} over time (* $\propto = 0.05$, $p = 0.022$)

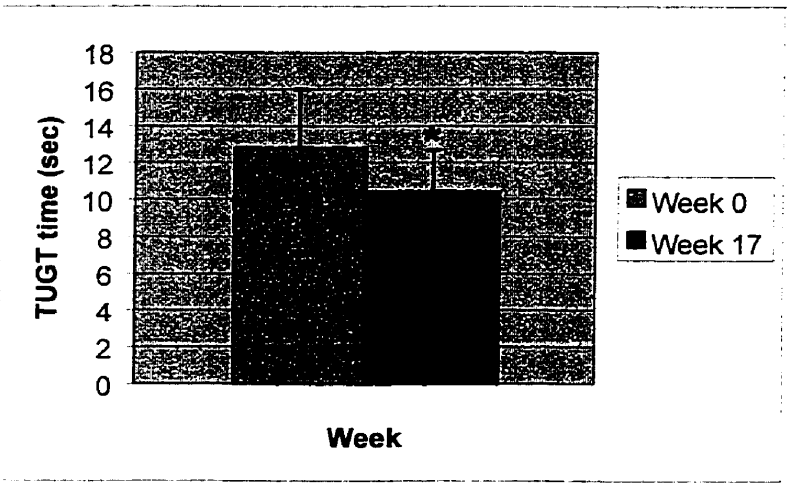


Figure 12: Changes in TUGT time over time (* $\propto = 0.05$, $p = 0.042$)

The results indicated that weight decreased significantly over the 16-week intervention period. A Tukey post hoc analysis showed that even though weight decreased from week 0 to week 9 and then again from week 9 to week 17, a significant change was only observed between week 0 and week 17 (See Appendix Q). Figure 10

shows a significant increase in total cholesterol levels over the 16-week intervention period. Specifically, cholesterol level increased on average by 0.2925 mmol/l. A significant increase of 1.187 ml/kg/min occurred in predicted VO_{2max} over the span of the intervention period (Figure 11). Finally, a significant decrease of 2.363 seconds in the time required to complete the TUGT, was also observed (Figure 12).

Discussion

Canadian statistics indicate that the percentage of seniors within population is rapidly growing and that by the year 2016 it will represent approximately 16% of the total Canadian population (Statistics Canada, 1999). This growing proportion is very important since as an individual grows older, changes occur within their life that affect how they live and the care that they require, e.g. independently, dependently or semi-dependently. These states of living are dependent on the individual's physiological capability, functional ability, and mental state as well as the absence of disease.

It is clearly stated within the literature that some combination of aging and behavioral change, specifically decreases in physical activity, result in decreased physiological function (Ostrow, 1989). These decreases in aerobic capacity, muscular strength and endurance and flexibility affect the overall level of functional ability of the senior. When an individual can no longer perform all the necessary activities of daily living a change in their living state occurs, a transition from an independent lifestyle to one that is either semi-dependent or dependent. When this occurs there are costs associated with the individual for the care/assistance that is required for them to live. This expense is often passed on to society in the form of increased medical costs. Consequently, as the percentage of the senior population continues to increase, the potential growth of the costs associated with some form of dependent living also increase. Therefore, it is necessary to provide guidelines to aid seniors in maintaining their physiological capability and independence.

Physical activity has been shown to offset or improve a senior's aerobic capacity, muscular strength and endurance, flexibility and mental state and well as reduce the risk

of certain diseases (LaCroix et al., 1996; MacRae et al, 1996; Mazzeo et al., 1998). The CDC and ACSM recommend accumulating a minimum of 30 minutes of moderate intensity physical activity over most days, preferably everyday (Lee & Paffenbarger, Jr., 1996) in order to obtain some health benefits. However, the literature fails to provide a clear definition of what constitutes moderate intensity. A review of literature pertaining to seniors revealed that the definitions of moderate intensity ranged from between 50% to 70% of heart rate reserve or VO_{2max} (Engels et al., 1998; Lee & Paffenbarger, Jr., 1996; Posner et al., 1992). With this broad definition it is difficult to determine what intensity of physical activity would be best for an older adult or if new intensity guidelines should be developed for this demographic.

Therefore, it was the purpose of this study to examine the effects of two different intensities (low and moderate intensity) of physical activity, on selected CHD risk factors, functional status and psychological status, with respect to depression, in a senior population. The general intent was to determine if a low intensity physical activity program could provide comparable health benefits with those observed in a moderate intensity physical activity program. As well, the results from the present study were compared to other intervention studies. The purpose of this was to determine if different operational definitions of moderate intensity had the same impact on health outcomes.

Group Effects

The results indicated that there was no significant difference between the low and moderate intensity groups for any of the 14 variables tested during the physical activity intervention (Table 10). This finding was somewhat surprising since the current literature

promotes the use of moderate intensity physical activity to improve health related fitness/benefits. Both the CDC and ACSM have put forth recommendations (Lee & Paffenbarger, 1996; Mazzeo et al., 1998) based on improvements observed in health related variables when physical activity is carried out at a moderate intensity. Since low intensity physical activity was not represented in the recommendations it was expected that moderate intensity physical activity would produce a significant increase in health benefits in comparison to low intensity physical activity. However, the absence of recommendations based on low intensity physical activity might be attributable to a lack of research in the area rather than the possibility that low intensity physical activity does not improve health benefits.

As previously mentioned no significant difference between the low and moderate intensity group was observed for any of the 14 variables examined in the present study (Tables 6-10). Based on these results it could be suggested that there is no difference in the health benefits received when using either low or moderate intensity physical activity. These findings in conjunction with the position held by Blair and Connelly (1996) suggest that some physical activity is better than none in reference to improving health status. As well, the results of the present study indicate that future research in this area may be warranted to clarify the potential difference in health benefits when using different physical activity intensities. However, caution should be exercised when interpreting the results from the present study since a small sample was used and a control group was not utilized. Without a control it is not possible to determine whether or not the changes observed were the result of the physical activity intervention or from an outside factor that was not controlled for.

It should be noted that the results from this study provide support for the dose-response theory (Haskell, 1994). Using the relationship between kcal expenditure per week and improvement in health benefits from the dose-response theory it is possible to predict the outcome for the study (Haskell, 1994). Based on the variables used for this intervention the model would have predicted that the two groups would not differ significantly. The rationale was due to the fact that, although intensity varied between experimental groups, total kilocalorie expenditure was controlled for during the study. Specifically, every subject in the study expended approximately the same amount of kilocalories per physical activity session. The exact kcal expenditure per session for each subject can be found in Table 5 in the methodology section. Therefore, since kilocalorie expenditure was equated between subjects, all of the subjects should have realized the same percentage of improvement for each health variable. Since percent improvement would be the same for each subject it would be unlikely that a significant difference would be observed between the two experimental groups.

At a minimum, the results of this study indicate that a regular program of low intensity physical activity has no detrimental effects on an individual's health related fitness. If those subject's in the low intensity group had shown an increase in CHD risk variables, a decrease in functional ability and or an increase in depressive symptoms then it could be inferred that low intensity physical activity had a negative impact on health. However, no such trends were observed and thus indicating that low intensity physical activity can be used to maintain the current health state and may possibly improve specific components of it.

Time Effects

The results of the analysis using the general linear model indicated that predicted VO_{2max}, TUGT time, body weight and total cholesterol level changed significantly over the duration of the intervention period (16 weeks). For predicted VO_{2max}, TUGT time and body weight the changes represented significant improvements whereas the change in total cholesterol level was in the opposite direction expected.

Predicted VO_{2max}

As previously mentioned predicted VO_{2max} significantly increased over the duration of the study for both the low and the moderate intensity. However, further analysis revealed that there was no significant difference in predicted VO_{2max} between groups. This finding is comparable to the results of several other intervention studies examining the effects of physical activity on physiological factors, such as VO_{2max} (Badenhop, Cleary, Schaal, Fox & Bartels, 1983; Foster et al., 1989). The results of the study conducted by Badenhop et al. (1983) examined the effects of high and low intensity cycling on selected physiological factors and found that relative VO_{2max} increased significantly for both high and low intensity groups, but failed to show any significant difference between the two groups. This finding as well as the results from the present study and others (Foster et al., 1989) clearly suggests that regular physical activity performed at a low intensity can improve relative VO_{2max} in a low fit senior population. Moreover, these studies provide evidence that it does not matter if physical activity is performed at low, moderate or high intensity since comparisons have failed to show

significant differences in VO_{2max} outcomes between groups of different training intensities.

The author considers VO_{2max} as a health related variable and not a performance related variable for the older adult. Therefore, an individual should be able to improve VO_{2max} by increasing energy expenditure. Based on the dose-response theory it is kcal expenditure that is important for determining the percentage of improvement in health variables (e.g. VO_{2max}) with greater improvements for sedentary individuals. Therefore, the intensity of the exercise only serves to determine the duration required to achieve these benefits. For example, if a senior needed to expend 500 kcal to create a 50% improvement in a specific health variable, then they may have to exercise at a low intensity for 40 minutes per day. However, if the individual worked at a moderate intensity then it may only be necessary to be physically active for 15 to 20 minutes per day. Consequently, when improvements in health benefits are examined in terms of energy expenditure, instead of exercise intensity, it is plausible that differences would not be observed between the different intensity groups if the kcal expenditure was similar for all the subjects participating.

This finding could prove to be very important when prescribing physical activity for sedentary seniors. It suggests that seniors could begin physical activity programs at a lower intensity while still accumulating health benefits and potentially reducing the risk of the individual having a negative experience. For example, moderate to high intensity physical activity programs used in a sedentary senior population may cause local muscle fatigue or soreness as well as the individual may be unable to complete a prescribed program creating feelings of failure. Therefore, by designing more achievable programs it

could prevent the development of negative attitudes towards physical activity and thus resulting in higher compliance rates for regular physical activity. This regular physical activity could help maintain and improve VO_{2max}. This is important since small improvements in VO_{2max} can help maintain faster walking speeds, which in turn can increase levels of self-confidence as well as independence (Norgan, 1992).

Weight

Current research has shown that physical activity can be used to decrease body weight (Andersen, Wadden, Bartlett, Zemel, Verde & Franckowiak, 1999; Miller, Koceja & Hamilton, 1997). A recent study reported a significant decrease in weight in individuals participating in a 6-month study utilizing moderate intensity (50%-60% HRR) aerobic exercise (Dengel, Hagberg, Pratley, Rogus and Glodberg, 1998). The results indicate that weight decreased significantly over the duration of the present study. These findings corroborate the current view of the literature that physical activity can be used to decrease body weight. The present study also demonstrated that low intensity physical activity could be used as a method for reducing weight in a senior population. The results from the present study differ from the literature in that the previous focus has been on using moderate to vigorous levels of physical activity for weight reduction (Andersen et al., 1999; Dengel et al., 1998). Currently, the CDC and the ACSM promote a minimum of moderate intensity physical activity to achieve health benefits, for example weight loss (Mazzeo et al., 1998; Pate et al., 1995). The findings in this study could be important in helping to reduce the risk of CHD disease in the senior population through controlling

obesity/weight gain which are known modifiable risk factors for CHD (Powers & Dodd, 1996).

As part of the aging process a behavioral change occurs in reference to physical activity, specifically, physical activity decreases with increasing age. However, when examining physical activity levels in a senior population the duration of the activities being performed are often not taken into account possibly misrepresenting the seniors current physical activity level. If physical activity is decreasing it might result in weight gain, which could increase an individual's risk for CHD. Previous studies have shown that physical activity performed at a moderate to vigorous intensity could help reduce body weight (Andersen et al., 1999; Dengel et al., 1998). However, since physical activity levels tend to be low for most seniors, they may be unable to tolerate vigorous or even moderate intensity physical activity. Therefore, if weight can be controlled using low intensity physical activity it provides an alternate and more comfortable avenue for modifying this risk factor and preventing CHD.

TUGT Time

The TUGT test showed that the time required to complete the task decreased significantly between week 0 and week 18. These results are in support of recent studies on exercise intervention that showed significant decreases in the time required to complete the TUGT test (Okumiya et al., 1996; Davis, Ross, Prèston, Nevitt & Wasnich, 1998). However, the results from this study contradict reports by MacRae et al. (1996) who reported that a 22-week walking program had no significant effect on TUGT time. It is possible that the differences observed between the present study and MacRae et al.'s

(1996) are attributable to differences in the sample population used. The population used by MacRae et al. (1996) was comprised of older nursing home residents whereas the population used in this study was defined as independent community dwelling seniors. Using different populations could possibly affect the design of the intervention strategy, such as physical activity intensity. For example, the walking intervention used by the MacRae et al. (1996) was performed at a self-selected pace. Therefore it is possible that physical activity intensity used by each individual in the study was less than the low intensity (35%-45% predicted VO_{2max}) prescribed by the present study.

The inconsistency between the results of the present study and the one conducted by MacRae et al. (1996) highlight an important area that should be examined in future research, i.e. what is the minimum level of physical activity required to improve performance on the TUGT? The results of this study demonstrate that an intensity of 35% VO_{2max} was sufficient enough to cause significant improvements. Based on the description of the population used by MacRae et al. (1996) it could be assumed that the self-selected walking pace was at a much lower intensity than the intensity used in this study. This indicates that there is a minimum intensity requirement required to improve functional performance in the TUGT. Consequently, it is important to determine the minimum level of intensity necessary for older adults to improve their functional ability. The theory behind this rationale is that if the low intensity is all that is required to improve functional ability, there is no need to stress an individual beyond this intensity and possibly create negative attitudes towards physical activity. Also, in the case of sedentary seniors low or moderate intensity may be considered quite difficult and may

result in muscular soreness or adverse effects that would outweigh the potential benefits of the physical activity.

Cholesterol Level

Ferrara et al. (1997) reported that total cholesterol levels decreased with age, however, these decreases did not begin until approximately age 65 and 75, for males and females, respectively. The literature also indicated that as physical activity increases, a decrease in total cholesterol level could be expected (Wei et al., 1997; Franklin & Kahn, 1996). However, the changes in total cholesterol levels observed in the present study do not support the findings in the literature. The trend observed in this study was that the total cholesterol level significantly increased between week 0 and week 17, suggesting that low and moderate intensity physical activity do not improve cholesterol profile. This finding suggests that low and moderate intensity physical activity does not decrease total cholesterol levels. This view is supported by a study conducted by Stein et al. (1990) who reported that total cholesterol levels did not change significantly after a 12 week training program, even for those subjects exercising at 85% of there maximal heart rate.

Conversely, it is possible that the results observed both in this study and the study by Stein et al. (1990) were influenced by external factors that cancelled out the benefit that would normally result when physical activity levels are increased. One factor that could have influenced the results is the duration of the physical activity intervention, 12-weeks in the study by Stein et al. (1990) and 16-weeks for this study. Previous studies that have shown improvement in cholesterol profile have been of a longer duration (Wei et al., 1997). Therefore, it is possible that neither of these studies was sufficient in

duration to observe a beneficial effect. Also, cholesterol level is directly influenced, by diet, specifically the amount fat being consumed on a daily basis. Since neither of these studies controlled for diet it is possible that the subjects changed their nutritional habits, which in turn negatively affected their total cholesterol level. The results from this study appear to support this view, since total cholesterol level significantly increased over the course of the study. Also, it is necessary for an individual to fast for 12 to 14 hours prior to having a cholesterol test performed. If the individual did not fast long enough, it is possible that any food consumed within this time period would affect the results of the test. However, it is improbable that this is the sole cause of the results observed since it is quite doubtful that most of the subjects forgot to fast. However, it is possible that some combination of diet and measurement error resulted in the trend observed.

Physical Activity Levels

The PASE questionnaire was used to determine the individual's physical activity level during week 0 and week 17 of the study. It was expected that these values would be approximately the same pre and post intervention. Even though there was no significant difference between PASE scores from week 0 and week 17, examination of the main effects plot (Appendix P) indicate that physical activity levels did increase over time. As well, the descriptive statistics (Table 8) indicated that there was a large non-significant difference in PASE scores between the 2 groups. This difference is most likely result of the 4 participants dropping out of the study. Based on an equal distribution of activity levels (low/high) in each group at the beginning of the study the drop out of these subjects from the groups skewed the calculated mean. The small increase in activity over

time was expected since the intervention directly changed the answer to question number 2 of the PASE questionnaire 'How often did you take a walk?' (Appendix D).

It was anticipated that physical activity patterns might change over the course of the study, since the study was conducted during the summer months when most individuals are more active. Therefore, in an attempt to determine if an individual's physical activity level was influenced by anything other than the physical activity intervention each subject was given an activity diary. The intent of the diaries was to record all physical activities outside of the physical activity intervention sessions. Along with the diaries each subject was also given a copy of Borg's RPE scale to rate the intensity of their activity. However, the subjects in the study experienced difficulty in completing the diaries and using the RPE scale even after numerous attempts to explain it. As a result most diaries only included walking activity and or just the activity performed during the intervention sessions (e.g. stretching, warm-up, cool-down). Therefore, the diaries provided little information about the subject's activity patterns during the study.

In retrospect the use of such tools to monitor physical activity in a senior population may be good in theory, however it may not be practical for a number reasons. The primary reason being the inconvenience created by requiring the individual to write every physical activity performed in a diary. Even for a younger age group this is a daunting task, even without having to worry about memory loss, the motor coordination required for writing as well as possible vision problems. A possible solution to this problem would have been to complete 24-hour physical activity recall with the aid of the researcher. This would have needed to be conducted on a daily basis. Using this method

could have provided more accurate information, however was not practical for this study based on the intervention duration.

Finally, even though the PASE questionnaire was designed for a senior population it appears that its use may be quite limited. Specifically, questions 4 through 6 may not be relevant to this sample population and probably as well as to most seniors over the age of 70 due to the types of activities in question. Scoring zero on these 4 questions decreases the subject's PASE score creating the appearance of a high level of inactivity. In the future, it would be better to use a questionnaire that determined physical activity levels based on ADLs and IADLs. These activities would reflect the physical activity level of this population much better than questions aimed at sport or resistance type activities.

Systolic and Diastolic Blood Pressure

Both the main effects plots for systolic and diastolic blood pressure indicate a decreasing trend with time. Even though the observed decreases in blood pressure were not statistically significant, it appears that the physical activity intervention had a minimal positive effect. However, with the absence of a control group it is impossible to determine if the decreases observed were the result of the physical activity or an influence external to the study. These trends support the current literature (Mazzeo et al., 1998), which suggests light to moderate activity is effective in lowering blood pressure in hypertensive adults.

It is possible that a significant decrease in blood pressure was not observed since all the subjects were not considered hypertensive. However, those subjects considered hypertensive by their physicians were taking some form of blood pressure medication. It

is possible that this medication had a masking effect on the benefits of physical activity. As well, several subjects had their blood pressure medication increased during the course of the study, which could also have caused the decreasing trend observed for blood pressure. Therefore caution should be exercised when interpreting the main effects plots for blood pressure.

Resting Heart Rate

Resting heart rate has been shown to be inversely associated with total physical activity (Bijnen, Feskens, Caspersen, Giampaoli, Nissinen, Menotti, Mosterd & Kromhout, 1996). Furthermore, research evidence indicates that endurance type activities can be used to decrease resting heart rate (Schuit, Dekker, de Vegt, Verheij, Rijneke & Schouten, 1998). For example, Bowman, Clayton, Murray, Reed, Subhan and Ford (1997) showed that elderly individuals who participated regularly in endurance type activities had lower resting heart rates than sedentary elderly individuals. Therefore, it was expected that the physical activity intervention used in this study would result in a decrease in resting heart rate. The trend observed reveals that resting heart rate (RHR) decreased during the first nine weeks of the study and then increased over the last nine weeks (Appendix P). Nevertheless, the RHR value at week 17 was lower than the value during week 0 representing an overall decreasing trend.

It should be noted that the changes observed in resting heart rate were not statistically significant. It is possible that significant changes in RHR did not occur as a result of pharmaceutical involvement. Many of the subjects participating in the study were using either beta-blocker or calcium channel blockers to suppress heart rate.

Therefore, any health benefits obtained as the result of physical activity may have been masked by the medication being used. Additionally, the slight increase in resting heart rate may be attributable to changes in the dosage of the medications being taken while participating in the study.

Waist Girth

The results indicated that waist girth did not change significantly with respect to time, however the graphical representation of this data highlights an interesting trend (Appendix P). Based on the experimental outcomes outlined in the introduction it was expected that waist girth would decrease over the 16-week intervention period. However, the opposite trend was observed in the main effects plot, waist girth actually increased from week 0 to week 17. The literature indicates that an increase in kilocalorie expenditure/physical activity should have resulted in a decrease in waist circumference or the measurement should have remained the same. One study has reported that endurance training resulted in a 25% decrease in intra-abdominal fat (Schwartz, Shuman, Larson, Cain, Fellingham, Beard, Kahn, Stratton, Cerqueria & Abrass, 1991). A decrease of this magnitude should be visible as a decrease in waist girth, since waist girth has been cited as an indicator of visceral adiposity (Després, 1992).

There are several possible explanations for the observed trend, such as changes in diet and or measurement error. Firstly, this study did not account for diet and it is possible that with an increase in physical activity the subject's altered their diet and increased their food intake. As well, there may have been a seasonal effect on their diet. The study was conducted during the summer months (May to September), which may

have resulted in a different type of diet or a greater consumption of food. Finally, measurement error could account for the differences observed in waist girth. The measurement was chosen specifically because it was a noninvasive measure of body composition. In order to ensure the comfort level of the subject, waist girth was measured over the subject's clothing at the level of the bottom rib. It is possible that difference thickness of clothing could account for the differences in measurements to some degree. Overall, it is plausible some combination of these events is responsible for the trend observed.

Finally, it is interesting to note that waist girth increased during the intervention period, but weight decreased significantly between week 0 and week 17. One possible explanation for this is that the weight lost during the study was a combination of adipose tissue and muscle mass. As well, adipose tissue may have decreased in the extremities and not in the trunk region. This is conceivable since the majority of women tend to deposit adipose tissue in the lower extremities in comparison to men who are more likely to store adipose tissue in the trunk region. Since the study utilized a larger number of female subjects (75%) it is plausible that body composition changes occurred in the extremities and not the trunk region.

Questionnaire Trends

The results revealed that there was no significant effect on GDS or GARS scores for exercise intensity (group) or time.

The results from the GDS questionnaires administered during week 0 indicate that the average score was 2.3 and 2.2 for groups 1 and 2, respectively. Gallo et al. (1995)

state that scores of 5 or greater on the short form may indicate depression. Therefore, based on the scores from the initial questionnaires it appears that none of the subjects participating in the study were suffering from depression. If an individual was not depressed at the onset of the study it is not likely that the physical activity intervention would have any effect on this variable. Therefore, the trend observed in the main effects plot was possibly the result of mathematical averaging and truly does not represent a decrease in depression over time.

Even though there was no evidence of depression in the sample population it is possible that physical activity had a protective effect on mental health. Since, an increase in depression between week 0 and week 17 was not observed and the main effects plot (Appendix P) indicated a slight decrease in GDS scores over the 16-week intervention period it is possible that the physical activity helped the seniors maintain their current mental state. An alternate explanation would be that the regular physical activity prevented the seniors participating in the study from developing depression or depressive symptoms. This theory is partially supported by the findings of McNeil, LeBlanc and Joyner (1991) who found that walking and social contact were effective in reducing levels of depression as well as depressive symptoms. The findings from the present study suggest that physical activity may have some type of protective effect on the individual in respect to the development of depression. However, to investigate this effect fully it would have been necessary to employ a control group in the present study as well as study the effects of social interaction on mental health.

In reference to the experimental outcomes it was expected that physical activity would have a positive influence on functional ability resulting in a decreased GARS

score. However, this trend was not observed (Appendix P). Both the average score for week 0 and week 17 were the same with the average score during week 9 being marginally higher. These values did not differ significantly from one another.

The lowest score that can be achieved on the GARS is 18, which represents a fully functional individual (Kempen et al., 1996). Examination of the mean scores from week 0 for group 1 (mean = 18) and group 2 (mean = 19.4) indicate that none of the individuals were classified as functionally impaired. Therefore, it was not possible to observe any changes in the scores unless the individual's functional capability decreased with the intervention.

A slight decrease in functional ability was observed at the midpoint assessment (week 9). However, the value was only slightly higher than the values observed during the week 0 and week 17 assessments. This non-significant increase in score could easily be the result of a minor illness or injury that was affecting the individual at the time they completed the questionnaire.

