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The Effects of Habitual Physical Activity on Number of Colds and Incidence of Cold Symptoms

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THE EFFECTS OF HABITUAL PHYSICAL ACTIVITY ON NUMBER OF COLDS AND INCIDENCE OF COLD SYMPTOMS

(TITLE)

BY

Katie Lynn Maniatis

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THE EFFECTS OF HABITUAL PHYSICAL ACTIVITY ON NUMBER OF COLDS AND INCIDENCE OF COLD SYMPTOMS

by
Katie Lynn Maniatis

A thesis submitted in fulfillment
of the requirements for
a Masters Degree in Physical Education

Department of PED
in the Graduate School
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ABSTRACT

The purpose of this investigation was to compare frequency of colds and symptoms of upper respiratory infection in college students who have different levels of habitual physical activity. Subjects were Eastern Illinois University students (N=535, aged 18-25). A survey was conducted which included questions inquiring about demographic information, physical activity habits, the number of colds contracted the month before the survey, and symptom number and severity. Data collection occurred between February 12th and March 1st, 1998. This particular time period was chosen for several reasons, including that student stress level should have been lower than at the beginning or end of the semester, and students had been back from break for a month, giving them time to acclimate to the environment in which they chose to live (dormitory, apartment, etc.). An ANOVA was conducted to check for significant differences in mean symptom score between activity groups (p=.0577). Moderate exercisers had the lowest mean symptom score followed by heavy exercisers, moderate actives, light actives, and sedentary, respectively. A Chi Square analysis was calculated for activity level and number of colds experienced within a month prior to survey distribution (p=.14). The mean number and intensity of symptoms gradually decreased with increased physical activity, with the exception of the heavy exercise group. Although the Chi square analysis was not statistically significant, the data showed that the mean rating of colds was least for the moderate actives and the moderate exercisers. Both the ANOVA and Chi Square analyses, when graphed, showed a J-curve appearance to the data, keeping in line with the current theory proposed by Nieman. This theory suggests that sedentary and heavy exercisers will have the most risk of infection, while moderate exercisers are at the least amount of risk. Also, Chi Square analyses were conducted for other factors which might effect immunity. Significant differences in symptom score were found between men and women, smokers and nonsmokers, and athletes and nonathletes.

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CHAPTER I

INTRODUCTION

"The Centers for Disease Control has estimated that over 425 million colds and flus occur annually in the United States, resulting in $2.5 billion in lost school and work days and medical costs" (Nieman, 1992, p. 1). Statistics such as these have drawn the attention of researchers and specifically exercise physiologists in recent years. Exercise physiologists have focused on whether physical activity has an effect on the human immune system. Searching for clues to human immunity is a new frontier in the world of research. For example, Nieman et al. (1993) reported that the natural killer cell, which is important in protecting the body against viral infections, was first discovered in the early 1970's. It should also be noted that this is an extremely difficult area of research due to the complexity of the immune system. Currently, there are no standard guidelines to follow in order to measure immunity and the effects of physical activity on immunity. Due to lack of standards in measurement, it is extremely difficult to compare research from different laboratories and researchers (Smith, 1994). Researchers also need to take into account the many variables which affect immunity. Smoking, age, nutrition, gender, environment, weather changes, hand washing habits, sleeping patterns, and stress level may all be involved in immunity.

Some interesting data exist about the relationship between physical activity and the immune system. First, many studies have concluded that overtraining or overexertion results in immunosuppression (Nieman et al, 1995; Kajiura, MacDougall, Ernst, & Younglia, 1995; Fry et al., 1994; Mackinnon, 1996; Nash, 1994; Nieman, 1992; Nieman, 1993; Pedersen, Rohde, & Zacho, 1996; Pyne, 1993; Shephard, Rhind, &Shek, 1994; Shephard & Shek, 1994; and Weidner, 1993). Although less definite, there seems to be a relationship between increased immunity and moderate amounts of exercise (Pedersen & Bruunsgaard, 1995; Greenleaf, 1994; Nash, 1994; Nieman, 1992; Nieman, 1993; and Weidner, 1993). Nieman (1993) has suggested that there is somewhat of a "J curve" appearance to the relationship of physical activity level and immune function. Both sedentary and overtrained persons would fall into an immunosuppressed category, while moderately active persons would fall into the immunoenhanced category.