Trigylcerides, LDL and HDL Levels

It was expected that trigylcerides and LDL levels would decrease significantly over time as a result of the physical activity intervention. However, even though a decreasing trend was observed (Appendix P) for the triglyceride levels, differences between the pre (week 0) and post (week 17) means were not significant. The same non-significant trend was observed for LDL levels as well (Appendix P). Research by Haskell (1994) has shown that LDL and triglyceride levels exhibit an inverse relationship with physical activity. Therefore, as physical activity increases a reduction in triglyceride and

LDL levels should be observed. As well, the dose-response relationship indicates that expending 300 kcal per week above baseline (based on 100 kcal expenditure per session, Table 5) should theoretically result in an approximate improvement of 30-35% for triglyceride profile (Canadian Society for Exercise Physiology, 1996). However, an improvement of this magnitude was not observed for either LDL or triglyceride profiles, but the trend for each variable did move in a positive direction.

Woolf-May, Kearney, Jones, Davison, Coleman and Bird (1998) support the findings of the present study, in reference to the LDL profile. In their study individuals participated in an 18-week walking program and the effect of this activity on LDL profile was examined. The results revealed a decreasing trend for LDL level, but it was non-significant. Based on this finding it is not surprising that the trend observed in this study was not significant, especially since the study by Woolf-May et al. (1998) was 2-weeks longer in duration and used higher slightly higher exercise intensities.

The relationship with HDL is positive, meaning that increases in physical activity resulted in an increased level of HDL (Haskell, 1994). Therefore, it was expected that HDL profile would increase significantly as a result of the intervention. A recent study conducted by Spate-Douglas and Keyser (1999) revealed that moderate intensity walking (60% HRR) was an adequate mode of activity for improving the HDL profile. As well, Young and Steinhardt (1995) revealed that a change in VO_{2max} should increase HDL levels in both males and females. Therefore, since VO_{2max} increased significantly in this study, a significant change in HDL profile appeared plausible. However, the trend observed in this study indicated that a very slight increase HDL levels had occurred, however the results were not significant ($\alpha = 0.05$, $p = 0.596$). The slight increase in

HDL levels supports the dose-response theory (Haskell, 1994), but the lack of a significant change is dissimilar to the findings of Spate et al. (1999) and Young and Steinhardt (1995).

The relationship between HDL and physical activity is more complex than it initially appears. The dose-response categorizes the improvements in HDL that occur as a result of physical activity as a delayed response. This means that kilocalorie expenditure has to be substantially increased before a minor improvement in HDL level is realized (Bouchard et al., 1994). Based on this theory it is unlikely that any significant changes in HDL would have been observed since the overall kilocalorie expenditure per week for each subject was only 300 kcal/week or less. Based on the dose-response graph an increase of 500 kcal/week above baseline would only result in approximately a 10% improvement in HDL profile (Bouchard et al., 1994).

Although the results were non-significant for the three variables (trigylcerides, LDL and HDL) the trends moved in the directions observed in previous research. This in itself suggests that the physical activity intervention did have some effect on these variables even if it was not significant. It should also be noted, that even though lipoprotein profiles did not improve they did not become any worse. This may indicate that the physical activity intervention played a role in maintaining the current lipoprotein profile. This would offer some protection from disease since profiles are not deteriorating, meaning the risk of disease is remaining constant and not increasing. This theoretical protection would apply to those individuals whose lipoprotein profile placed them in low to moderate risk categories. However, this theoretical effect would not apply

to those individuals with lipoprotein profiles at the extreme end of the lipoprotein spectrum since they are already at extreme risk of having a cardiac incident.

The non-significance observed in this study may have been a direct result of the duration of the intervention. It is possible that if the intervention had been longer in duration that a significant difference would have been observed between the pre and post values for both triglyceride and LDL profiles. It is also possible that a greater increase HDL would have been observed with a longer duration study, however, based on the research of Bouchard et al. (1994) it is still possible a significant difference would not be seen unless kilocalorie expenditure was greatly increased.

Self Reported Evidence

During and after the 16-week physical activity intervention the subjects often provided opinions on how they felt the study was progressing. For example, many subjects reported that since they began the regular physical activity program that they were able to perform certain tasks better, such as being able to climb stairs with less difficulty and being able to rise from a seated position with greater ease. As well, several subjects stated that they were now able to walk greater distances without having to stop and rest. These self-reports are supported by quantitative evidence from the TUGT and predicted VO_{2max} tests. Since significant improvements were observed in both variables it was expected that the subjects would have experiences, such as the ones previously mentioned.

Finally, several subjects reported that their range of motion at certain joints increased. For example, one subject required a chair to stretch their quadriceps at the

onset of the study because they could not bend their leg enough to reach their ankle. However, by the midpoint of the study the individual's range of motion had increased enough that they could now grasp their ankle to stretch. Even though flexibility and range of motion were not variables examined by this study it is still important to note the potential benefits of regular physical activity on this variable.

Also, these perceptions of physiological improvement possibly played a strong role in motivating the subjects to attend the physical activity sessions. Since the subjects could visibly observe improvements in their health they may have become more interested in the physical activity and therefore facilitated their health benefits through adherence to the physical activity program. In future studies it would be beneficial to perform some qualitative research (group or participant interviews) to determine the specific role of perceived physiological improvement as a motivator for physical activity. As well, future studies should also consider studying the impact of perceived changes on self-efficacy or life satisfaction with increasing physical activity.

Data Analysis

Model adequacy checks performed as part of the data analysis revealed that several of the assumptions associated with the analysis of variance were violated for the model used to analyze triglyceride levels (Figures 9 and 10). At the time of the analysis several variance stabilizing transformations were applied, but with little effect. The next option would have been to remove the outlier and observe what affect it had on the assumptions. However, since the sample size for the study was small ($n = 8$) it was

decided that it was more important to have the outlier as part of the data set rather than remove from it.

The outward coning distribution seen in figure 8 could be attributed to the large decrease observed in subject 8's triglyceride level, 5.2 mmol/l to 1.72 mmol/l. It is possible that this two-fold decrease was what caused the increased variance at the one end of the residual verses fitted value plot. This large change in triglyceride profile might have been the result of lipid reducing medication being used by the subject. As well, during the course of the study the subject's type and dosage medication changed several times and it is possible that this change might have been partially responsible for the large decrease in triglyceride level. Since changing prescriptions did not violate any rules of the study and since it could not be proven that the decrease was not the result of the physical activity intervention, there was no valid reason to remove the outlier from the sample population.

However, by retaining subject 8's data it is necessary to explain why this individual differed so greatly from the other 7 subjects. One reason for such a large difference is the sample size itself. It is possible that this small sample does not accurately represent the true variance that exists between individuals for triglyceride levels. Therefore, it is possible that if a larger sample size was used, there would be greater overall variance and these results would not appear any different than the rest. An alternate explanation is that some combination of external variables that was not present in the other subjects caused the change. As mentioned above the new medication may have played some role in combination with the physical activity. As well, it is possible that the subject made modifications to their diet, which could have contributed to

decreasing triglyceride levels. An alternate explanation would be that the subjects did not fast for the first measurement, but did for the second. As mentioned in reference to total cholesterol, not fasting for 12 to 14 hours would have an effect on lipoprotein profile.

In considering the type of analysis used in the present study it is important to mention that there is the possibility that a type II error occurred. A type II error is when H_0 is accepted when it should have been rejected, in other words the analysis indicated that there was no significant difference between the treatment means when there actually was. The possibility of a type II error should be considered when examining group effect results as well as the results from the trial effects.

It should also be noted that regression to the mean may explain some of the effects observed in the present study. This theory states that every time a sample is taken from a population, the closer the measured value will be to the population mean. Therefore, the possibility exists that the trends and differences observed are the result of regression to the mean and to the physical activity intervention.

Sample Size

This study utilized a sample of convenience, which was obtained through a series of advertisement campaigns. By selecting a sample population using this method a certain bias was introduced into the study, suggesting that only specific types of people respond to these types of advertisements.

Haskell (1994) as well as Blair and Connelly (1996) state that those individuals that are sedentary and begin a regular activity program realize the greatest health benefits. Based on this theory, it was the intention of this study to recruit mainly sedentary seniors.

By selecting a sedentary population it was more likely that significant changes in the variables would occur over the relatively short duration (16-week intervention) of the study. However, the individuals that responded to the advertisements tended to be already active to some degree. As a result the population used in this study was more active than anticipated. Therefore, it decreased the likelihood that significant changes would be observed in all the variables.

Initially, the exclusion criteria for the study were quite rigorous. There were restrictions in regards to mental state, physiological state and pharmaceutical interventions. However, it was necessary to decrease many of the pharmaceutical criteria in order to obtain a sample population. Specifically, individuals were allowed to participate in the program, even if taking contraindicated medication, as long as their heart rate responded to exercise. All the subjects that participated in the study met this criterion, however the medications being taken may have had a pronounced effect on several of the variables being measured (systolic and diastolic blood pressure and resting heart rate). Since some individuals were on medication to suppress heart rate and or blood pressure, it was impossible to obtain a true resting value. Therefore, all results were compared to artificial base lines, which were regulated by the individual's medication. It is possible that several of these variables may have displayed significant changes if the pharmaceutical intervention was removed or if a population free of medication had been used.

Limitations

There were several limitations that were associated with this study, which included sample size, lack of a control group, seasonal effects, and lack of dietary control.

The primary limitation of this study was the sample size (n = 8), which possibly limited the results as well as the power of the statistical analysis. Of the 14 variables examined only four changed significantly over the course of the study. It is possible that increasing sample size would have increased the number of variables that changed significantly.

The problem of recruiting senior participants is long-term exercise intervention studies is often difficult. A paper published by Halbert, Silagy, Finucane, Wither and Hamdorf (1999) described a recruitment technique used for a study examining exercise training in a senior population. This technique involved sending 2878 letters to potential participants of which 913 agreed to attend a prescreening appointment. Prescreening further reduced the potential sample to 351 of which 299 agreed to participate in the study. These numbers indicate that approximately one out of every ten individuals initially contacted agreed to participate in the study (Halbert et al., 1999). According to this information it would have been necessary to contact approximately 250 individuals to find 25. This calculation is based on one out of every ten individuals wanting to participate and does not take into account initial reply to the invitation or the percentage of individuals that would not meet inclusion criteria. As well, the recruitment effort described by Halbert et al. (1999) took approximately 15 weeks and was conducted over a large geographic area. As a result of the timelines associated with this study and the

geographic region it was conducted in it would not have been possible to use the type of recruitment strategy detailed above.

The lack of a control group prevented the results from being compared to a baseline. In the case of many of the variables examined in this study the trends would have been more meaningful if it had been possible to compare them to a control group. The lack of a control limits what can be inferred from the findings. Since most of the subjects participating were on some type of heart medication a control group might have aided in determining the true effect of the physical activity intervention on several of the variables. If a control group had been used that mimicked the active population in terms of medication it would have been possible to determine specifically what proportion of the effects were the result of the physical activity intervention and the pharmaceutical intervention.

The summer season can also be considered a limitation of this study for several reasons. It is widely recognized that activity levels tend to be higher during the summer months than during the winter months. It is possible that a seasonal increase in physical activity might have had some effect on the variables of interest. Since the activity diaries were not completed correctly it was impossible to determine what, if any effect, season had on activity levels. In addition, the summer season had a direct impact on the recruitment phase of study. Many individuals who expressed interest in the program were unwilling to commit to a 16-week program that ran through the entire summer. However, from these initial meetings it was evident that if the program had been run in the fall or the winter the recruitment phase would have generated larger numbers.

The final factor that possibly limited this study, particularly the interpretation of the blood lipoprotein results, is that diet was not controlled or monitored. Since many of the variables can be affected by both physical activity and diet it is difficult to determine what caused the effects observed in this study. For this study, it was assumed that diet remained relatively constant throughout the intervention phase and any changes seen in the 14 variables were the result of an increase in physical activity. However, several of the results seem to indicate that this assumption was violated, the significant increase in total cholesterol levels and the increasing trend observed for waist girth. These observed changes most likely reflect an increase in caloric intake as well as an increase in fat concentration in the foods being consumed.

Based on the duration of the study and the sample size expected (n = 25) it was decided not to use dietary recall forms. This decision resulted in having to make assumptions about the subject's diets, but after reviewing the activity diaries, it is conceivable that the subjects would have had as much difficulty completing dietary recall forms accurately. If these forms were not accurate they would have provided little useful information.

Recommendations

From this study several points can be highlighted as important suggestions for future research.

One recommendation not based on the limitations, deals with group size and physical activity compliance. Upon completion of the physical activity intervention the subjects underwent an informal debriefing. From this session it was disclosed that all the

individuals especially liked the size of the group. They felt that the size had provided enough diversity, but had allowed them to get to know one another and form friendships. In a sense it was as if a small social club had been formed. As a result of this social interaction, the individuals viewed the intervention sessions as fun and not as a form of exercise. Based on these comments it may be appropriate to utilize multiple small experimental groups (8-12 participants) instead of two or three larger experimental groups in future intervention studies involving seniors. Constructing small groups may increase the cohesiveness of the group as well as increase adherence to the program.

Currently, the participants of this study no longer meet as a group to walk. However, all the participants report that they are still walking on a regular basis and three of the participants have since joined another walking club being offered by the Northwood Community Center. As well, several participants that live in the same area meet and walk together on an occasional basis.

Additionally, the theme of trying to walk across Canada also appeared to strengthen group cohesion as well as increase exercise compliance. For this task the subjects worked as a group, not on an individual basis. This was done to create a goal without creating a competitive situation. Therefore, it is recommended that when designing physical activity interventions a 'fun goal' should be established rather than requiring the individuals to work toward completing a set number of minutes or repetitions.

As previously mentioned in the limitation section future studies should consider employing the use of a control group as well as performing some type of dietary analysis. It is also recommended that extracurricular physical activity be monitored throughout the

course of intervention studies. The present study attempted to do this using activity diaries, which turned out to be problematic, indicating that a better monitoring method is needed to accomplish this goal. It is suggested that physical activity questionnaires administered at regular intervals may provide a suitable answer to this problem. If an individual's physical activity level does not change then the scores should remain relatively constant over time. It may also be possible to monitor weekly activity levels using accelerometers. Depending on the accelerometer it may be possible to gather information on both the intensity of the activities as well as overall kcal expenditure. However, these devices are expensive and may not be practical for studies employing a large sample population.

As highlighted in the discussion there were several confounding variables that existed within the present study such as diet, seasonal effect, drug interventions and physical activity patterns. It is possible that these variables may have influenced the trends and results observed in this study. For example, if a participant increased their physical activity outside of the intervention it could facilitate an increase in health benefits. As well, a change in diet could have had a positive or negative impact on the health benefits such as weight or waist girth. For example, if a participant increased the fat content of their diet this may negate or decrease any positive effect that physical activity would have on blood lipids. Medication may have also played an effect by either masking improvements in specific variables (blood pressure, heart rate, lipoproteins) or producing artificial results (decreasing or increasing trends). Finally, the summer season might have produced changes in physical activity and diet patterns, which in turn might have affected the results. It should also be noted that there may have been other

confounding variables not examined by this study, but which might have affected the results, such as sociodemographic factors. In the future it may advantageous to collect sociodemographic data to help explain the results.

Conclusions

Caution should be taken when interpreting the results from the present study given the small sample size and its corresponding low statistical power. However, the results from the present study appear to suggest that there were no significant differences in health outcome measures for the senior participants using different physical activity intensities. This study suggested that the participants who used low intensity physical activity improved their health profile to the same degree as those participants who participated in moderate intensity physical activity. As well, the study indicated that low intensity physical activity significantly improved body composition, predicted VO_{2max} and TUGT time in a senior population. For some variables low intensity may not have been great enough to create significant improvements in the short duration of this study, but it did begin to enhance their current level of health. However, since the sample size was small (n=8) the findings cannot be generalized to the general senior population.

The study also suggests that it might be important to consider the role of energy expenditure when prescribing physical activity for seniors. It is possible that the lack of difference between the different intensity groups was the result of equating energy expenditure between the participants. This suggests that when prescribing physical activity it may be necessary to determine the energy expenditure required to observe a specific level of improvement in a given health variable before determining the intensity

and the duration of the activity. Once energy expenditure has been determined an intensity for the physical activity can be chosen based on the senior's current fitness level. The intensity will then determine the amount (duration) of physical activity required on a daily basis. However, more research is required in this area before any recommendations can be made.

This study also revealed that the benefits observed for moderate intensity, defined as 50% to 60% of heart rate reserve, were similar to the findings of other research examining the effects of different exercise intensity on various outcomes. This suggests that lower values of heart rate reserve can possibly be used when prescribing physical activity for seniors without sacrificing potential benefits.

After examining the results from the present study and those from the literature it is plausible to suggest that low intensity physical activity may play a role in maintaining or improving physiological characteristics, functional ability, psychological well-being. as well the reduction of selected CHD risk factors. At a minimum, the results of this study suggest that the idea of using low intensity physical activity should be further explored in future research.

Appendix A

Subject Recruitment Advertisement

NEW at Northwood

Are you interested in starting a physical activity program or increasing your physical activity?

If the answer is yes,

Come join the ***NEW*** walking club and participate in a research study.

What is in it for you?

- A great social experience
- Have your blood pressure checked.
- You can find out what your cholesterol level is.
- Supervised activity sessions where you can ask questions.

If you want to know more or want to participate please contact

Scott Grandy Call **494-1243**
or **454-2293** and leave a message.

NEW

Seniors Walking Club

If you are,

- 65 years of age or older.
- Not active or describe your physical activity level as low to moderate.
- Are interested in starting a physical activity program or increasing your physical activity.

Then you are invited to participate in research study examining the health benefits associated with a regular walking program.

What is in it for you?

- A great social experience
- Have your blood pressure regularly checked.
- You can find out what your cholesterol level is.
- Supervised activity sessions where you can ask questions.

If you want to know more or want to participate please contact

Scott Grandy at **494-1243** or **454-2293** and leave a message

Appendix B

Mini Mental State Examination

Standardized Mini-Mental State Examination (SMMSE)

Education: _____
Occupation: _____

Establish rapport.
Ask each question a maximum of 3 times. If no response, score 0.
Do not hint or give physical cues (e.g. head shaking, etc.)

	score (value)
1. *Allow 10 seconds for each reply*	
a) **WHAT YEAR IS THIS?**	
Accept exact answer only	_____ (1)
b) **WHAT SEASON IS THIS?**	
During last week of old season or first week of new season, Accept either season.	_____ (1)
c) **WHAT MONTH IS THIS?**	
On the first day of a new month, or last day of a previous month, Accept either month.	_____ (1)
d) **WHAT IS TODAY'S DATE?**	
Accept previous or next date, e.g. on the 7th accept the 6th or 8th	_____ (1)
e) **WHAT DAY OF THE WEEK IS THIS?**	
Accept exact answer only	_____ (1)
2. ***Allow 10 seconds for each reply***	
a) **WHAT COUNTRY ARE WE IN?**	
Accept exact answer only	_____ (1)
b) **WHAT PROVINCE ARE WE IN?**	
Accept exact answer only	_____ (1)
c) **WHAT CITY ARE WE IN?**	
Accept exact answer only	_____ (1)
d) **WHAT IS THE NAME OF THIS HOSPITAL?**	
Accept exact answer only	_____ (1)
e) **WHAT FLOOR ARE WE ON NOW?**	
Accept exact answer only	_____ (1)

3. I AM GOING TO NAME 3 OBJECTS. AFTER I HAVE SAID ALL 3 OBJECTS, I WANT YOU TO REPEAT THEM. REMEMBER WHAT THEY ARE BECAUSE I AM GOING TO ASK YOU TO NAME THEM AGAIN IN A FEW MINUTES.

BALL CAR MAN
Say them slowly at approximately 1 second intervals

PLEASE REPEAT THE 3 ITEMS
score 1 point for each correct reply on the first attempt; if not all 3 items are repeated, repeat until they are learned or to a maximum of 5 times _____ (3)

4. SPELL THE WORD "WORLD"
help with the correct spelling if necessary

NOW SPELL IT BACKWARDS PLEASE
allow 30 seconds to spell backwards; see guide for scoring

note: serial sevens (counting backwards from 100 by 7's five times) may be used instead of spelling world backwards, but this must be decided beforehand. i.e. if the subject is not able to do one task, do not use the other task

5. NOW WHAT WERE THE 3 OBJECTS I ASKED YOU TO REMEMBER?
score 1 point for each correct response regardless of order

6. WHAT IS THIS CALLED?
show wristwatch; accept wristwatch or watch, not clock, time, etc.

7. WHAT IS THIS CALLED?
show pencil; accept pencil only; score 0 for pen.

8. REPEAT THIS PHRASE AFTER ME: "NO IFS ANDS OR BUTS"
allow 10 seconds for response; repetition must be exact

9. *show enlarged command* CLOSE YOUR EYES
READ THE WORDS ON THIS PAGE AND DO WHAT IT SAYS
if the subject just reads and does not close eye, then repeat original instructions to a maximum of three; allow 10 seconds; score 1 point only if subject closes eyes; subject does not have to read aloud

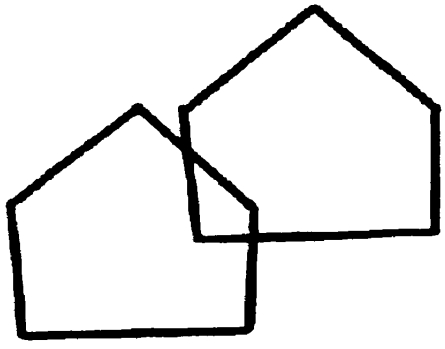
10. *ask the subject if right or left handed; if subject is right handed say "Take this piece of paper in your left hand..."; take piece of paper, hold it up in front of the subject*
TAKE THIS PIECE OF PAPER IN YOUR RIGHT/LEFT HAND, FOLD PAPER IN HALF ONCE WITH BOTH HANDS, AND PUT THE PAPER DOWN ON THE FLOOR
allow 30 seconds; score 1 point for each instruction executed

11. *hand subject a pencil and page 3 of this form*
WRITE ANY COMPLETE SENTENCE ON THIS LINE
allow 30 seconds; the sentence should make sense; ignore spelling errors

12. *place enlarged 5 sided design, pencil, eraser and paper in front of the subject*
COPY THIS DESIGN PLEASE
allow multiple tries until subject is finished and hands it back; there must be a 4 sided figure between the two 5 sided figure; maximum time - 1 minute; see scoring guide.

WRITE SENTENCE BELOW

COPY DESIGN BELOW



SUMMARY

TOTAL SCORE _____ (30)

CATEGORY OF MENTAL STATUS

_____ normal range (24-30)

_____ mild cognitive impairment (20-23)

_____ moderate cognitive impairment (11-19)

_____ severe cognitive impairment (0-10)

COMMENTS:

TIME OF DAY:

DATE:

NAME OF EXAMINER/DEPARTMENT:

Note: the Standardized Mini-Mental State Examination was developed by Dr. William Molloy at the Ottawa Civic Hospital in Ontario.

Appendix C

Informed Consent

Informed Consent

You are invited to take part in a research study that will help determine the health benefits that can be obtained by participating in a walking program. Research has shown that physical activity can reduce the risk of cardiovascular disease, improve performance of activities of daily living as well as have a positive effect on psychological well-being. The purpose of this study is to determine if these benefits can be obtained by using low and moderate intensity walking programs. The study will be conducted by Scott Grandy (MSc student) and Dr. Phil Campagna from the School of Health and Human Performance, Dalhousie University.

The following study consists of two parts, a prescreening session and an exercise and testing session. You will not be able to take part in phase two of the study if you do not meet the prescreening criteria.

PART 1 - Prescreening:

All potential subjects will be screened by their family physician or a physician employed by the study before being allowed to participate in the exercise and testing phase of the study. This screening will include completing an informed consent form, completing the Mini-Mental State Examination and a medical screening. If you meet the study criteria, you will proceed to the exercise and testing portion of the study. If you do not meet the criteria, you will be unable to participate in the second part of the study.

PART 2:

This part of the study will be conducted over an 18 week period an will consist of both exercise sessions and testing sessions. As a participant you will be required to attend 3 exercise sessions per week and keep a daily journal of your physical activity.

Tentative Schedule

- Testing Session 1 (Week 1) - 12 minute walk test, Physical Activity Scale for the Elderly, blood analysis, height, weight, waist girth, timed 'Get up & go', blood pressure, heart rate, Groningen Activity Restriction Scale, Geriatric Depression Survey.
- Testing Session 2 (Week 2) - Height, weight, waist girth, timed 'Get up & go', blood pressure, heart rate, Groningen Activity Restriction Scale, Geriatric Depression Survey.
- Testing Session 3 (Week 18) - 12 minute walk test, Physical Activity Scale for the Elderly, blood analysis, height, weight, waist girth, timed 'Get up & go', blood pressure, heart rate, Groningen Activity Restriction Scale, Geriatric Depression Survey.

The blood analysis will require you to fast for 12 hours before having the blood drawn. Your blood will then be analyzed for high density lipoproteins, low density lipoproteins, total cholesterol and total triglycerides.

The risk associated with this study is minimal. However, performing physical activity may result in localized muscle fatigue and/or soreness, primarily in the legs, that could last up to several days. It may also cause

abnormal changes in blood pressure and/or heart rate, which could cause nausea, dizziness or lead to fainting. In case of and emergency the researcher and the research assistants are CPR and first aid certified.

It is anticipated that participating in the study will help increase your weekly activity level, which can help improve your health. As well, your blood pressure will be monitored on a weekly basis and your cholesterol level will be determined at the beginning and end of the study.
If at any time you feel uncomfortable completing any questionnaire or answering a particular question you have the right to stop or skip that particular question.

You, as the participant have the right to withdraw from the study and/or have your results removed from the study, without penalty, at any point in time. You have the right to be fully informed about the study and the procedure and if something is not clear, to have it clarified or further explained. You have the right to ask questions, before, during and after the study is complete.

It is your obligation, as a participant, to answer the researcher's questions truthfully. It is also your obligation to immediately notify the researcher or the research assistants if you experience any pain or discomfort during any of the training or testing sessions.

The researcher retains the right to stop the training sessions and or remove you from the study if he feels it may be hazardous to your health.

I, the undersigned, have read the above and understand the testing procedure as well as my rights and responsibilities. I understand the risks involved with the study and hereby give my consent to participate in this study. I understand that all the results will remain confidential and my identity will not be revealed under any circumstances. I also consent to release the data collected for academic and publication purposes as long as anonymity is maintained.

Name: _____ Date: _____
(Please print)

Signature: _____

Witness: _____ Date: _____

If there are any questions please contact one of the following individuals:

Scott Grandy	(W) 494 - 1243 or (H) 454 - 2293
Dr. Phil Campagna	(W) 494 - 1145

Appendix D

PASE Sample Question

Sample Question

Please complete the following questionnaire by either circling the correct response or filling in the blank. Here is an example:

Over the past 7 days, how often did you walk outside your home or yard for any reason? For example, for fun or exercise, walking to work, walking the dog, etc.?

[0.] NEVER [1.] SELDOM (1-2 DAYS) [2.] SOMETIMES (3-4 DAYS) [3.] OFTEN (5-7 DAYS)

↓

GO TO NEXT QUESTION

2a. On average, how many hours per day did you spend walking?

_____

[1.] LESS THAN 1 HOUR [2.] 1 BUT LESS THAN 2 HOURS

[3.] 2-4 HOURS [4.] MORE THAN 4 HOURS

Answer all items as accurately as possible. All information is strictly confidential.

Appendix E

Groningen Activity Restriction Scale

Groningen Activity Restriction Scale (GARS)

The following questions refer to daily activities which should be performed frequently. In each question it is asked whether you *are able to perform* the activity at this moment. It is not attended to assess whether you are actually performing the activities, but if you can do them if necessary.

Response categories for each item
1) Yes, I can do it fully independently without any difficulty.
2) Yes, I can do it fully independently, but with some difficulty.
3) Yes, I can do it fully independently, but with great difficulty.
4) No, I cannot do it fully independently, I can only do it with someone's help.

GARS items
1. Can you, fully independently, dress yourself?
2. Can you, fully independently, get in and out of bed?
3. Can you, fully independently, stand up from sitting in a chair?
4. Can you, fully independently, wash your face and hands?
5. Can you, fully independently, wash and dry your whole body?
6. Can you, fully independently, get on and off the toilet?
7. Can you, fully independently, feed yourself?
8. Can you, fully independently, get around in the house?
9. Can you, fully independently, go up and down stairs?
10. Can you, fully independently, walk outdoors? (if necessary with a cane)?
11. Can you, fully independently, take care of your feet and toenails?
12. Can you, fully independently, prepare breakfast or lunch?
13. Can you, fully independently, prepare dinner?
14. Can you, fully independently, do "light" household activities (for example, dusting and tidying up)?
15. Can you, fully independently, do "heavy" household activities (for example, mopping, cleaning the windows and vacuuming)?
16. Can you, fully independently, wash and iron clothes?
17. Can you, fully independently, make the beds?
18. Can you, fully independently, do the shopping?

Appendix F

Geriatric Depression Scale

Geriatric Depression Scale (GDS)

Choose the answer for how you felt over the past week.

1. Are you basically satisfied with your life?	yes/no
2. Have you dropped many of your activities or interests?	yes/no
3. Do you feel that your life is empty?	yes/no
4. Do you often get bored?	yes/no
5. Are you in good spirits most of the time?	yes/no
6. Are you afraid that something bad is going to happen to you?	yes/no
7. Do you feel happy most of the time?	yes/no
8. Do you often feel helpless?	yes/no
9. Do you prefer to stay at home, rather than going out and doing new things?	yes/no
10. Do you feel you have more problems with memory than most?	yes/no
11. Do you think it is wonderful to be alive now?	yes/no
12. Do you feel pretty worthless the way you are now?	yes/no
13. Do you feel full of energy?	yes/no
14. Do you feel your situation is hopeless?	yes/no
15. Do you think most people are better off than you are?	yes/no

Appendix G

Sample Calculation for Exercise Time and Energy Expenditure.

Name:	XXXX		beats per minute (bpm)
		Resting heart rate (HRR)	
Age:	79		72
Sex:	Male	**Maximal Heart rate (MHR)**	84

Distance from 12 min walk:	***0.48***	**miles**	
Pred. VO_{2max}:	***31.052*** ①	**ml/kg/min**	
			Energy expenditure
		MET's	
Percent $VO_{2reserve}$			**kcal/min**
35% VO_{2res}	***13.1*** ②	***3.8*** ③	***5.6*** ④
45% VO_{2res}	15.9	4.5	6.8
50% VO_{2res}	17.3	4.9	7.4
60% VO_{2res}	20.0	5.7	8.6
Percent heart rate reserve		15 Second	1 Minute
35% HRR	***76*** ⑥	19	76
45% HRR	77	19	77
50% HRR	78	20	78
60% HRR	79	20	79

	Exercise Intensity and Duration of Exercise (minutes)			
Total energy expenditure	**35% $VO_{2reserve}$**	**45% $VO_{2reserve}$**	**50% $VO_{2reserve}$**	**60% $VO_{2reserve}$**
50 kcal	***9*** ⑤	7	7	6
75 kcal	13	11	10	9
100 kcal	18	15	14	12

Sample Calculations

① Predicted VO_{2max} = 19.9X + 21.5 ml/kg/min where X = distance in miles
= 19.9(***0.48***) + 21.5 ml/kg/min
= ***31.052 ml/kg/min***

② 35% $VO_{2Reserve}$ = 0.35(VO_{2max} - $VO_{2Reserve}$) + $VO_{2Reserve}$
where $VO_{2Reserve}$=3.5 ml/kg/min
= 0.35(***31.052*** – 3.5) + 3.5
= ***13.1 ml/kg/min***

③ MET's = ($VO_{2Reserve}$ ml/kg/min)/(3.5 ml/kg/MET)
= 13.1/3.5
= ***3.8 MET's***

④ Kcal/minute = MET's * 1.5 kcal/min/MET
= 3.8 * 1.5
= 5.6 ***kcal/min***

⑤ Exercise duration = desired energy expenditure/kcal/min
= 50 kcal/(5.6 kcal/min)
= ***9 minutes***

⑥ 35% Heart Rate Reserve (HRR) = 0.35(MHR-RHR) + RHR
= 0.35 (84-72) + 72
= ***76 bpm***

Where MHR = maximum heart rate

Where RHR = resting heart rate

Appendix H

Activity Diary

Day of the Week	Type of Activity	Intensity	Duration
Monday			
Tuesday			
Wednesday			
Thursday			

Day of the Week	Type of Activity	Intensity	Duration
Friday			
Saturday			
Sunday			

Appendix I

Borg's Ratings of Perceived Exertion

Borg's CR10 Scale Instructions

Basic Instruction: 10, "Extremely strong – Max P," is the main anchor. It is the strongest perception (P) you have experienced. It may be possible, however, to, experience or to imagine something even stronger. Therefore, "Absolute maximum" is placed somewhat further down the scale without a fixed number and marked with a "•". If you perceive an intensity stronger than 10, you may use a higher number.

Start with a *verbal expression* and then choose a *number*. If your perception is "Very weak," say 1; if "Moderate," say 3; and so on. You are welcome to use half values (such as 1.5, or 3.5 or decimals, for example, 0.3, 0.8, or 2.3). It is very important that you answer what *you* perceive and not what you believe you ought to answer. Be as honest as possible and try not to overestimate or underestimate the intensities.

Scaling perceived exertion: We want you to rate your perceived (P) exertion, that is, how heavy and strenuous the exercise feels to you. This depends mainly on the strain and fatigue in your muscles and on your feeling of breathlessness or aches in the chest. But you must only attend to your subjective feelings and not to the physiological cues or what the actual physical load is.

1	is "very light" like walking slowly at your own pace for several minutes.
3	is not especially hard; it feels fine, and it is no problem to continue.
5	you are tired, but you don't have any great difficulties
7	you can still go on but have to push yourself very much. You are very tired.
10	This is as hard as most people have ever experienced before in their lives.
•	This is "Absolute maximum," for example, 11 or 12 or higher

Scaling pain: What are your worst experiences of pain? If you use 10 as the strongest exertion you have ever experienced or can think of, how strong would you say that your three worst pain experiences have been?

10	"Extremely strong--Max P" is your main point of reference. It is anchored in your previously experienced worst pain, which you just described, the "Max P".
•	Your worst pain experienced, the "Max P," may not be the highest possible level.

There may be pain that is still worst. If that feeling is somewhat stronger, you will say 11 or 12. If it is much stronger, 1.5 times "Max P," you will say 15!

0	Nothing at all	"No P"
0.3		
0.5	Extremely weak	Just noticeable
1	Very weak	
1.5		
2	Weak	Light
2.5		
3	Moderate	
4		
5	Strong	Heavy
6		
7	Very strong	
8		
9		
10	Extremely strong	"Max P"
11		
•	Absolute maximum	Highest possible

Borg CRIO scale

Appendix J

Raw Data

Table J1: Raw data for resting heart rate and systolic blood pressure.

Subject	Age	RHR (beats per 15 sec)			Systolic Blood Pressure		
		T1	T2	T3	T1	T2	T3
1	73	13	18	18	100	118	118
3	73	20	15	22	130	194	128
4	70	21	22	18	132	134	142
6	77	15	14	15	166	132	144
7	77	15	15	15	150	118	118
10	88	20	18	20	122	120	120
11	79	27	20	20	132	130	132
18	66	17	15	12	162	132	144

Table J2: Raw data for diastolic blood pressure and weight.

Subject	Diastolic blood pressure			Weight (kg)		
	T1	T2	T3	T1	T2	T3
1	60	78	70	63	64.5	62.5
3	80	86	82	72.5	72.5	72
4	80	70	78	59.5	60	59
6	80	62	66	62.5	61	60
7	74	68	68	79.5	78.5	77.5
10	82	64	74	55	55.5	54.5
11	78	82	70	71	64.5	67
18		88	78	92	89	85

Table J3: Raw data for waist girth and predicted VO_{2max}.

Subject	Waist Girth (cm)			Predicted VO_{2max} (ml/kg/min)	
	T1	T2	T3	T1	T3
1	77.2	81.5	93	22.7	22.5
3	88	87	104	21.4	23.2
4	89	96	95	21.4	22.3
6	91.5	92	98	19.6	21
7	101.4	98	98	33.6	32.8
10	87.5	94	90	20.0	22
11	100	100	97.5	22.1	24.5
18	105.5	102.5	100	35.0	37

Table J4: Raw data for the Physical Activity Scale for the Elderly, Groningen Activity Restriction Scale and the Geriatric Depression Scale.

Subject	PASE		GARS			GDS		
	T1	T3	T1	T2	T3	T1	T2	T3
1	157.68	170	18	19	18	0	2	0
3	72.8	100	18	18	18	3	1	2
4	65	149.6	18	18	18	4	4	4
6	68.44	94.22	18	21	18	0	1	0
7	159.14	141.94	18	18	18	4	0	0
10	31.4	40	24	22	23	4	3	3
11	108.12	111.1	19	19	20	2	1	1
18	69.01	79.3	18	18	18	1	3	1

Table J5: Raw data for triglyceride, cholesterol and high density lipoprotein profiles.

Subject	Trigylcerides (mmol/l)		Cholesterol (mmol/l)		HDL-Cholesterol (mmol/l)	
	T1	T3	T1	T3	T1	T3
1	1.63	1.21	7.24	8.02	2.1	2.51
3	2.46	2.53	5.5	5.39	1.4	1.31
4	3.26	4.29	7.72	7.81	0.99	1.29
6	2.5	3.7	5.63	6.22	1.54	1.02
7	2.18	2.16	5.95	6.07		0.98
10	0.94	1.18	5.57	6.01	1.17	1.29
11	2.23	1.76	4.39	4.26	1.13	1.28
18	5.2	1.72	2.6	3.16	0.48	0.59

Table J6: Raw data for low density lipoprotein profile and for the timed 'Up & Go' test.

Subject	LDL-Cholesterol (mmol/l)		TUGT time (sec)	
	T1	T3	T1	T3
1	4.42	4.97	9.9	11.4
3	3.01	2.96	10.6	9.6
4	5.28	4.61	12.7	9.6
6	2.98	3.56	12.0	11.5
7		4.13	13.6	9.0
10	3.98	4.2	19.9	15.0
11	2.27	2.2	10.1	9.9
18	3.6	1.81	13.5	7.4

Appendix K

Two Sample T-Tests

Table K1: Two Sample T-Test and Confidence Interval For resting heart rate.

Group	N	Mean	StDev	SE Mean
1	3	64.0	14.4	8.3
2	5	80.0	18.3	8.2

95% CI for mu (1) - mu (2): (-46.6, 14.6)
T-Test mu (1) = mu (2) (vs not =): T = -1.28 P = 0.25 DF = 6
Both use Pooled StDev = 17.1

Table K2: Two Sample T-Test and Confidence Interval for systolic blood pressure.

Group	N	Mean	StDev	SE Mean
1	3	126.7	25.2	15
2	5	142.8	19.8	8.9

95% CI for mu (1) - mu (2): (-55, 22.8)
T-Test mu (1) = mu (2) (vs not =): T = -1.02 P = 0.35 DF = 6
Both use Pooled StDev = 21.8

Table K3: Two Sample T-Test and Confidence Interval for diastolic blood pressure.

Two sample T for Diastolic

Group	N	Mean	StDev	SE Mean
1	3	71.3	10.3	5.9
2	4	80.00	1.63	0.82

95% CI for mu (1) - mu (2): (-21.7, 4.32)
T-Test mu (1) = mu (2) (vs not =): T = -1.72 P = 0.15 DF = 5
Both use Pooled StDev = 6.61

Table K4: Two Sample T-Test and Confidence Interval for weight.

Two sample T for Weight

Group	N	Mean	StDev	SE Mean
1	3	71.67	8.28	4.8
2	5	68.1	14.5	6.5

95% CI for mu (1) - mu (2): (-19.3, 26.4)
T-Test mu (1) = mu (2) (vs not =): T = 0.38 P = 0.72 DF = 6
Both use Pooled StDev = 12.8

Table K5: Two Sample T-Test and Confidence Interval for waist girth.

```
Two sample T for WG

Group       N      Mean      StDev   SE Mean
1           3      88.9       12.1       7.0
2           5     94.70       7.73       3.5

95% CI for mu (1) - mu (2): ( -22.7,  11.0)
T-Test mu (1) = mu (2) (vs not =): T = -0.85  P = 0.43  DF = 6
Both use Pooled StDev = 9.43
```

Table K6: Two Sample T-Test and Confidence Interval for Geriatric Depression Scale.

```
Two sample T for GDS

Group       N      Mean      StDev   SE Mean
1           3      2.33       2.08       1.2
2           5      2.20       1.79      0.80

95% CI for mu (1) - mu (2): ( -3.2,  3.51)
T-Test mu (1) = mu (2) (vs not =): T = 0.10  P = 0.93  DF = 6
Both use Pooled StDev = 1.89
```

Table K7: Two Sample T-Test and Confidence Interval for triglyceride profile.

```
Two sample T for TRI

Group       N      Mean      StDev   SE Mean
1           3     2.090      0.422      0.24
2           5      2.83       1.57      0.70

95% CI for mu (1) - mu (2): ( -3.07,  1.59)
T-Test mu (1) = mu (2) (vs not =): T = -0.77  P = 0.47  DF = 6
Both use Pooled StDev = 1.30
```

Table K8: Two Sample T-Test and Confidence Interval for cholesterol profile.

```
Two sample T for CHOL

Group       N      Mean      StDev   SE Mean
1           3     6.230      0.903      0.52
2           5      5.18       1.88      0.84

95% CI for mu (1) - mu (2): ( -1.85,  3.94)
T-Test mu (1) = mu (2) (vs not =): T = 0.89  P = 0.41  DF = 6
Both use Pooled StDev = 1.62
```

Table K9: Two Sample T-Test and Confidence Interval for high density lipoprotein profile.

Two sample T for HDL

Group	N	Mean	StDev	SE Mean
1	2	1.750	0.495	0.35
2	5	1.062	0.384	0.17

95% CI for mu (1) - mu (2): (-0.19, 1.57)
T-Test mu (1) = mu (2) (vs not =): T = 2.01 P = 0.10 DF = 5
Both use Pooled StDev = 0.408

Table K10: Two Sample T-Test and Confidence Interval for low density lipoprotein profile.

Two sample T for LDL

Group	N	Mean	StDev	SE Mean
1	2	3.715	0.997	0.70
2	5	3.62	1.13	0.51

95% CI for mu (1) - mu (2): (-2.29, 2.47)
T-Test mu (1) = mu (2) (vs not =): T = 0.10 P = 0.92 DF = 5
Both use Pooled StDev = 1.11

Table K11: Two Sample T-Test and Confidence Interval for Physical Activity Scale for the Elderly.

Two sample T for PASE

Group	N	Mean	StDev	SE Mean
1	3	129.9	49.4	29
2	5	68.4	27.2	12

95% CI for mu (1) - mu (2): (-3, 126)
T-Test mu (1) = mu (2) (vs not =): T = 2.33 P = 0.059 DF = 6
Both use Pooled StDev = 36.2

Table K12: Two Sample T-Test and Confidence Interval for predicted VO_{2max}.

Two sample T for VO2

Group	N	Mean	StDev	SE Mean
1	3	25.90	6.70	3.9
2	5	23.62	6.44	2.9

95% CI for mu (1) - mu (2): (-9.4, 14.0)
T-Test mu (1) = mu (2) (vs not =): T = 0.48 P = 0.65 DF = 6
Both use Pooled StDev = 6.53Table K13: Two Sample T-Test and Confidence Interval for timed 'Up & Go' test.

Table K13: Two Sample T-Test and Confidence Interval for timed "Up & Go' test.

Two sample T for TUGT

Group	N	Mean	StDev	SE Mean
1	3	11.07	1.46	0.84
2	5	13.82	3.68	1.6

95% CI for mu (1) - mu (2): (-8.34, 2.8)
T-Test mu (1) = mu (2) (vs not =): T = -1.21 P = 0.27 DF = 6
Both use Pooled StDev = 3.12

Appendix L

Model 1: GROUP TRIAL GROUP*TRIAL SUBJECT(GROUP) Results

Table L1: Summary table of General Linear Model results for systolic blood pressure.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for Systolic, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	190.7	190.7	190.7	0.31	0.599
Trial	2	149.3	238.0	119.0	0.40	0.681
Group*Trial	2	1076.6	1076.6	538.3	1.79	0.208
Subject(Group)	6	3711.8	3711.8	618.6	2.06	0.135
Error	12	3603.4	3603.4	300.3		
Total	23	8731.8				

Unusual Observations for Systolic

Obs	Systolic	Fit	StDev Fit	Residual	St Resid
5	194.000	163.556	12.916	30.444	2.64R
7	150.000	124.889	12.916	25.111	2.17R
8	118.000	141.556	12.916	-23.556	-2.04R

R denotes an observation with a large standardized residual.

Table L2: Summary table of General Linear Model results for diastolic blood pressure.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	7	1 3 7 4 6 10 11

Analysis of Variance for Diastoli, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	0.14	0.14	0.14	0.00	0.969
Trial	2	59.81	33.43	16.71	0.44	0.656
Group*Trial	2	236.86	236.86	118.43	3.11	0.089
Subject(Group)	5	438.33	438.33	87.67	2.30	0.123
Error	10	380.67	380.67	38.07		
Total	20	1115.81				

Unusual Observations for Diastoli

Obs	Diastoli	Fit	StDev Fit	Residual	St Resid
20	82.0000	72.3333	4.3627	9.6667	2.22R

R denotes an observation with a large standardized residual.

Table L3: Summary table of General Linear Model results for resting heart rate.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for RHR, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	199.51	199.51	199.51	0.44	0.530
Trial	2	129.33	76.36	38.18	0.44	0.654
Group*Trial	2	431.02	431.02	215.51	2.49	0.125
Subject(Group)	6	2695.82	2695.82	449.30	5.19	0.008
Error	12	1039.64	1039.64	86.64		
Total	23	4495.33				

Unusual Observations for RHR

Obs	RHR	Fit	StDev Fit	Residual	St Resid
5	60.000	72.889	6.938	-12.889	-2.08R

R denotes an observation with a large standardized residual.

Table L4: Summary table of General Linear Model results for weight.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for Weight, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	141.88	141.88	141.88	0.35	0.577
Trial	2	19.19	14.28	7.14	2.83	0.098
Group*Trial	2	5.23	5.23	2.62	1.04	0.384
Subject(Group)	6	2454.96	2454.96	409.16	162.34	0.000
Error	12	30.24	30.24	2.52		
Total	23	2651.50				

Unusual Observations for Weight

Obs	Weight	Fit	StDev Fit	Residual	St Resid
20	64.5000	67.1333	1.0845	-2.6333	-2.27R
24	85.0000	87.4000	1.0845	-2.4000	-2.07R

R denotes an observation with a large standardized residual.

Table L5: Summary table of General Linear Model results for waist girth.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for WG, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	85.07	85.07	85.07	0.80	0.407
Trial	2	82.18	124.04	62.02	3.28	0.073
Group*Trial	2	110.09	110.09	55.05	2.92	0.093
Subject(Group)	6	641.92	641.92	106.99	5.67	0.005
Error	12	226.56	226.56	18.88		
Total	23	1145.82				

Unusual Observations for WG

Obs	WG	Fit	StDev Fit	Residual	St Resid
9	98.000	105.456	3.239	-7.456	-2.57R

R denotes an observation with a large standardized residual.

Table L6: Summary table of General Linear Model results for Groningen Activity Restriction Scale scores.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for GARS, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	10.3361	10.3361	10.3361	1.21	0.314
Trial	2	0.3333	0.3556	0.1778	0.24	0.792
Group*Trial	2	0.0222	0.0222	0.0111	0.01	0.985
Subject(Group)	6	51.2889	51.2889	8.5481	11.43	0.000
Error	12	8.9778	8.9778	0.7481		
Total	23	70.9583				

Unusual Observations for GARS

Obs	GARS	Fit	StDev Fit	Residual	St Resid
14	21.0000	19.1333	0.5909	1.8667	2.96R

R denotes an observation with a large standardized residual.