Many investigators have measured immunity by taking blood samples and evaluating the presence of certain leukocytes in relationship to varying amounts of physical activity either cross-sectionally, longitudinally, or during acute bouts of exercise. While useful in determining cellular responses, these types of studies may lack validity in a real life situation. Cellular activity may not reflect what is actually happening to these people. Are they fighting illness? Do they feel ill? These types of studies may not provide a complete picture. Very few studies have evaluated the effects of physical activity on immunity using a large sample size. Also, many studies focus on elite athletes, marathon runners, and most studies use predominantly male subjects. More testing is needed using a general population.

Scope of the Study

The subjects for this study were students aged 17 to 25 years who were enrolled in Eastern Illinois University (located in east central Illinois). University athletes were included in the sample to evaluate their resistance to sickness in comparison to the general population of university students. This study incorporated a large number of subjects and attempted to better define the relationship of habitual physical activity and immune function.

Purpose

The purpose of this study was to compare the frequency of colds and symptoms of upper respiratory infection(s) in college students who have different levels of habitual physical activity.

Hypothesis

Students with moderate levels of habitual physical activity will have a lower incidence of colds and upper respiratory symptoms than students who are either sedentary or who have a very high level of activity.

Limitations

1. The months of January and February are considered cold and flu season. This may have a bearing on the results, yet any season could have an effect one way or the other. Spring and fall are allergy season, and summer would most likely show very few colds. For example, the pilot study which took place during the fall resulted in many subjects pointing out that their "cold" symptoms were in fact allergies.

2. After collecting all of the surveys and compiling the data, it was observed that a stress level should have been asked of subjects, because stress can be influential in a person's ability to fight infection.

Definition of Terms

Common Cold: when all airways are affected or blocked. (Ex: If your only symptom is a sore throat, this is not a cold.)

Habitual Physical Activity:

Sedentary: persons who engage in less active pastimes and very rarely or never exercise and sweat; persons who rarely exert themselves physically.

Light Activity: occasional mild exercise which usually doesn't induce sweating, and has no habitual regularity.

Low Moderate Activity: activities intense enough to induce sweating or mild aerobic exertion and which are usually pursued one to two times per week for between 10-20 minutes.

Moderate Activity: aerobic activities which require significant exertion and may result in shortness of breath and sweating and are usually pursued three to five times per week for between 20-60 minutes; however, these activities are not so intense that they create a discomfort other than sweating.

Heavy Activity: intense aerobic activity which is usually pursued five to seven days per week for 40 minutes or more, resulting in uncomfortable levels of shortness of breath and/or sweating.

Immune System: the human body's complex set of cells designed to resist almost all types of organisms or toxins that tend to damage the tissues and organs (Guyton & Hall, 1996).

Leukocytes: the mobile units of the bodies protective system, mostly made up of white blood cells (Guyton and Hall, 1996).

Natural Killer Cells: large lymphocytes that are thought to aid against virally infected cells, certain tumor cells, and some microorganisms (Acker et al, 1996).

T-Cells: T-lymphocytes that are formed and released into the lymph (Guyton and Hall, 1996).

CHAPTER II

LITERATURE REVIEW

Introduction

In 1982, Soppi, Varjo, Eskola, and Laitinen performed the first study investigating the relationship between physical activity and immunity. Since then much research has been done in this field; however, it has been less than twenty years since the first study, and this area of research is still in development. This chapter will summarize what research has been done thus far on the relationship between physical activity and immunity.

First, a short summary on immune function will be presented. Next, the effects of acute exercise on the immune system will be discussed. Overtraining has a number of effects on immunity. This chapter will explain what exactly is happening to the immune system and to an individual during overtraining. What about when a person is completely sedentary? According to Nieman (1992), those who excessively exercise have a slightly higher risk of infection than sedentary individuals. On the other hand, moderate activity is said to boost immune function. The mystery remains as to what amount of moderate activity enhances immunity. Many studies in this area have evaluated the effects of a certain level of physical activity on a certain cell within the immune system. Cellular activity will only be discussed in relation to the topics within this study. There are many other factors which affect the immune system, including age, stress level, rate of exposure, and certain psychological factors. Although this type of research is relatively new, there is much to consider when investigating the relationship between physical activity and immunity.