Table L7: Summary table of General Linear Model results for Geriatric Depression Scale scores.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for GDS, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	3.600	3.600	3.600	0.73	0.427
Trial	2	3.083	4.017	2.008	1.67	0.229
Group*Trial	2	2.517	2.517	1.258	1.05	0.380
Subject(Group)	6	29.733	29.733	4.956	4.13	0.018
Error	12	14.400	14.400	1.200		
Total	23	53.333				

Unusual Observations for GDS

Obs	GDS	Fit	StDev Fit	Residual	St Resid
1	0.00000	1.66667	0.81650	-1.66667	-2.28R
2	2.00000	0.33333	0.81650	1.66667	2.28R
7	4.00000	2.33333	0.81650	1.66667	2.28R

R denotes an observation with a large standardized residual.

Table L8: Summary table of General Linear Model results for triglyceride profile.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for TRI, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	1.583	1.583	1.583	0.84	0.396
Trial	1	0.214	0.165	0.165	0.14	0.725
Group*Trial	1	0.028	0.028	0.028	0.02	0.884
Subject(Group)	6	11.371	11.371	1.895	1.56	0.302
Error	6	7.294	7.294	1.216		
Total	15	20.489				

Unusual Observations for TRI

Obs	TRI	Fit	StDev Fit	Residual	St Resid
15	5.20000	3.60800	0.85404	1.59200	2.28R
16	1.72000	3.31200	0.85404	-1.59200	-2.28R

R denotes an observation with a large standardized residual.

Table L9: Summary table of General Linear Model results for cholesterol profile.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for CHOL, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	3.9373	3.9373	3.9373	0.73	0.424
Trial	1	0.3422	0.3082	0.3082	4.47	0.079
Group*Trial	1	0.0020	0.0020	0.0020	0.03	0.869
Subject(Group)	6	32.1595	32.1595	5.3599	77.81	0.000
Error	6	0.4133	0.4133	0.0689		
Total	15	36.8544				

Table L10: Summary table of General Linear Model results for high density lipoprotein profile.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	7	1 3 4 6 10 11 18

Analysis of Variance for HDL, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	1.61573	1.61573	1.61573	4.87	0.078
Trial	1	0.01646	0.02633	0.02633	0.50	0.512
Group*Trial	1	0.01170	0.01170	0.01170	0.22	0.658
Subject(Group)	5	1.65996	1.65996	0.33199	6.27	0.033
Error	5	0.26464	0.26464	0.05293		
Total	13	3.56849				

Table L11: Summary table of General Linear Model results for low density lipoprotein profile.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	7	1 3 4 6 10 11 18

Analysis of Variance for LDL, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	0.4368	0.4368	0.4368	0.18	0.691
Trial	1	0.1081	0.0066	0.0066	0.02	0.898
Group*Trial	1	0.2537	0.2537	0.2537	0.70	0.441
Subject(Group)	5	12.3406	12.3406	2.4681	6.81	0.028
Error	5	1.8121	1.8121	0.3624		
Total	13	14.9513				

Table L12: Summary table of General Linear Model results for Physical Activity Scale for the Elderly.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for PASE, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	10128.4	10128.4	10128.4	4.32	0.083
Trial	1	1493.2	1076.6	1076.6	2.33	0.177
Group*Trial	1	339.2	339.2	339.2	0.74	0.424
Subject(Group)	6	14071.8	14071.8	2345.3	5.09	0.034
Error	6	2766.8	2766.8	461.1		
Total	15	28799.5				

Unusual Observations for PASE

Obs	PASE	Fit	StDev Fit	Residual	St Resid
7	65.000	94.073	16.634	-29.073	-2.14R
8	149.600	120.527	16.634	29.073	2.14R

R denotes an observation with a large standardized residual.

Table L13: Summary table of General Linear Model results for predicted VO_{2max}.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for VO2, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	8.932	8.932	8.932	0.11	0.753
Trial	1	5.641	3.775	3.775	8.88	0.025
Group*Trial	1	2.035	2.035	2.035	4.79	0.071
Subject(Group)	6	495.377	495.377	82.563	194.32	0.000
Error	6	2.549	2.549	0.425		
Total	15	514.534				

Unusual Observations for VO2

Obs	VO2	Fit	StDev Fit	Residual	St Resid
3	21.4000	22.1667	0.5322	-0.7667	-2.04R
4	23.2000	22.4333	0.5322	0.7667	2.04R

R denotes an observation with a large standardized residual.

Table L14: Summary table of General Linear Model results for timed 'Up & Go' test.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for TUGT, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	9.087	9.087	9.087	0.74	0.424
Trial	1	22.326	15.965	15.965	4.77	0.072
Group*Trial	1	5.370	5.370	5.370	1.61	0.252
Subject(Group)	6	74.057	74.057	12.343	3.69	0.069
Error	6	20.069	20.069	3.345		
Total	15	130.909				

Appendix M

Model Adequacy Plots for the model 1

GROUP TRIAL GROUP*TRIAL SUBJECT(GROUP)

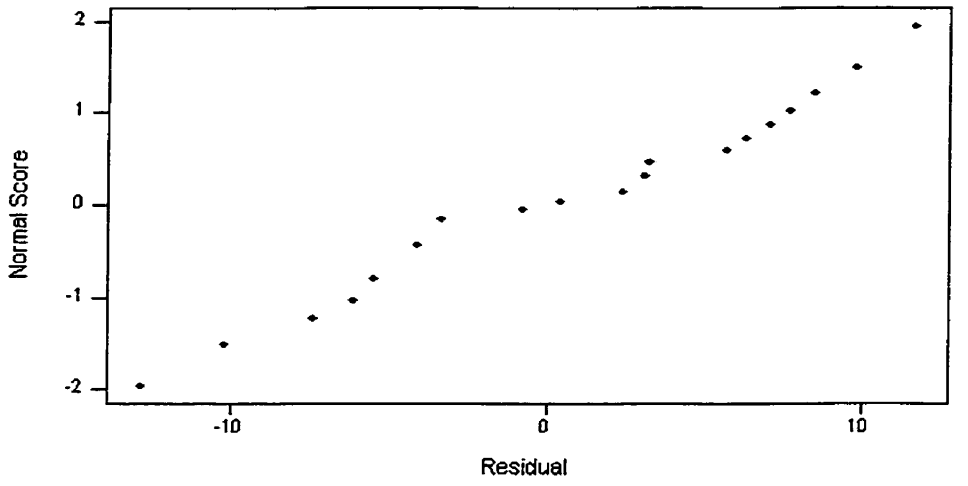


Figure M1: Normal probability plot of the residuals for the response resting heart rate.

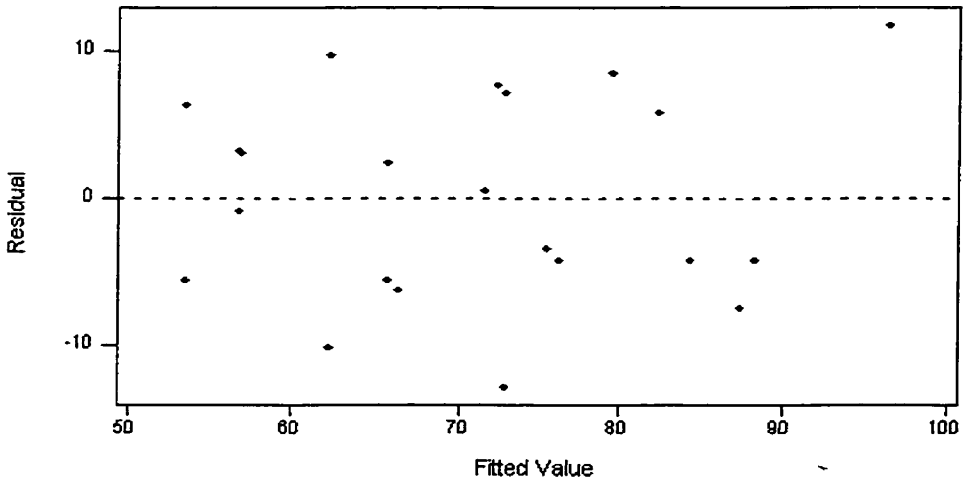


Figure M2: Residuals versus the fitted values for the response resting heart rate.

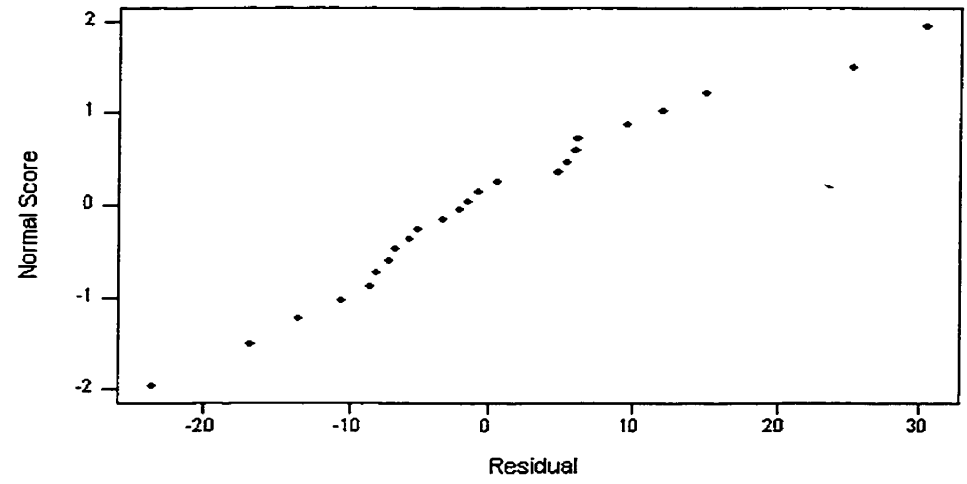


Figure M3: Normal probability plot of the residuals for the response systolic blood pressure.

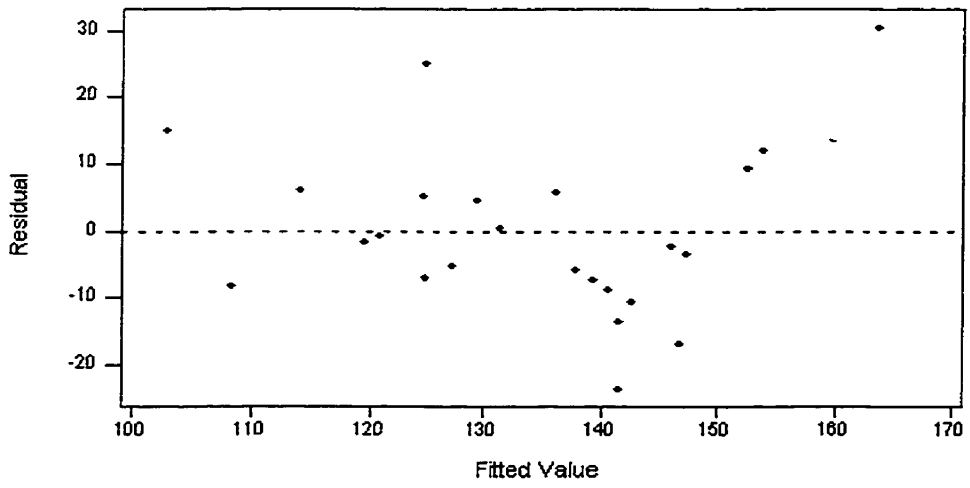


Figure M4: Residuals versus the fitted values for the response systolic blood pressure.

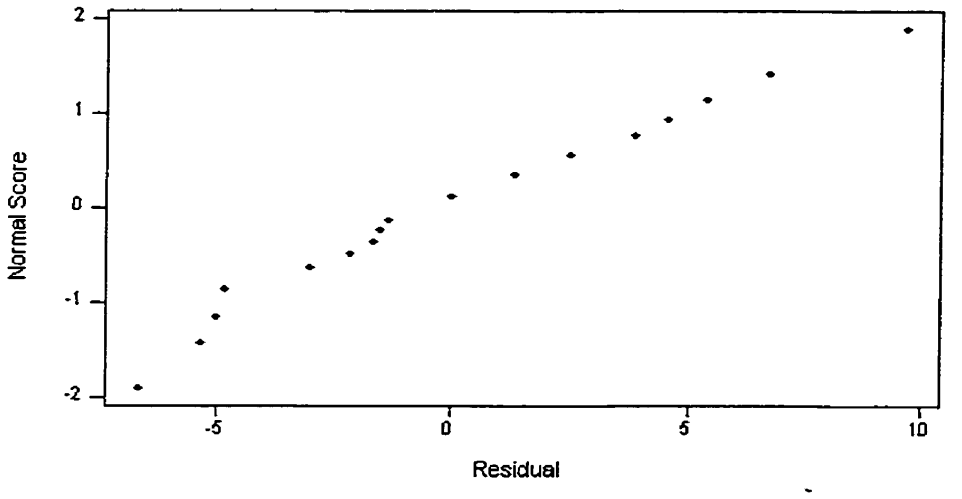


Figure M5: Normal probability plot of the residuals for the response diastolic blood pressure.

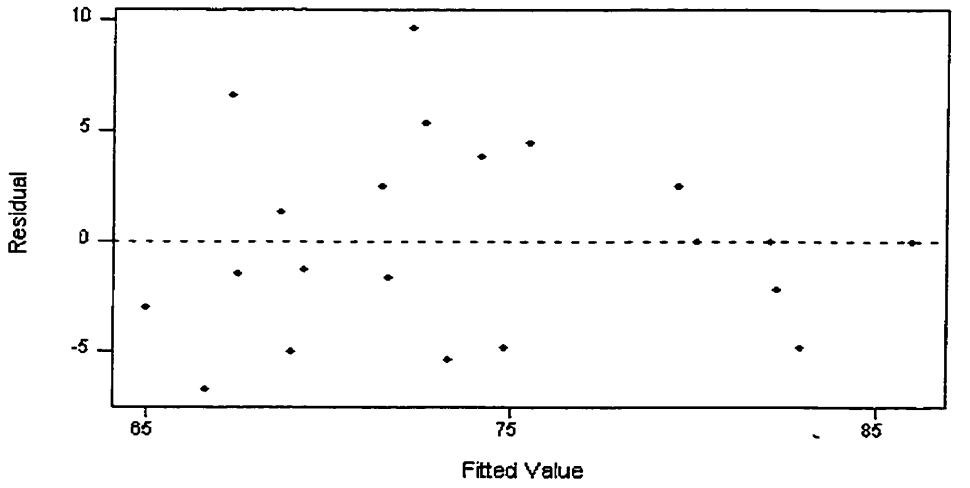


Figure M6: Residuals versus the fitted values for the response diastolic blood pressure.

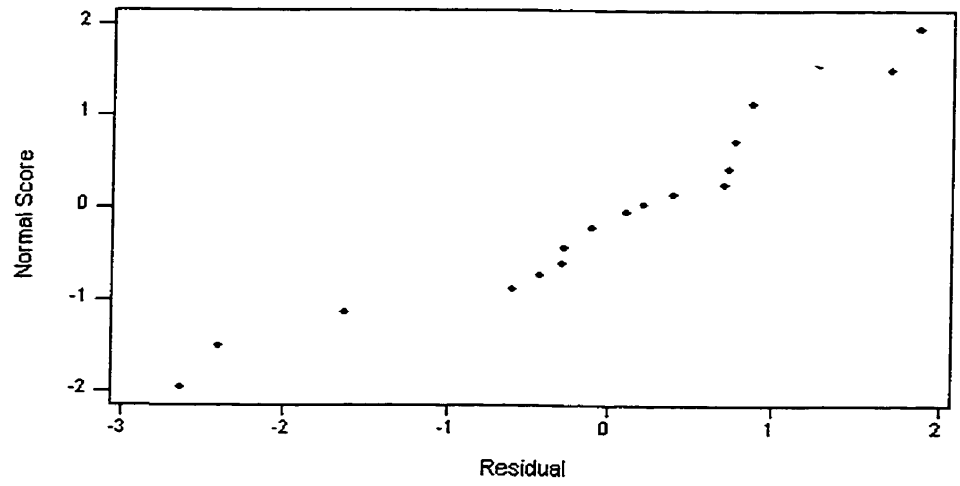


Figure M7: Normal probability plot of the residuals for the response weight.

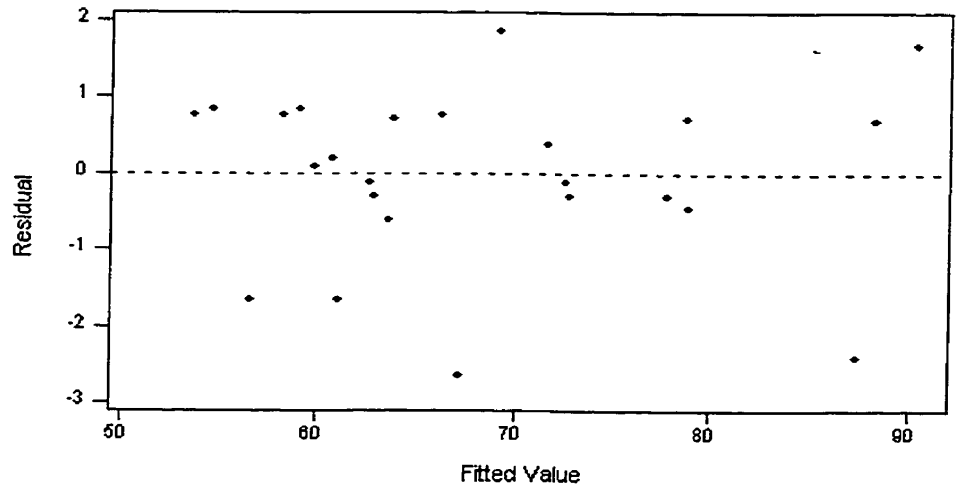


Figure M8: Residuals versus the fitted values for the response weight.

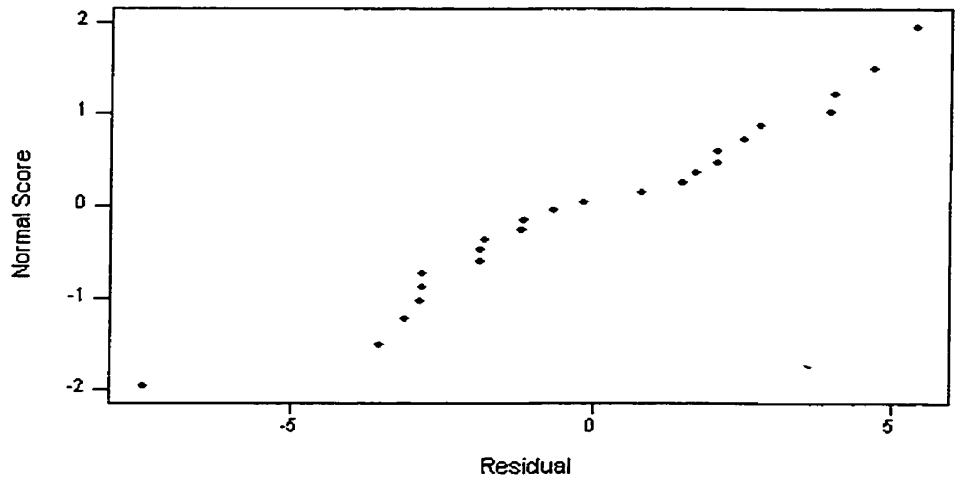


Figure M9: Normal probability plot of the residuals for the response waist girth.

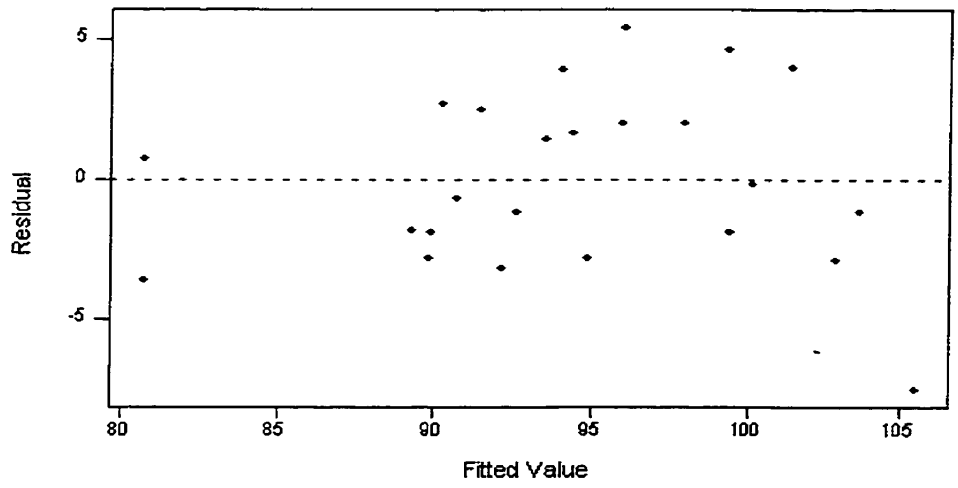


Figure M10: Residuals versus the fitted values for the response waist girth.

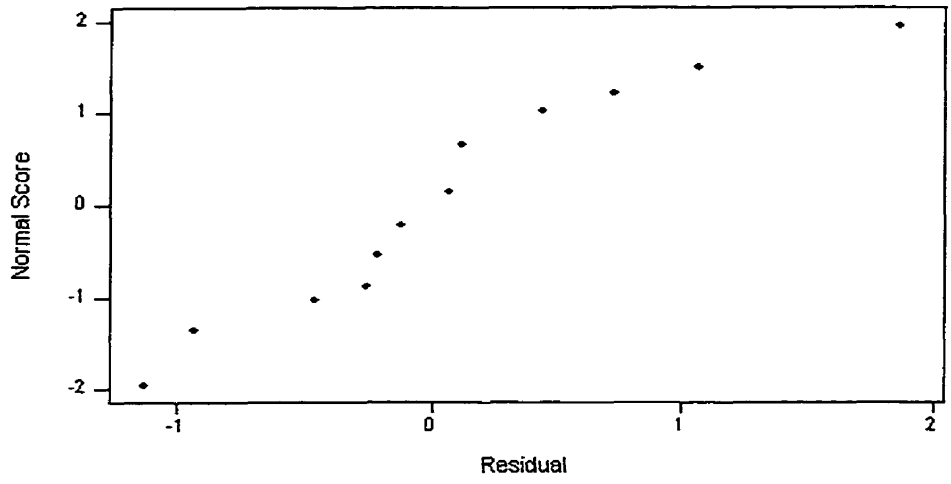


Figure M11: Normal probability plot of the residuals for the response Groningen Activity Restriction Scale.

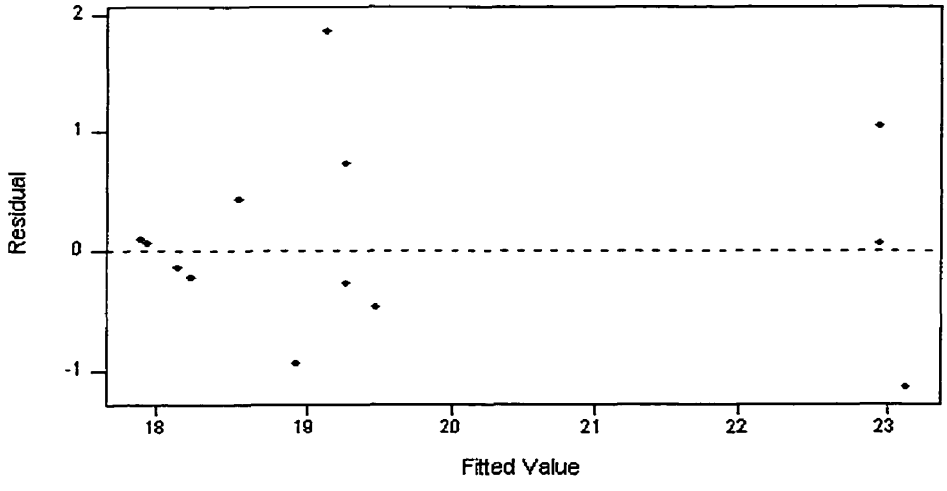


Figure M12: Residuals versus the fitted values for the response Groningen Activity Restriction Scale.