The Immune System

Human immunity is a complex system which fights bacteria, viruses, fungi, and parasites when the body is exposed to them. There are many components to this "army". According to Roger J. Booth (1993), the immune system is composed of four separate categories which work together. These are the primary lymphoid organs, the secondary lymphoid organs, the cells, and the molecules. Furthermore, each of these is subdivided. The primary lymphoid organs are the bone marrow and thymus. The secondary lymphoid organs are the spleen, lymph nodes, tonsils, adenoids, Peyer's patches, gut-associated lymphoid, and islands. The cellular portion of the immune system is immense and includes lymphocytes, monocytes, macrophages, and other antigen-presenting cells. Finally, the molecules include antibodies, complement, and cytokines (Booth, 1993). There has been much emphasis on the cellular component of the immune system; however, it seems that researchers pick apart certain cells and extrapolate singular responsibility for the relationship between certain cells and immunity. It is more likely that the answer is an array of cellular and chemical components which work together to give enhanced immunity. It is certainly beneficial to find the relationship between specific cells and immunity, but then it is necessary to compile this information in order to develop a full picture. Booth (1993) reports that blood samples contain only 2% of the total lymphoid pool, yet many researchers use blood sampling to investigate lymphocyte levels within the body.

It is important to understand the nature of a cold for the scope of this study. Colds usually originate from one of several rhinoviruses. They occur more frequently between mid-September to late April and early May (Swain et al, 1998). As common as the cold is, there is no cure as of now. The best advice professionals give for prevention is frequent hand washing.

Acute Exercise and Immunity

During acute exercise there are a number of changes which take place in the immune system, including fluctuations of many types of lymphocytes. As early as 1902, Larrabee detected leukocyte changes during physical activity (as cited in Pedersen and Bruunsgaard, 1995). Shephard and Shek (1994) give a helpful summary of the cellular changes in a typical response during acute physical activity. Leukocyte counts tend to increase during exercise and fall immediately following exercise and then rise to preexercise levels about six hours after exercise. On the other hand monocytes usually increase during and after exercise. Counting lymphocytes during acute exercise is difficult because it varies with each type. For example, interleukin 2 counts increase, cytotoxic cell counts increase, but helper cell counts decrease. Natural killer cells increase in count and activity unless the exercise is long or exhausting in nature. Cell proliferation rates or production rates are unchanged by moderate activity and depressed by heavy activity. Immunoglobulin levels decrease from high intensity exercise (Shephard and Shek, 1995). In 1991 a study was conducted using maximal bicycle ergometry testing. It was found that natural killer (NK) cells increased in activity and number (Solomon, 1991). Yet, several other studies showed that even one intense exercise session causes immunosuppression (Fitzgerald, 1991).

So we know what happens to the immune system during acute exercise on a cellular level, but what does this all mean? There have not been any conclusive reports as to the applicability of cell counts with overall immunity. It is known that there are differences in immune response when comparing moderate amounts of activity and high intensity, long duration exercise. Perhaps the difference lies in the fact that high intensity exercise increases leukocytosis by as much as 50-100%, and then three to six hours later the levels are 30-50% lower than preexercise, while moderate amounts of exercise do not produce nearly as much of a decrease (Nieman, 1994). Very simply put, Nieman theorizes that

> "To spot invading bacteria and viruses, immune cells must constantly circulate through the bloodstream, just the way cops patrol the streets on the lookout for trouble," he explains. "Physical activity increases heart rate and speeds up blood flow, which in turn speeds the circulation of immune cells though the body. Increased blood flow may even jog immune cells out of lymph nodes, where they tend to gather, and into the bloodstream. That's crucial. The more immune cells you've got out there on the beat, the more likely they are to bump into the bad guys and arrest them."
> (as cited in Jaret, 1993, pp. 44 , 45).

This is an excellent analogy to explain why moderate activity as opposed to inactivity might enhance immunity, yet it fails to explain why long duration, high intensity exercise could cause the opposite effect.