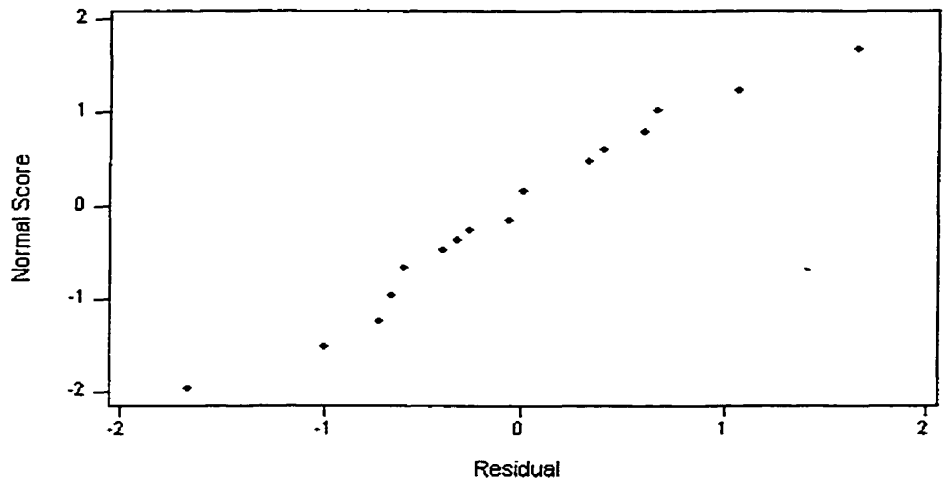


Figure M13: Normal probability plot of the residuals for the response Geriatric Depression Scale.

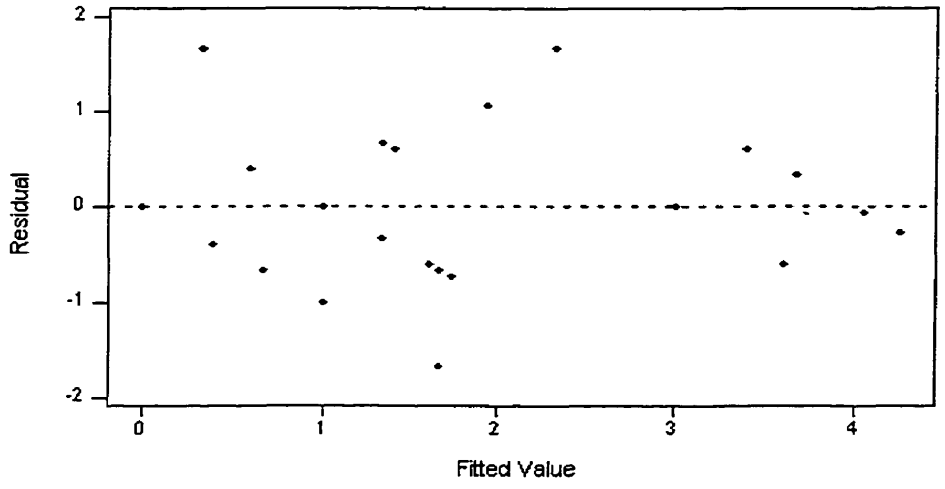


Figure M14: Residuals versus the fitted values for the response Geriatric Depression Scale.

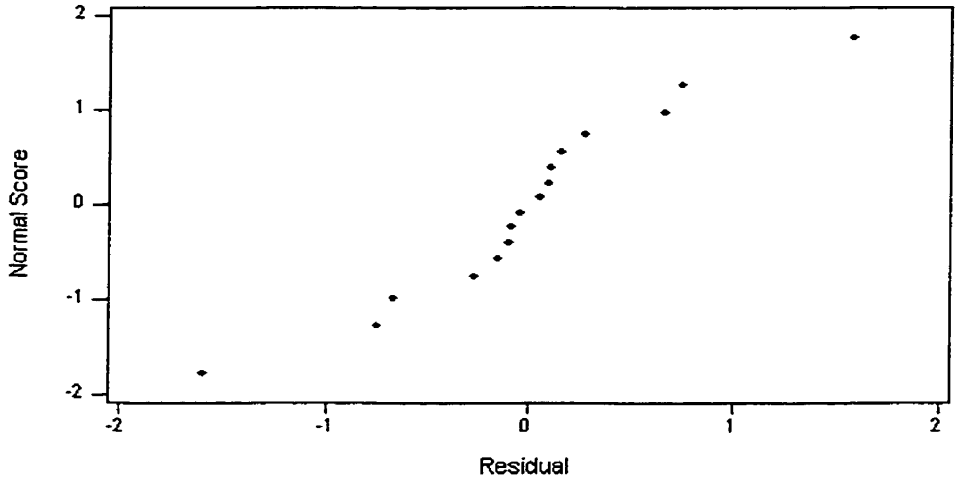


Figure M15: Normal probability plot of the residuals for the response triglyceride profile.

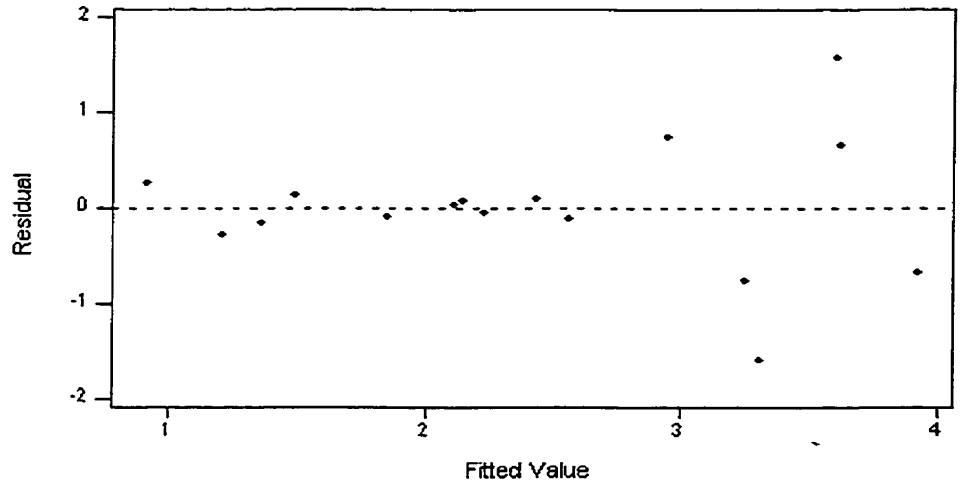


Figure M16: Residuals versus the fitted values for the response triglyceride profile.

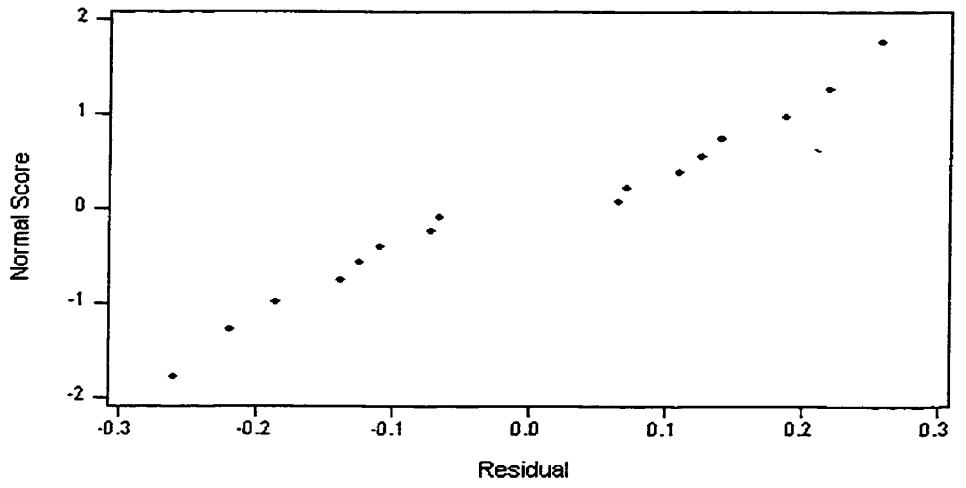


Figure M17: Normal probability plot of the residuals for the response cholesterol profile.

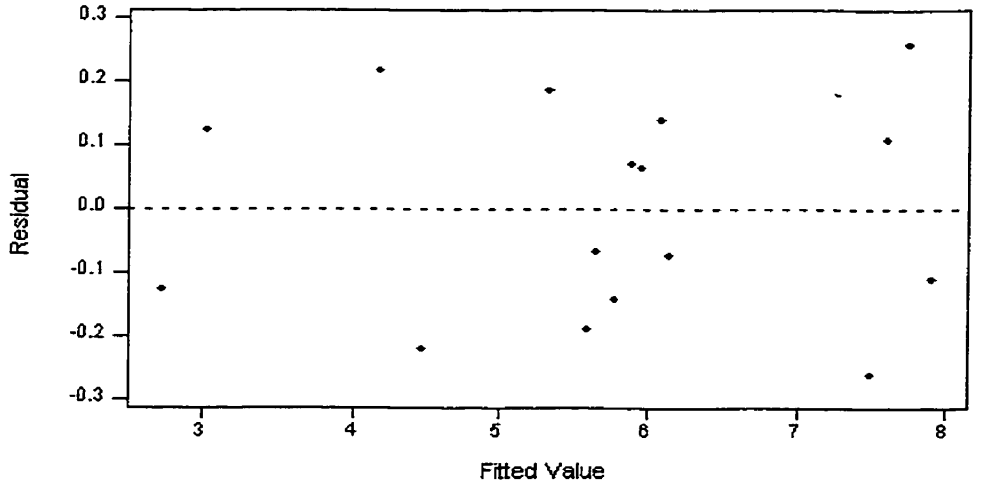


Figure M18: Residuals versus the fitted values for the response cholesterol profile.

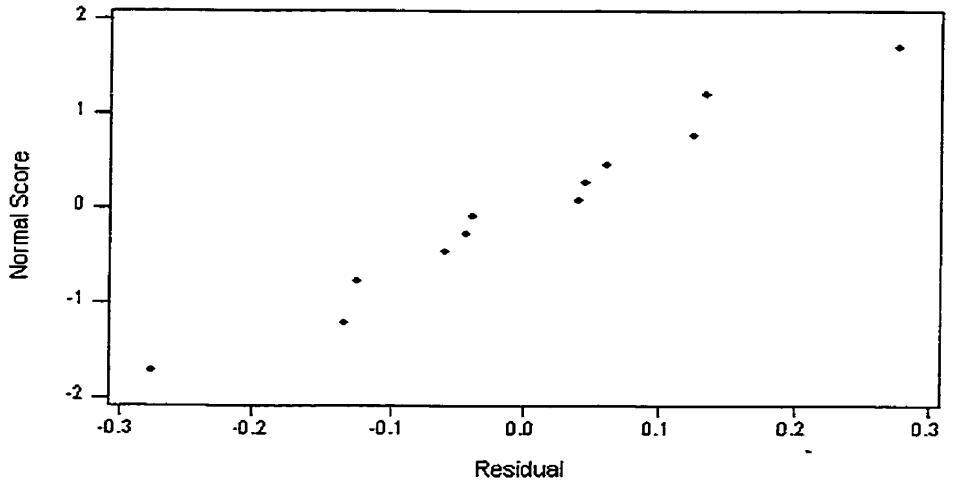


Figure M19: Normal probability plot of the residuals for the response high density lipoprotein profile.

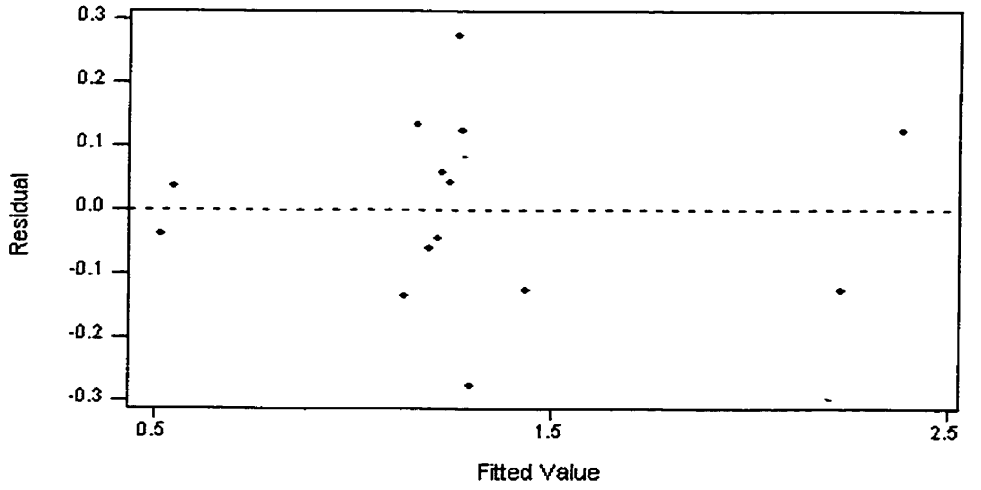


Figure M20: Residuals versus the fitted values for the response high density lipoprotein profile.

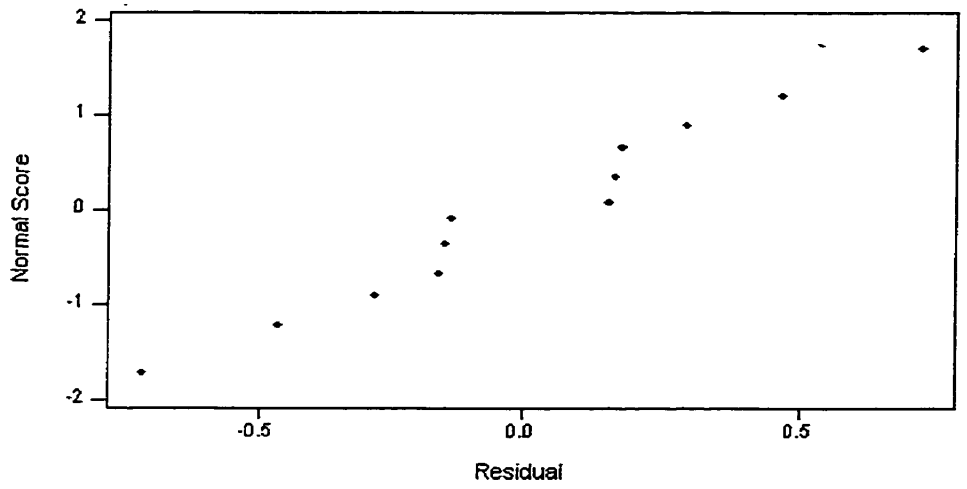


Figure M21: Normal probability plot of the residuals for the response low density lipoprotein profile.

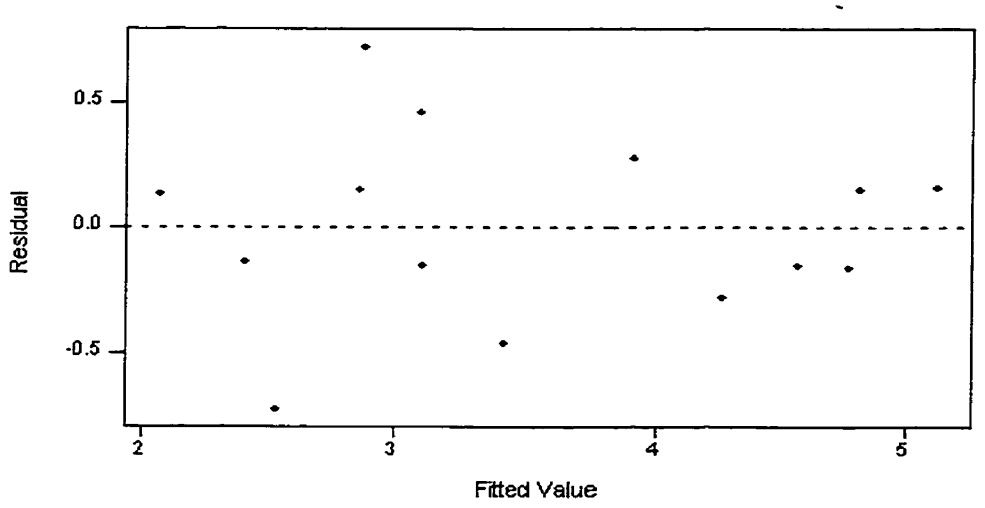


Figure M22: Residuals versus the fitted values for the response low density lipoprotein profile.

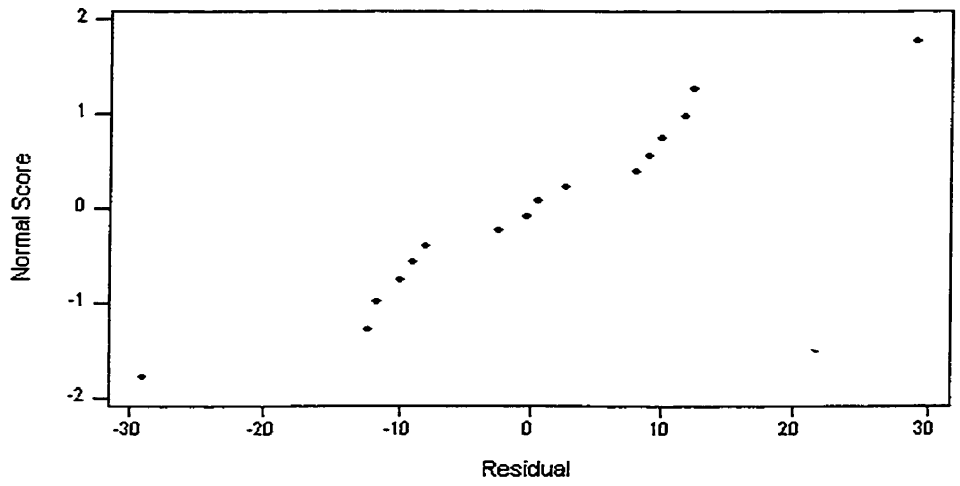


Figure M23: Normal probability plot of the residuals for the response Physical Activity Scale for the Elderly.

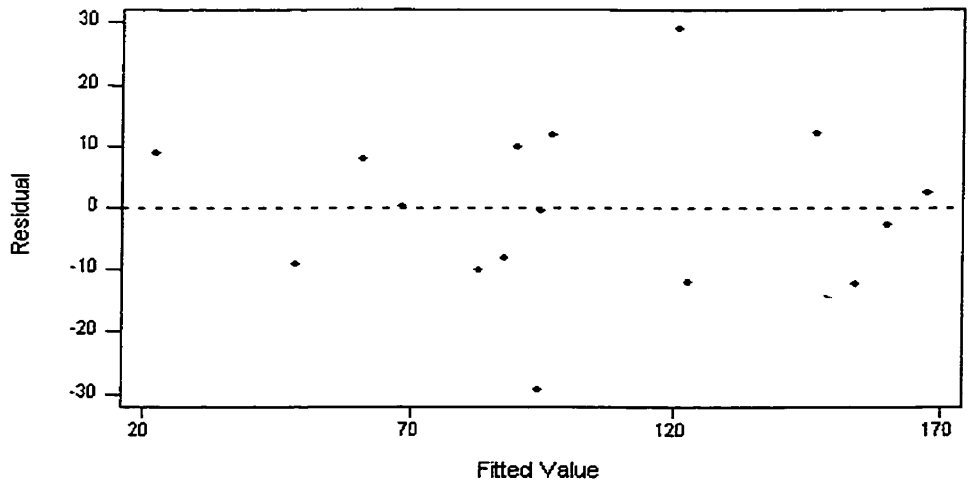


Figure M24: Residuals versus the fitted values for the response Physical Activity Scale for the Elderly.

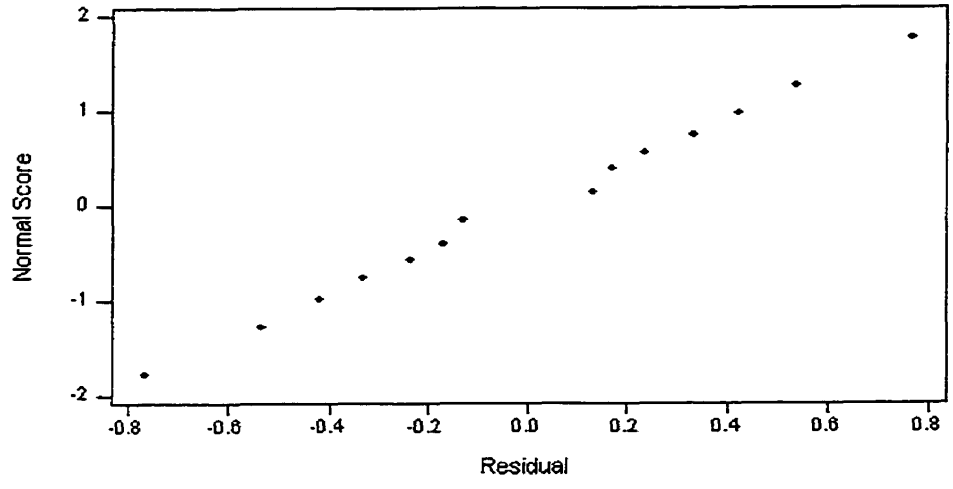


Figure M25: Normal probability plot of the residuals for the response predicted VO_{2max}.

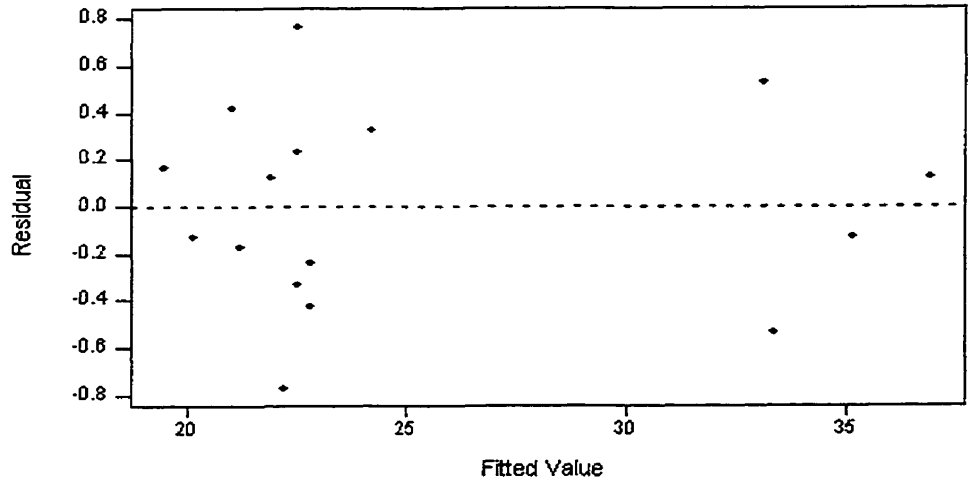


Figure M26: Residuals versus the fitted values for the response predicted VO_{2max}.

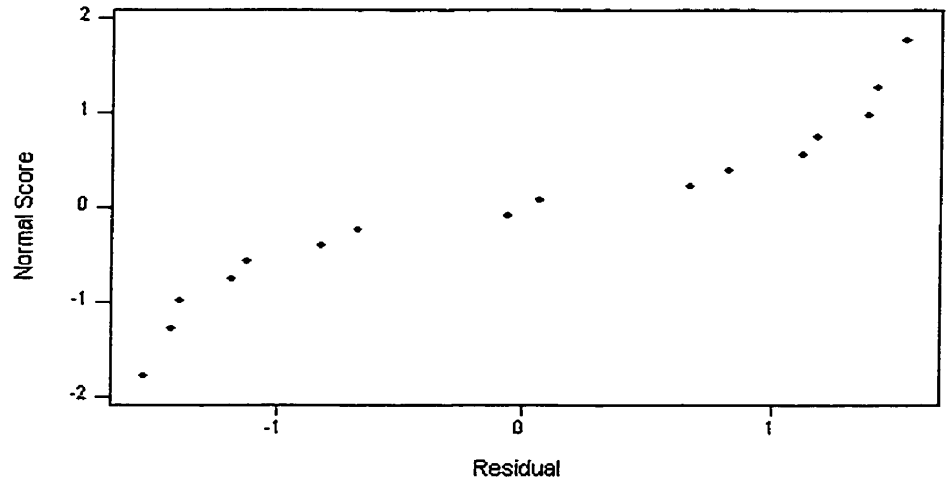


Figure M27: Normal probability plot of the residuals for the response timed 'Up & Go' test.

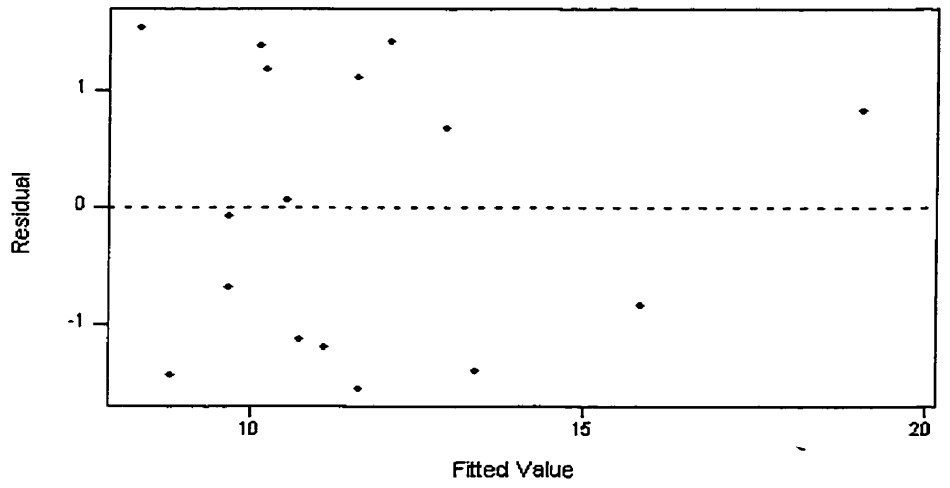


Figure M28: Residuals versus the fitted values for the response timed 'Up & Go' test.

Appendix N

Model 2: GROUP TRIAL SUBJECT(GROUP) results

Table N1: Summary table of General Linear Model results for systolic blood pressure.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for Systolic, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	190.7	190.7	190.7	0.31	0.599
Trial	2	149.3	149.3	74.7	0.22	0.803
Subject(Group)	6	3711.8	3711.8	618.6	1.85	0.161
Error	14	4680.0	4680.0	334.3		
Total	23	8731.8				

Unusual Observations for Systolic

Obs	Systolic	Fit	StDev Fit	Residual	St Resid
5	194.000	151.333	11.802	42.667	3.06R

R denotes an observation with a large standardized residual.

Table N2: Summary table of General Linear Model results for diastolic blood pressure.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	7	1 3 7 4 6 10 11

Analysis of Variance for Diastoli, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	0.14	0.14	0.14	0.00	0.969
Trial	2	59.81	59.81	29.90	0.58	0.574
Subject(Group)	5	438.33	438.33	87.67	1.70	0.208
Error	12	617.52	617.52	51.46		
Total	20	1115.81				

Unusual Observations for Diastoli

Obs	Diastoli	Fit	StDev Fit	Residual	St Resid
1	60.0000	71.7143	4.6962	-11.7143	-2.16R

R denotes an observation with a large standardized residual.

Table N3: Summary table of General Linear Model results for resting heart rate.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for RHR, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	199.5	199.5	199.5	0.44	0.530
Trial	2	129.3	129.3	64.7	0.62	0.554
Subject(Group)	6	2695.8	2695.8	449.3	4.28	0.012
Error	14	1470.7	1470.7	105.0		
Total	23	4495.3				

Unusual Observations for RHR

Obs	RHR	Fit	StDev Fit	Residual	St Resid
1	52.000	68.500	6.616	-16.500	-2.11R

R denotes an observation with a large standardized residual.

Table N4: Summary table of General Linear Model results for waist girth.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for WG, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	85.07	85.07	85.07	0.80	0.407
Trial	2	82.18	82.18	41.09	1.71	0.217
Subject(Group)	6	641.92	641.92	106.99	4.45	0.010
Error	14	336.66	336.66	24.05		
Total	23	1145.82				

Unusual Observations for WG

Obs	WG	Fit	StDev Fit	Residual	St Resid
6	104.000	95.496	3.165	8.504	2.27R

R denotes an observation with a large standardized residual.

Table N5: Summary table of General Linear Model results for weight.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for Weight, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	141.88	141.88	141.88	0.35	0.577
Trial	2	19.19	19.19	9.59	3.79	0.049
Subject(Group)	6	2454.96	2454.96	409.16	161.45	0.000
Error	14	35.48	35.48	2.53		
Total	23	2651.50				

Unusual Observations for Weight

Obs	Weight	Fit	StDev Fit	Residual	St Resid
20	64.5000	67.4375	1.0276	-2.9375	-2.42R
24	85.0000	87.6042	1.0276	-2.6042	-2.14R

R denotes an observation with a large standardized residual.

Table N6: Summary table of General Linear Model results for Groningen Activity Restriction Scale Scores.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for GARS, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	10.3361	10.3361	10.3361	1.21	0.314
Trial	2	0.3333	0.3333	0.1667	0.26	0.775
Subject(Group)	6	51.2889	51.2889	8.5481	13.30	0.000
Error	14	9.0000	9.0000	0.6429		
Total	23	70.9583				

Unusual Observations for GARS

Obs	GARS	Fit	StDev Fit	Residual	St Resid
14	21.0000	19.1667	0.5175	1.8333	2.99R

R denotes an observation with a large standardized residual.

Table N7: Summary table of General Linear Model results for Geriatric Depression Scale scores.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	3	1 2 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for GDS, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	3.600	3.600	3.600	0.73	0.427
Trial	2	3.083	3.083	1.542	1.28	0.310
Subject(Group)	6	29.733	29.733	4.956	4.10	0.014
Error	14	16.917	16.917	1.208		
Total	23	53.333				

Unusual Observations for GDS

Obs	GDS	Fit	StDev Fit	Residual	St Resid
7	4.00000	1.75000	0.70956	2.25000	2.68R

R denotes an observation with a large standardized residual.

Table N8: Summary table of General Linear Model results for triglyceride profile.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for TRI, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	1.583	1.583	1.583	0.84	0.396
Trial	1	0.214	0.214	0.214	0.20	0.665
Subject(Group)	6	11.371	11.371	1.895	1.81	0.227
Error	7	7.322	7.322	1.046		
Total	15	20.489				

Unusual Observations for TRI

Obs	TRI	Fit	StDev Fit	Residual	St Resid
15	5.20000	3.57562	0.76705	1.62438	2.40R
16	1.72000	3.34437	0.76705	-1.62437	-2.40R

R denotes an observation with a large standardized residual.

Table N9: Summary table of General Linear Model results for cholesterol profile.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for CHOL, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	3.9373	3.9373	3.9373	0.73	0.424
Trial	1	0.3422	0.3422	0.3422	5.77	0.047
Subject(Group)	6	32.1595	32.1595	5.3599	90.33	0.000
Error	7	0.4154	0.4154	0.0593		
Total	15	36.8544				

Table N10: Summary table of General Linear Model results for Physical Activity Scale for the Elderly.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for PASE, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	10128.4	10128.4	10128.4	4.32	0.083
Trial	1	1493.2	1493.2	1493.2	3.37	0.109
Subject(Group)	6	14071.8	14071.8	2345.3	5.29	0.023
Error	7	3106.0	3106.0	443.7		
Total	15	28799.5				

Unusual Observations for PASE

Obs	PASE	Fit	StDev Fit	Residual	St Resid
7	65.000	97.639	15.798	-32.639	-2.34R
8	149.600	116.961	15.798	32.639	2.34R

R denotes an observation with a large standardized residual.

Table N11: Summary table of General Linear Model results for predicted VO_{2max}.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for VO2, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	8.932	8.932	8.932	0.11	0.753
Trial	1	5.641	5.641	5.641	8.61	0.022
Subject(Group)	6	495.377	495.377	82.563	126.07	0.000
Error	7	4.584	4.584	0.655		
Total	15	514.534				

Table N12: Summary table of General Linear Model results for timed 'Up & Go' test.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	8	1 3 7 4 6 10 11 18

Analysis of Variance for TUGT, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	9.087	9.087	9.087	0.74	0.424
Trial	1	22.326	22.326	22.326	6.14	0.042
Subject(Group)	6	74.057	74.057	12.343	3.40	0.067
Error	7	25.439	25.439	3.634		
Total	15	130.909				

Table N13: Summary table of General Linear Model results for high density lipoprotein profile.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	7	1 3 4 6 10 11 18

Analysis of Variance for HDL, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	1.61573	1.61573	1.61573	4.87	0.078
Trial	1	0.01646	0.01646	0.01646	0.36	0.572
Subject(Group)	5	1.65996	1.65996	0.33199	7.21	0.016
Error	6	0.27634	0.27634	0.04606		
Total	13	3.56849				

Unusual Observations for HDL

Obs	HDL	Fit	StDev Fit	Residual	St Resid
7	1.54000	1.24571	0.16223	0.29429	2.09R
8	1.02000	1.31429	0.16223	-0.29429	-2.09R

R denotes an observation with a large standardized residual.

Table N14: Summary table of General Linear Model results for low density lipoprotein profile.

Factor	Type	Levels	Values
Group	fixed	2	1 2
Trial	fixed	2	1 3
Subject(Group)	random	7	1 3 4 6 10 11 18

Analysis of Variance for LDL, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	1	0.4368	0.4368	0.4368	0.18	0.691
Trial	1	0.1081	0.1081	0.1081	0.31	0.596
Subject(Group)	5	12.3406	12.3406	2.4681	7.17	0.016
Error	6	2.0658	2.0658	0.3443		
Total	13	14.9513				

Unusual Observations for LDL

Obs	LDL	Fit	StDev Fit	Residual	St Resid
13	3.60000	2.79286	0.44356	0.80714	2.10R
14	1.81000	2.61714	0.44356	-0.80714	-2.10R

R denotes an observation with a large standardized residual.

Appendix O

Model Adequacy Plots for the model 2

GROUP TRIAL SUBJECT(GROUP)

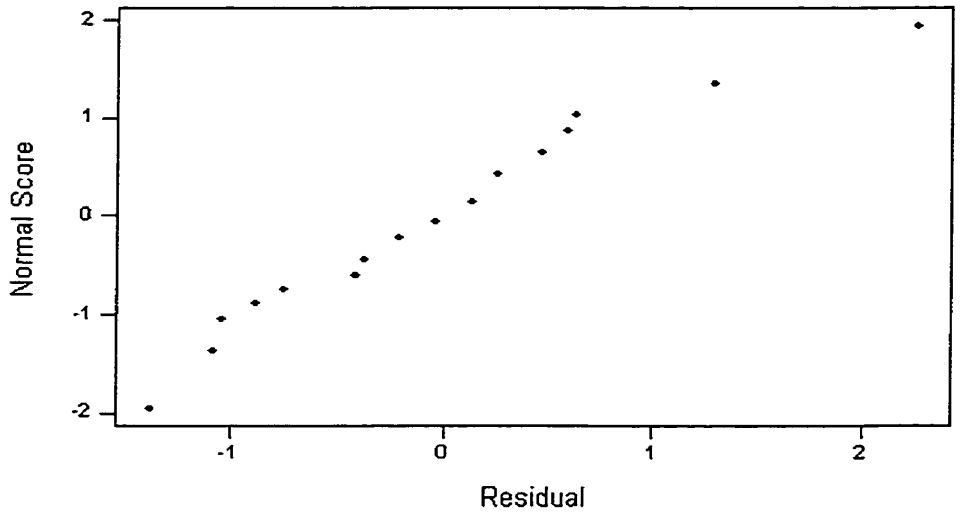


Figure O1: Normal probability plot of the residuals for the response Geriatric Depression Scale Scores.

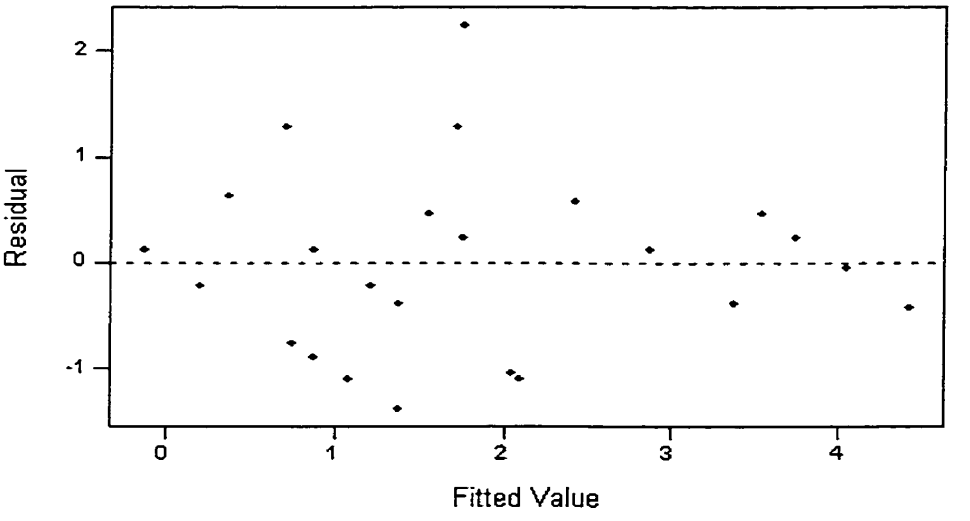


Figure O2: Residuals versus the fitted values for the response Geriatric Depression Scale Scores.

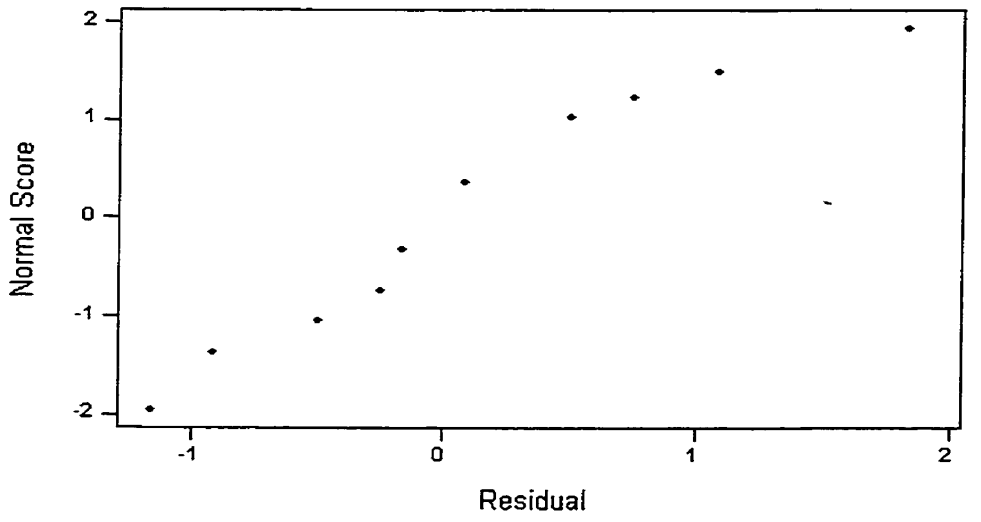


Figure O3: Normal probability plot of the residuals for the response Groningen Activity Restriction Scale Scores.

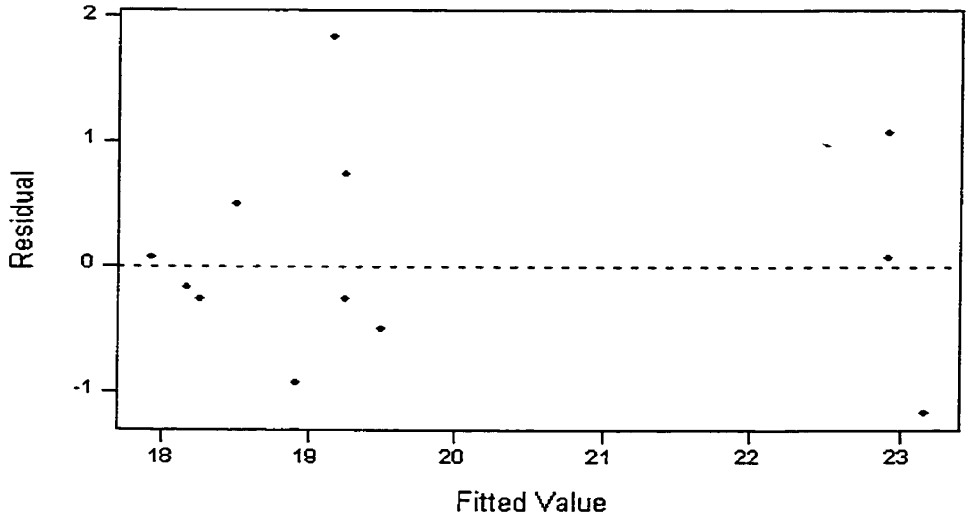


Figure O4: Residuals versus the fitted values for the response Groningen Activity Restriction Scale Scores.

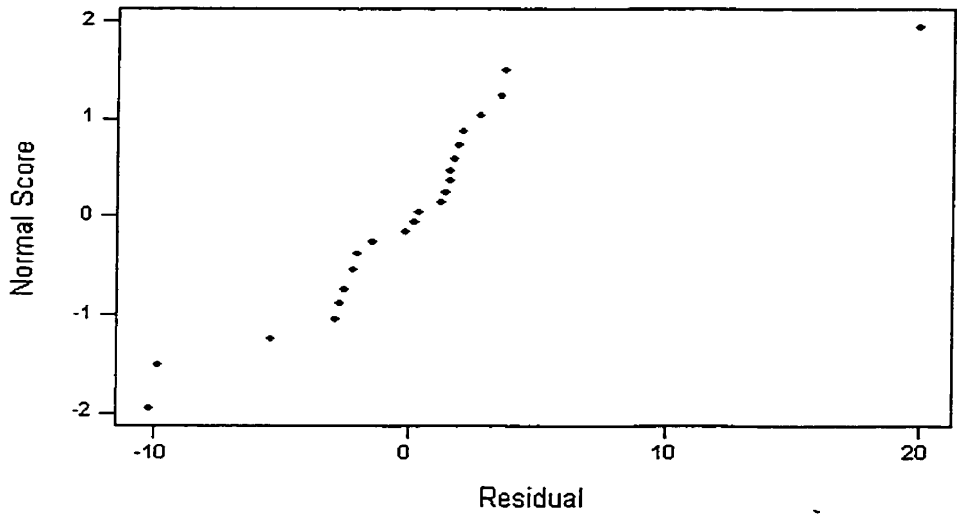


Figure O5: Normal probability plot of the residuals for the response weight.

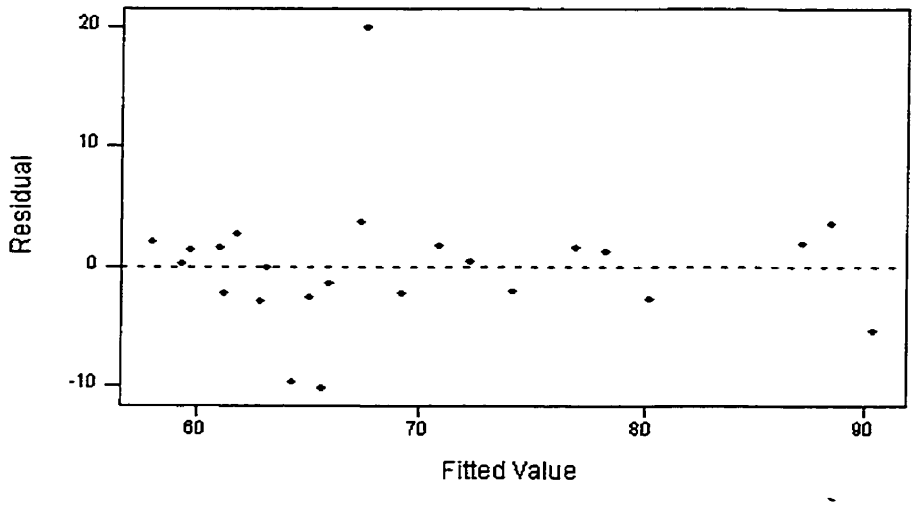


Figure O6: Residuals versus the fitted values for the response weight.

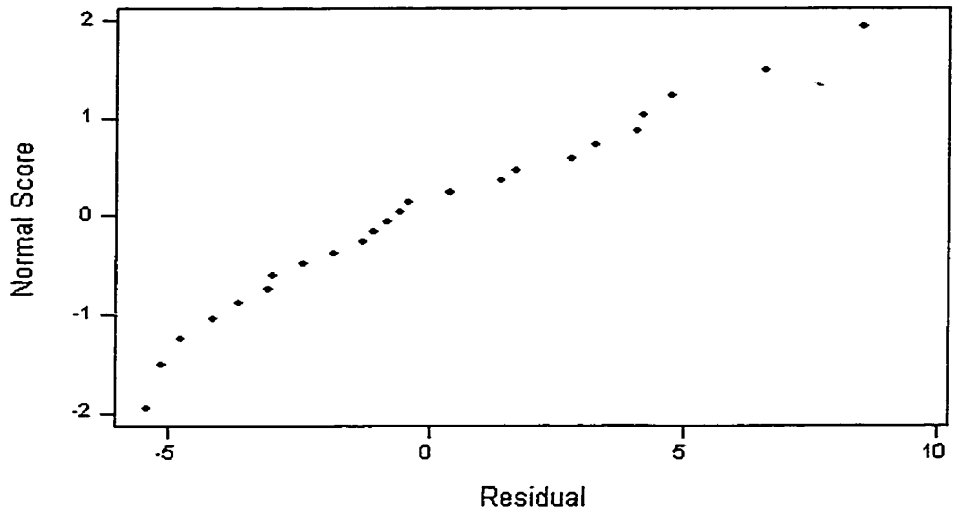


Figure O7: Normal probability plot of the residuals for the response waist girth.

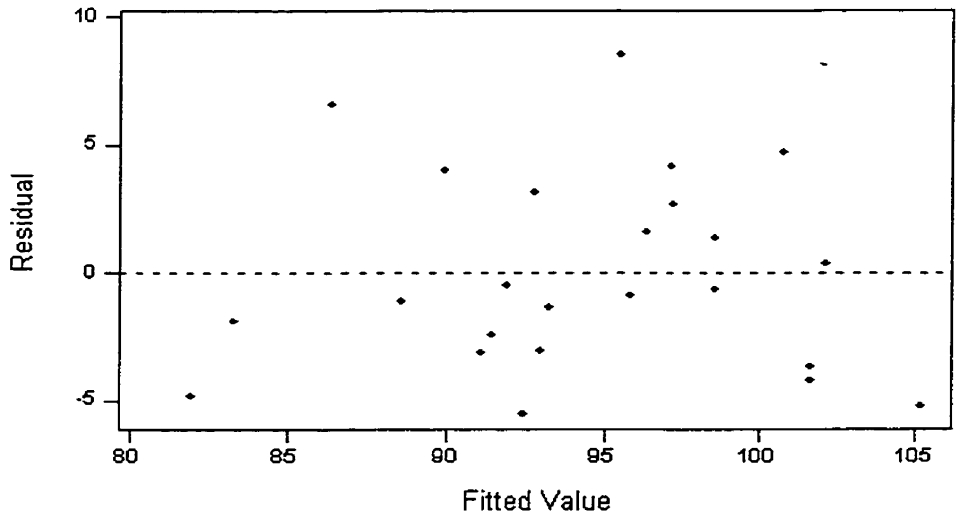


Figure O8: Residuals versus the fitted values for the response waist girth.

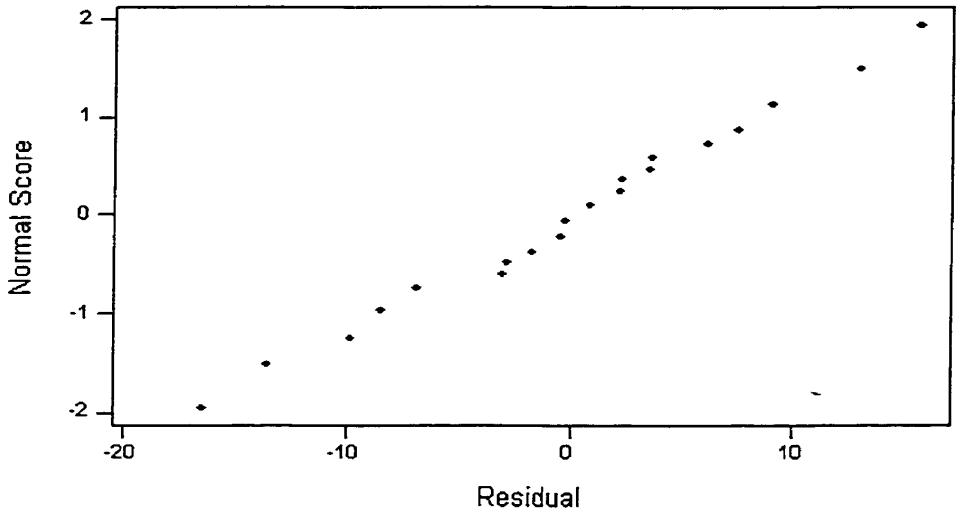


Figure O9: Normal probability plot of the residuals for the response resting heart rate.

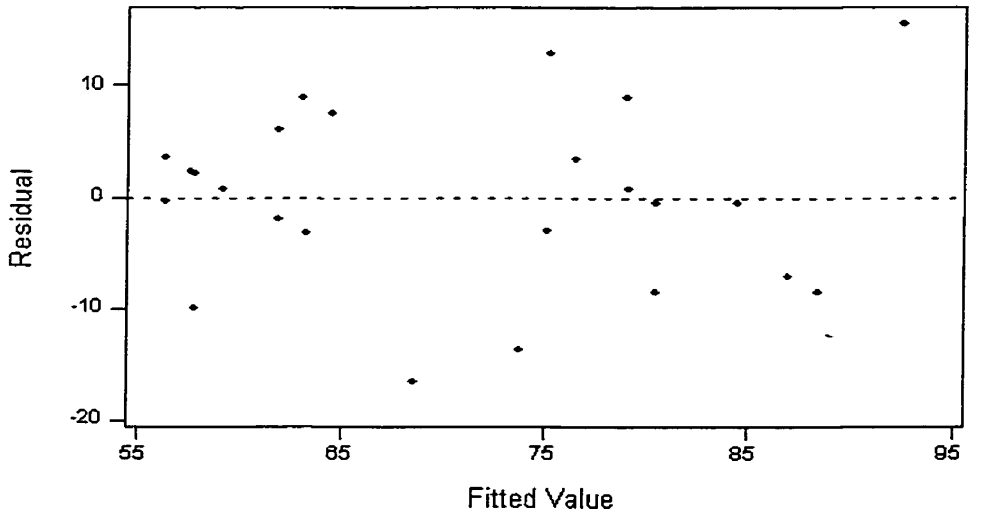


Figure O10: Residuals versus the fitted values for the response resting heart rate.

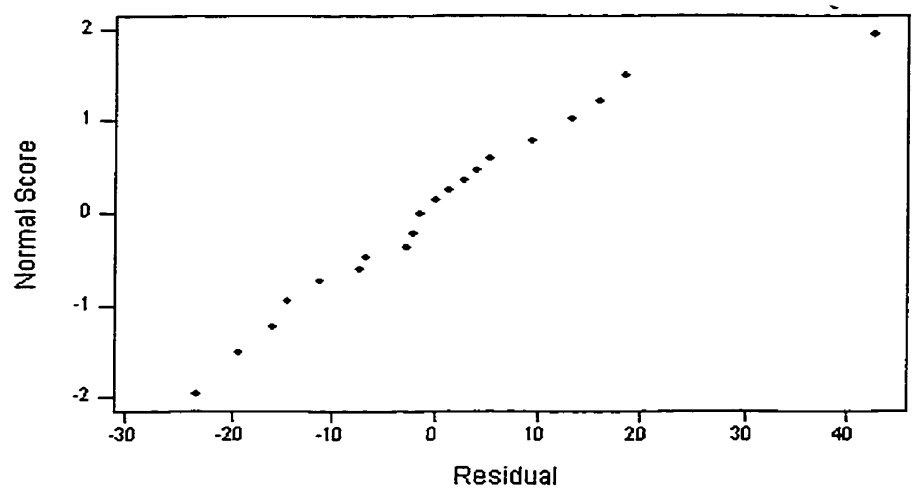


Figure O11: Normal probability plot of the residuals for the response systolic blood pressure.

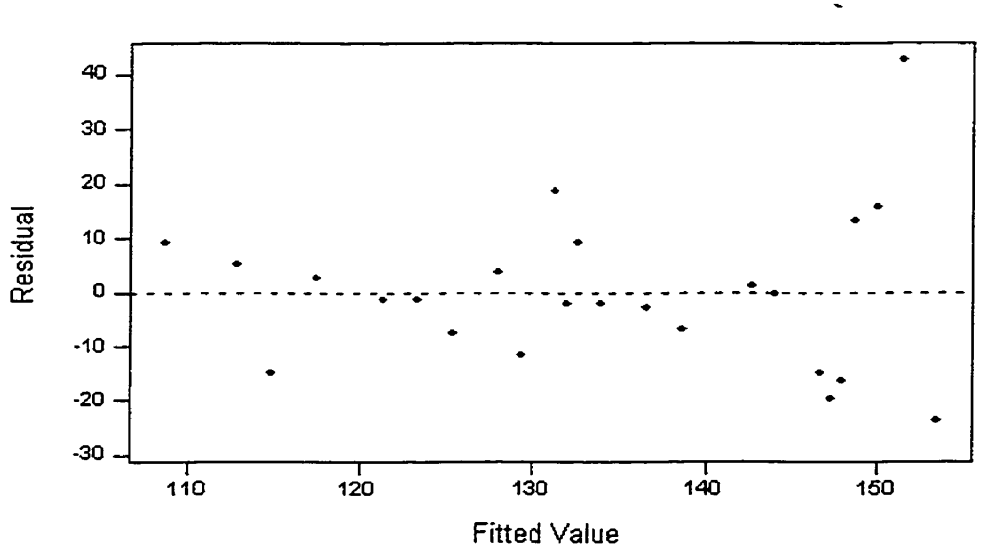


Figure O12: Residuals versus the fitted values for the response systolic blood pressure.

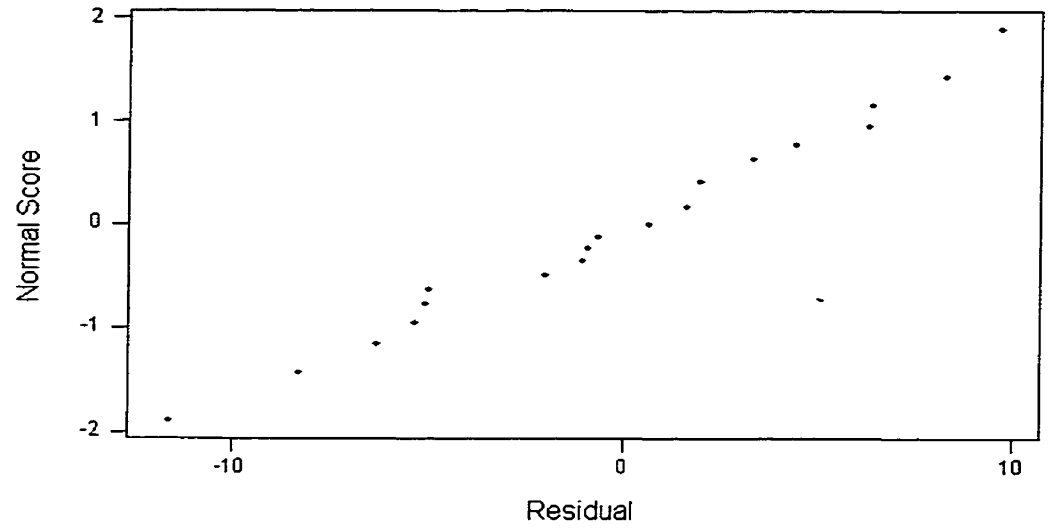


Figure O13: Normal probability plot of the residuals for the response diastolic blood pressure.

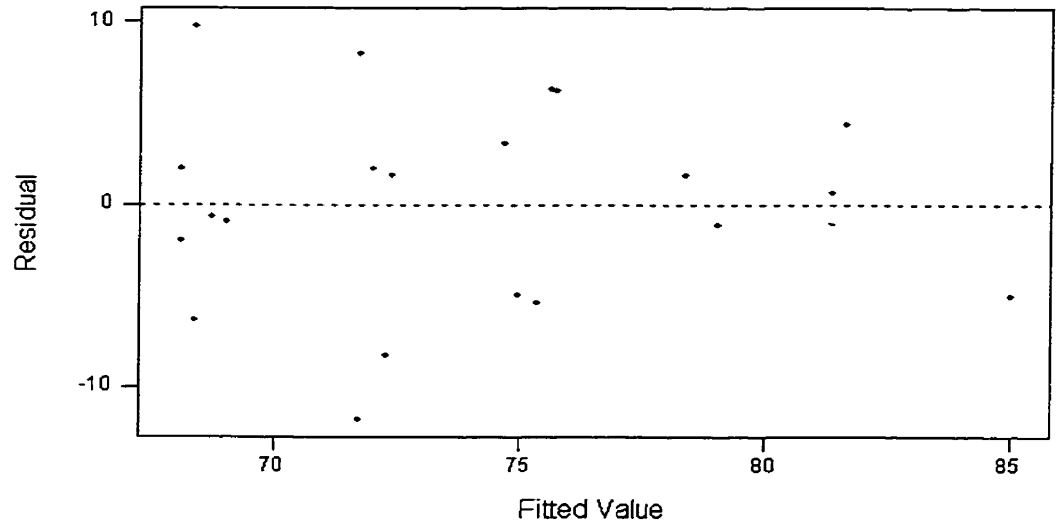


Figure O14: Residuals versus the fitted values for the response diastolic blood pressure.

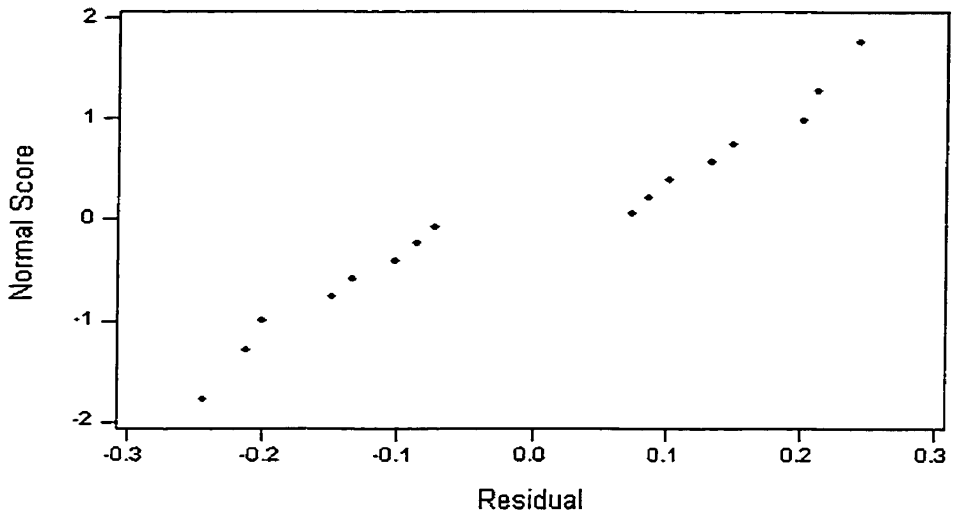


Figure O15: Normal probability plot of the residuals for the response cholesterol.

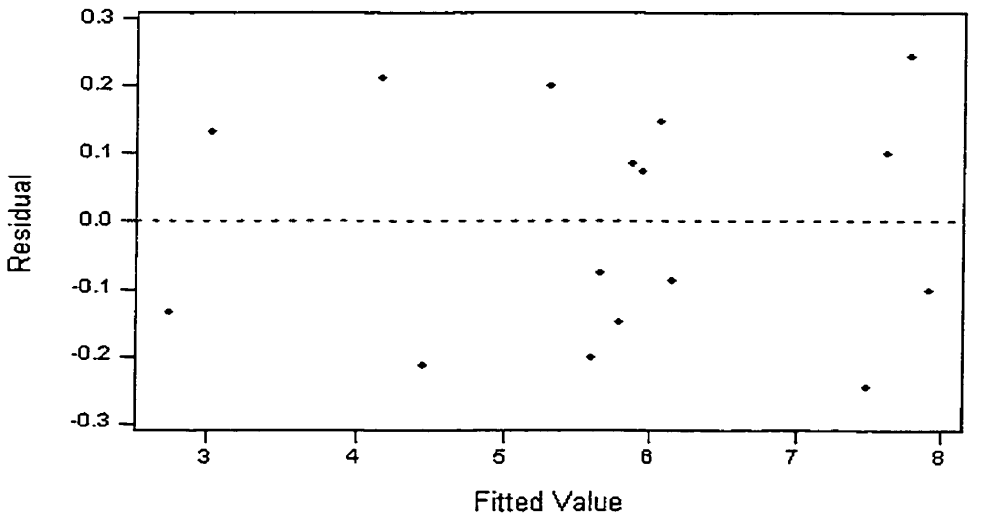


Figure O16: Residuals versus the fitted values for the response cholesterol.

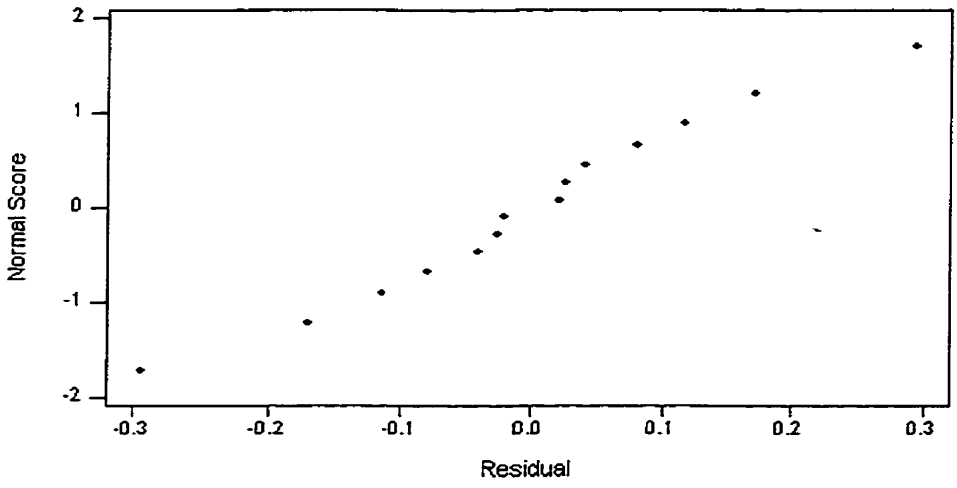


Figure O17: Normal probability plot of the residuals for the response high density lipoprotein (HDL).

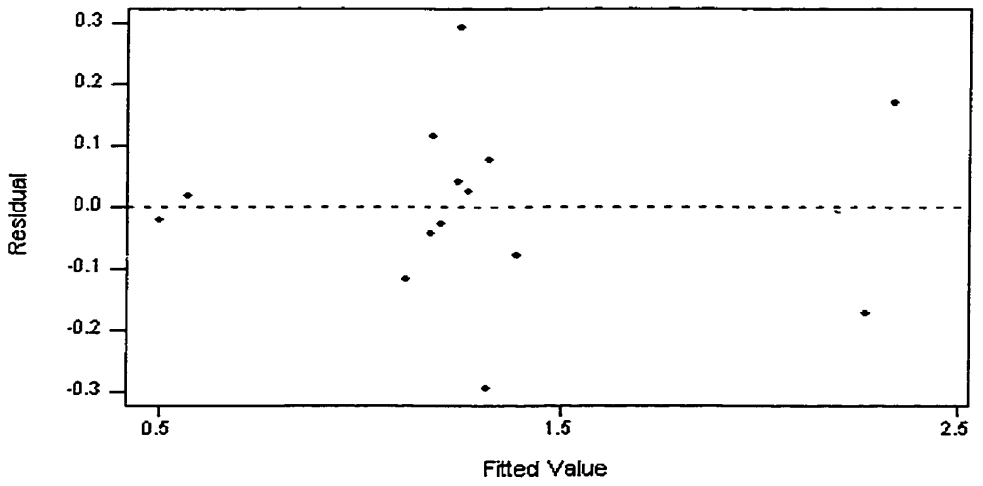


Figure O18: Residuals versus the fitted values for the response high density lipoprotein (HDL).

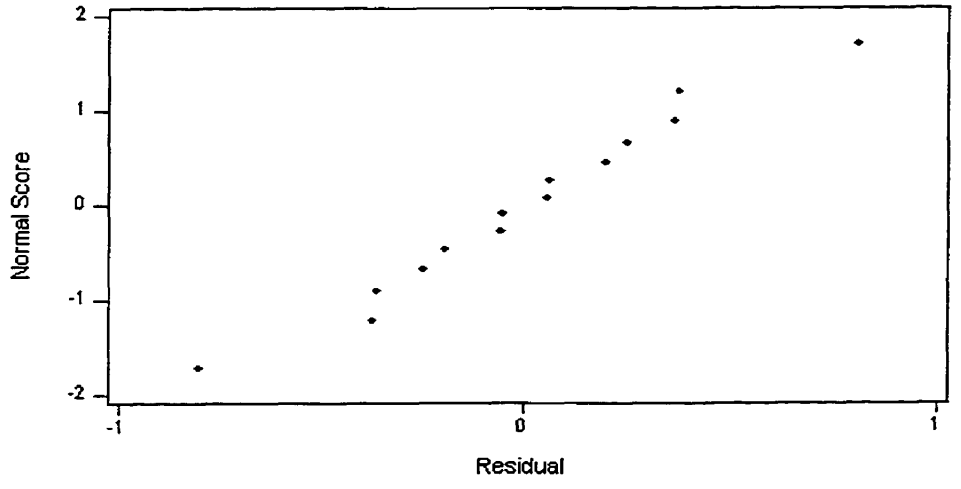


Figure O19: Normal probability plot of the residuals for the response low density lipoprotein (LDL).

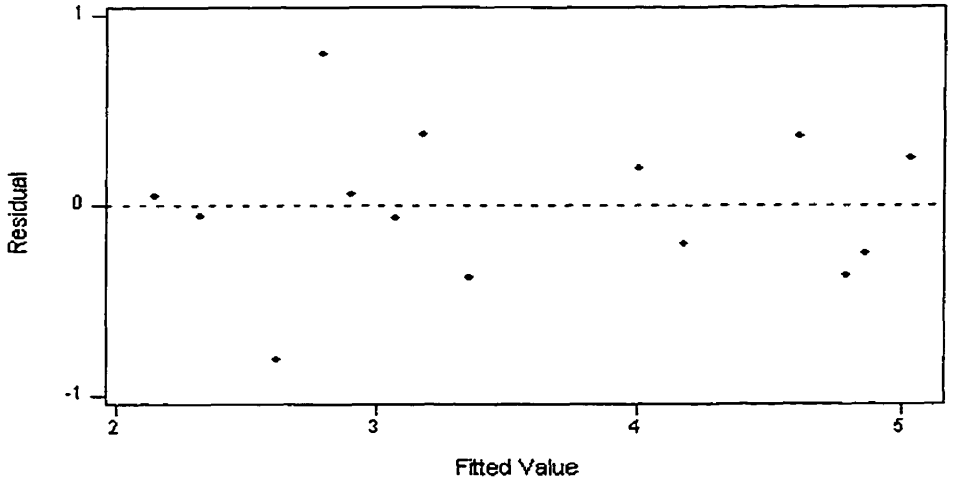


Figure O20: Residuals versus the fitted values for the response low density lipoprotein (LDL).

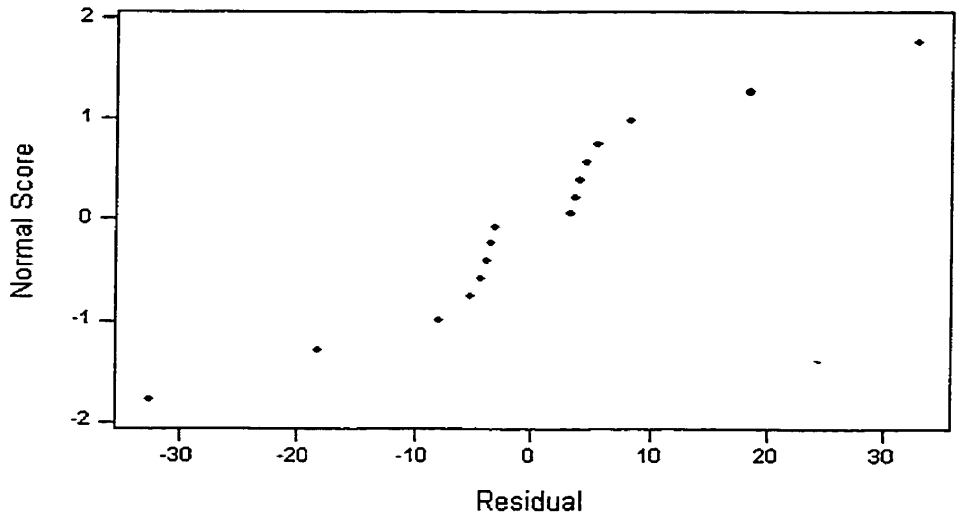


Figure O21: Normal probability plot of the residuals for the response Physical Activity Scale for the Elderly.

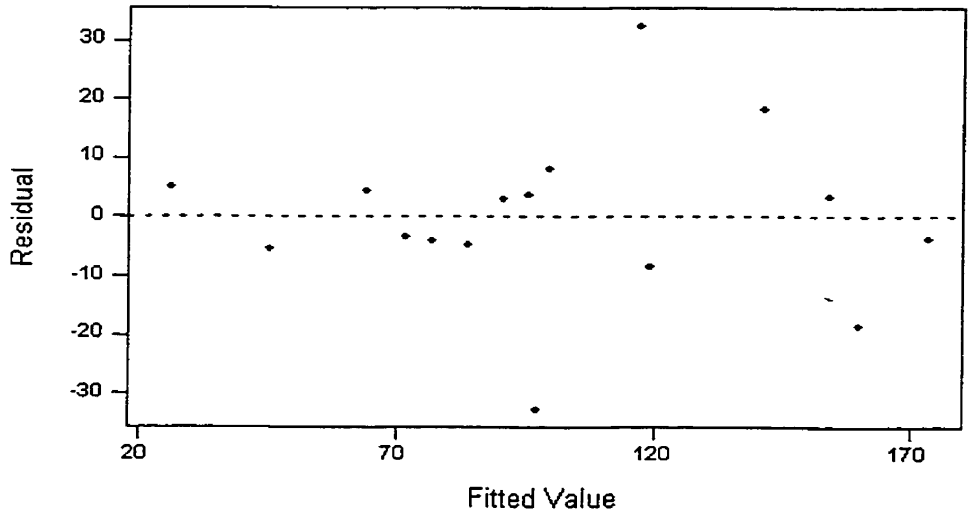


Figure O22: Residuals versus the fitted values for the response Physical Activity Scale for the Elderly.

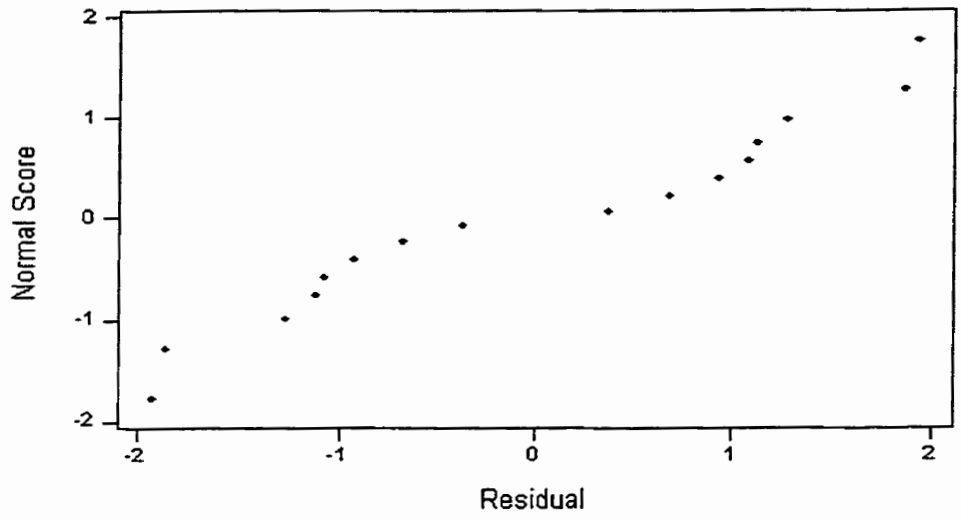


Figure O23: Normal probability plot of the residuals for the response timed 'Up & Go' test.

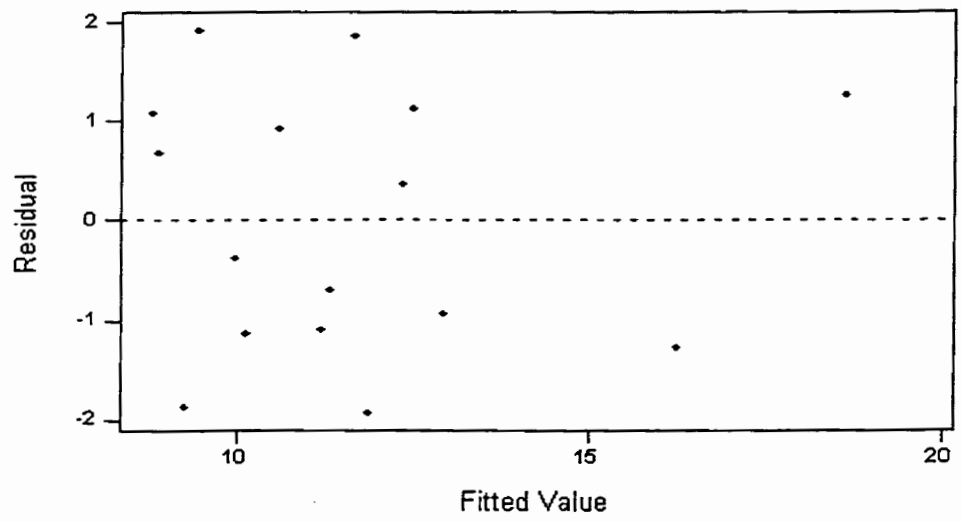


Figure O24: Residuals versus the fitted values for the response timed 'Up & Go' test.

Appendix P

Main Effects Plots

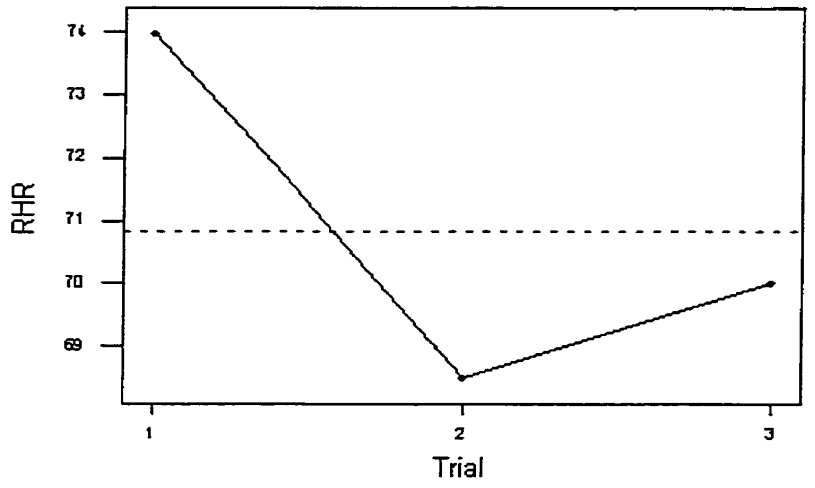


Figure P1: Main effects plot for resting heart rate.

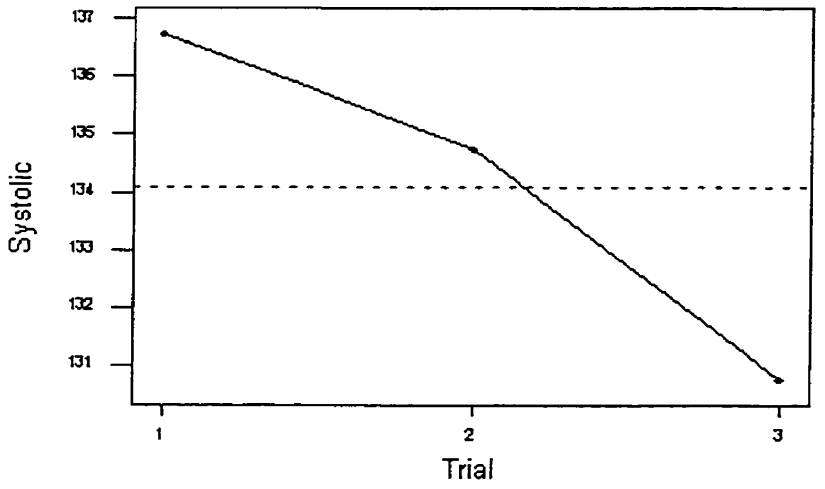


Figure P2: Main effects plot for systolic blood pressure.

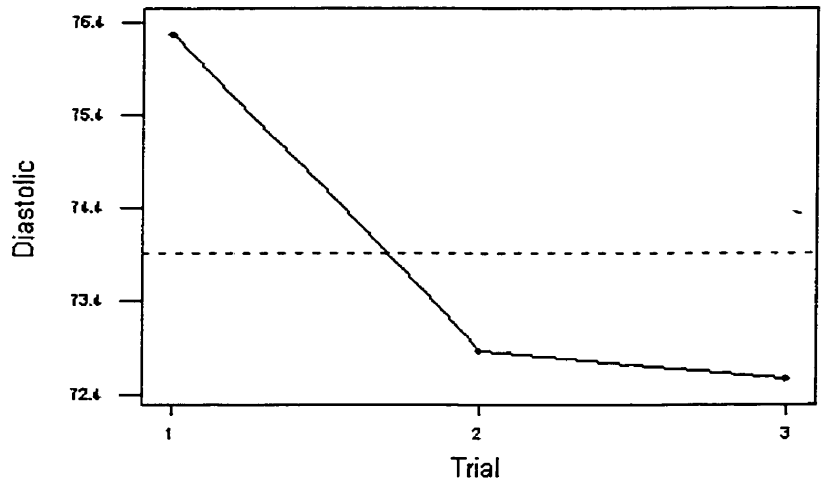


Figure P3: Main effects plot for diastolic blood pressure.

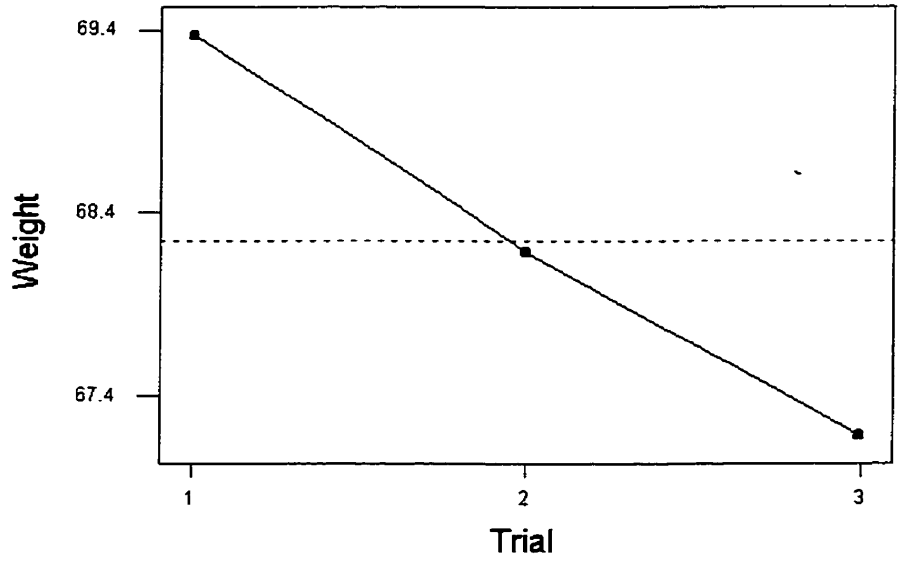


Figure P4: Main effects plot for weight.

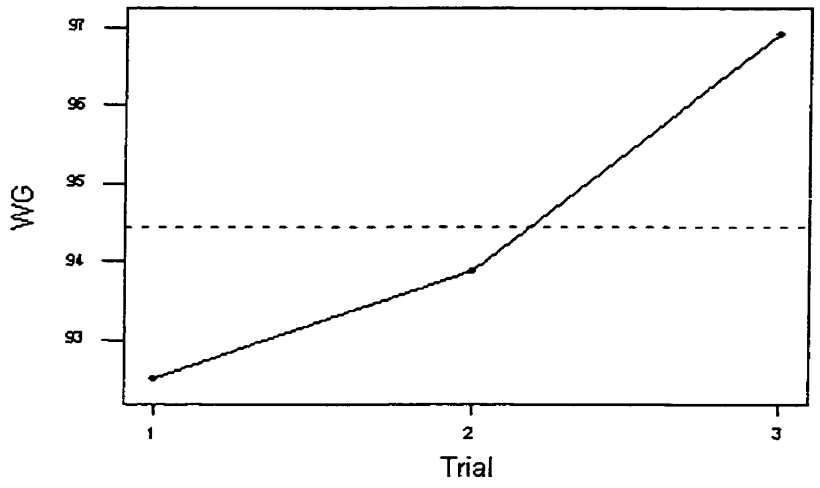


Figure P5: Main effects plot for waist girth.

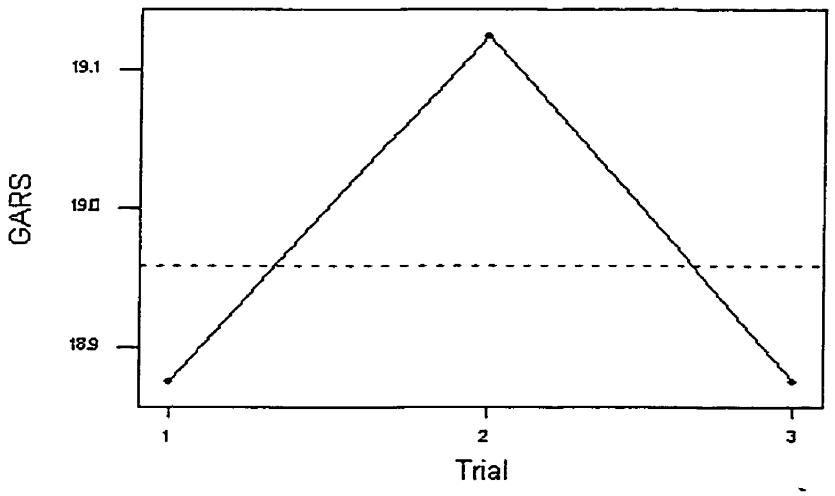


Figure P6: Main effects plot for Groningen Activity Restriction Scale.

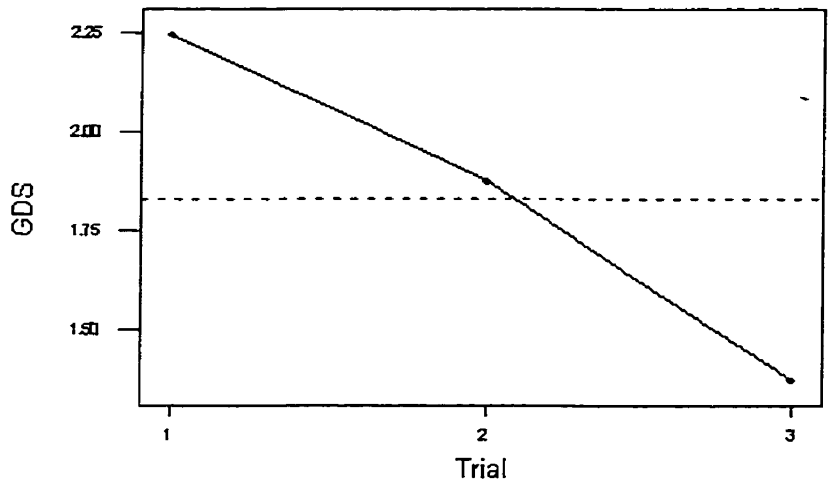


Figure P7: Main effects plot for Geriatric Depression Scale.

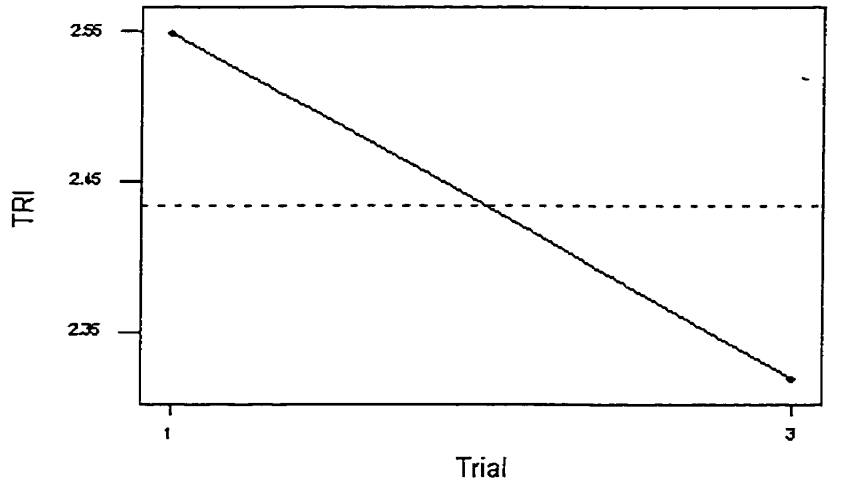


Figure P8: Main effects plot for triglyceride profile.

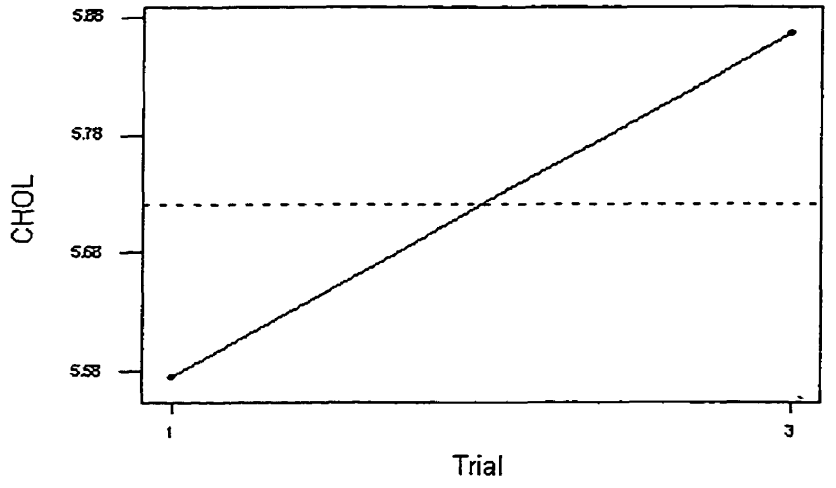


Figure P9: Main effects plot for cholesterol profile.

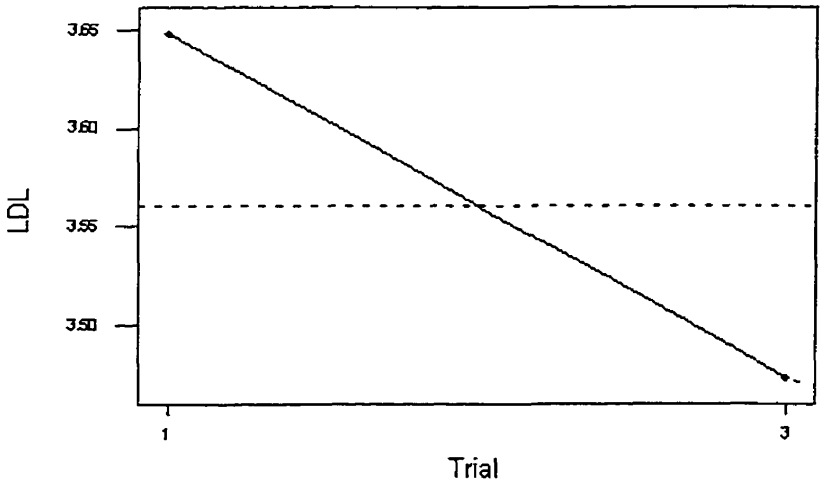


Figure P10: Main effects plot for low density lipoprotein profile.

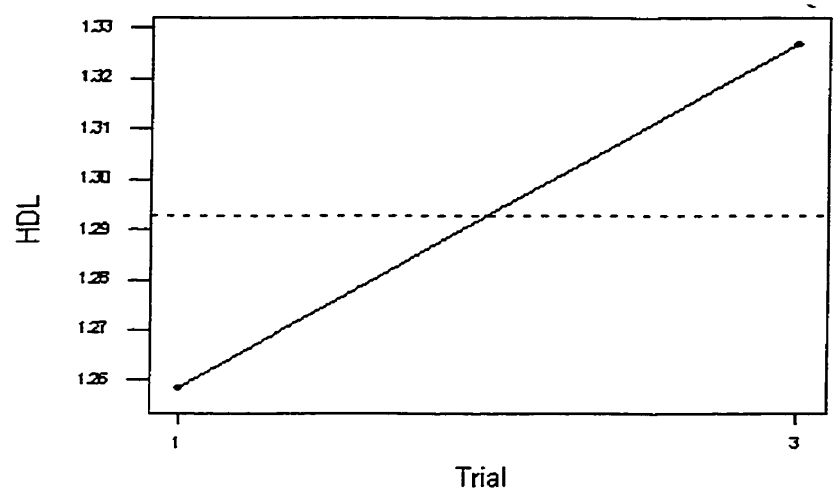


Figure P11: Main effects plot for high density lipoprotein profile.

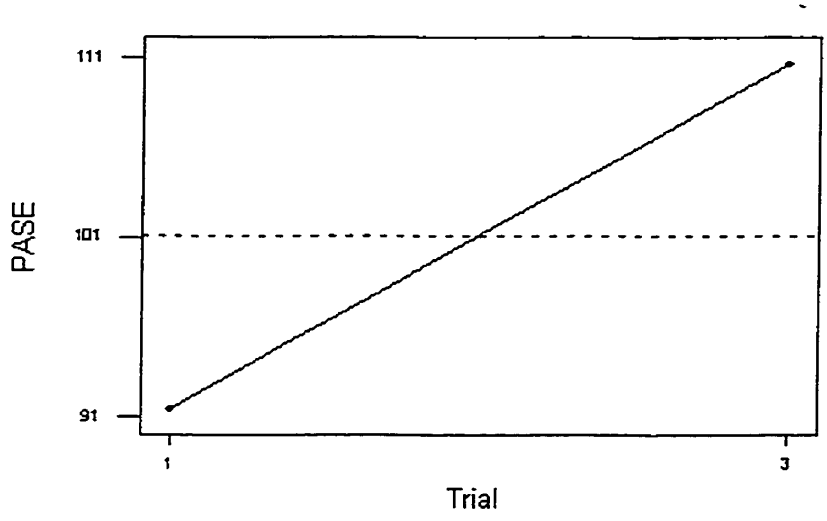


Figure P12: Main effects plot for Physical Activity Scale for the Elderly.

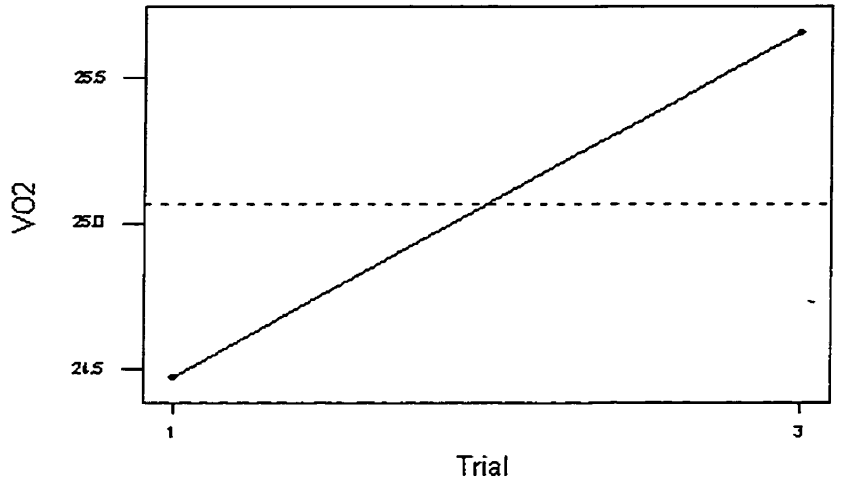


Figure P13: Main effects plot for predicted VO_{2max}.

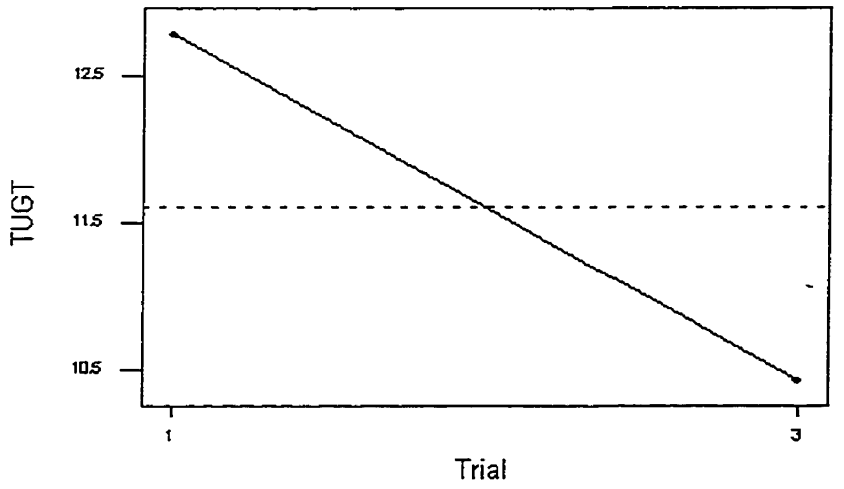


Figure P14: Main effects plot for timed 'Up & Go' test.

Appendix Q

Tukey Post Hoc Tests

Model - GROUP TRIAL SUBJECT(GROUP)

Table Q1: Results from Tukey post hoc test for weight.

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Weight
All Pairwise Comparisons among Levels of Trial

Trial = 1 subtracted from:

Trial     Lower     Center     Upper  ---------+---------+---------+----
---
2        -3.270    -1.187    0.8950          (-------------*------------
-)
3        -4.270    -2.187   -0.1050   (------------*-------------)
                                     ---------+---------+---------+----
---
                                            -3.0       -1.5        0.0


Trial = 2 subtracted from:

Trial     Lower     Center     Upper  ---------+---------+---------+----
---
3        -3.082    -1.000     1.082           (-------------*-----------
--)
                                     ---------+---------+---------+----
---
                                            -3.0       -1.5        0.0

Tukey Simultaneous Tests
Response Variable Weight
All Pairwise Comparisons among Levels of Trial

Trial = 1 subtracted from:

Level      Difference       SE of              Adjusted
Trial        of Means  Difference   T-Value     P-Value
2              -1.187      0.7960    -1.492      0.3243
3              -2.187      0.7960    -2.748      0.0392

Trial = 2 subtracted from:

Level      Difference       SE of              Adjusted
Trial        of Means  Difference   T-Value     P-Value
3              -1.000      0.7960    -1.256      0.4415
```

Table Q2: Results from Tukey post hoc test for cholesterol profile.

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable CHOL
All Pairwise Comparisons among Levels of Trial

Trial = 1 subtracted from:

Trial      Lower     Center      Upper  ----------+---------+---------+---
---
3       0.004296     0.2925     0.5807  (-----------------*---------------
--)
                                        ----------+---------+---------+---
---
                                                0.16      0.32      0.48


Tukey Simultaneous Tests
Response Variable CHOL
All Pairwise Comparisons among Levels of Trial

Trial = 1 subtracted from:

Level      Difference       SE of              Adjusted
Trial        of Means  Difference    T-Value     P-Value
3              0.2925      0.1218      2.402      0.0474
```

Table Q3: Results from Tukey post hoc test for predicted VO_{2max}..

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable VO2
All Pairwise Comparisons among Levels of Trial

Trial = 1 subtracted from:

Trial      Lower     Center      Upper  -------+---------+---------+------
---
3         0.2300      1.187      2.145   (---------------*---------------)
                                         -------+---------+---------+------
---
                                              0.60      1.20      1.80


Tukey Simultaneous Tests
Response Variable VO2
All Pairwise Comparisons among Levels of Trial

Trial = 1 subtracted from:

Level      Difference       SE of              Adjusted
Trial        of Means  Difference    T-Value     P-Value
3              1.187      0.4046      2.935      0.0219
```

Table Q4: Results from Tukey post hoc test for timed 'Up & Go' test.

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable TUGT
All Pairwise Comparisons among Levels of Trial

Trial = 1 subtracted from:

Trial     Lower    Center     Upper  -+---------+---------+---------+--
---
3        -4.618    -2.363   -0.1070  (--------------*--------------)
                                     -+---------+---------+---------+--
---
                                   -4.5      -3.0      -1.5       0.0


Tukey Simultaneous Tests
Response Variable TUGT
All Pairwise Comparisons among Levels of Trial

Trial = 1 subtracted from:

Level      Difference       SE of              Adjusted
Trial        of Means  Difference    T-Value    P-Value
3              -2.363      0.9532     -2.479     0.0423
```

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