Overtraining, High Intensity Exercise, and Immunity

Definition and Position

Overtraining is chronically over-exerting the body physically to the point of harm. Many times an overtrained athlete experiences insomnia, sickness, depression, and decreased performance. Overtraining and high intensity exercise of over an hour tend to cause immunosuppression (Nieman et al., 1995; Kajiura, MacDougall, Ernst, & Younglai, 1995; Fry et al., 1994; Mackinnon, 1996; Nash, 1993; Nieman, 1992; Nieman, 1993; Pedersen, Rhode, & Zacho, 1996; Pyne, 1993; Shephard, Rhind, &Shek, 1994; Shephard & Shek, 1994; and Weidner, 1993).

How Much is Too Much?

The intensity and volume of training that induce overtraining symptoms are highly dependent upon the individual. Some of the symptoms which commonly accompany overtraining are amenorrhoea, increased susceptibility to infection, and increased susceptibility to stress fractures (Fry et al., 1994). Pedersen and Bruunsgaard (1995) report that the immune system is only suppressed with activity of one hour or more accompanied by a high intensity. In 1993, Peters and Bateman compared 150 runners who competed in a 56 km race and found that infection was more likely in those runners who trained at a higher intensity prior to the race (as cited in Pyne, 1994). It might be noted that a 56 km race could cause immunosuppression in itself and their findings may not be due to training intensity. Berglund and Hemmingson (1990) reported upper respiratory infections in 121 male and 53 female elite cross-country skiers. They found upper respiratory infections to be the single most common reason for absence from training. Interestingly, the mean number of infections was the same as a non-trained adult during the same season. In 1991, Heath et al. showed that mileage was an indicator of amount of upper respiratory tract infections (as cited in Pyne, 1994). Even Olympic athletes may come down with a cold or upper respiratory infection which affects performance. UK Olympic gold medalist Sebastian Coe was so affected by an upper respiratory infection that he failed to qualify for the Seoul Olympics (Fitzgerald, 1988). In another study, Verde et al. (1992) reports that of ten distance runners, two developed an acute rhinoviral infection after their training had been significantly increased. This in itself is not conclusive evidence; however in conjunction with other findings it is worth noting. Fitzgerald (1991) explained that according to several studies, student athletes are much more susceptible to infections than other students. The reasoning behind these studies seems to be linked to stress of competition and/or overtraining. Nieman (1992) conducted a landmark study in which he followed participants of the Los Angeles Marathon and a group of persons who had trained for the competition but did not compete. He found that 12.9% of the Los Angeles Marathon runners that he followed reported symptoms of infection, while only 2.2% of the controls reported infection symptoms. Additionally, 40% of these runners reported illness in the two months prior to the race. Running more than 96 km per week nearly doubled a runner's chances of developing an infection. It is safe to assume that marathon type events are immunosuppressive, yet the amount of activity at which this changes and the immune system is enhanced is still unclear.

Why Does Overtraining Suppress the Immune System?

There aren't clear answers to this question, but there is speculation that it is associated with increased epinephrine and cortisol levels. Nieman et al. (1992) and Berk et al. (1990) concluded that cortisol rose 59% above normal levels after three hours of acute running. Rohde et al. (1996) studied the changes in serum glutamine during a triathlon. This study revealed that there were glutamine concentration decreases; however, there were also significant decreases in serum amino acids, NK cell activity, and lymphokine activated killer (LAK) cell activity. The methods with which this group performed their study appear sound, except for the low subject number of eight male elite athletes. Blood samples were obtained at rest and during each event of the race. From this study, it appears that serum glutamine, amino acid depletion, NK cell activity, and LAK cell activity might play a role in the suppression of the immune system that is often seen accompanying high intensity, long duration activity.

Conclusion to High Intensity, Long Duration Exercise and Immunity

It is clear that overtraining and high intensity exercise have detrimental effects on the immune system. There are parameters which lend to overtraining. Verde et al. (1992) concluded that the best determinant of overtraining in athletes is increased fatigue and decreased vigor. The simple conclusion is that overtraining does not lend to maximum athletic performance and increases the chance of infection.

Moderate Activity and Immunity

Introduction and Position

The effects of moderate activity on the immune system are much less clear. It is thought that moderate activity causes enhancement in immunity (Pedersen and Bruunsgaard, 1995; Greenleaf, 1994; Nash, 1993; Nieman, 1992; Nieman, 1993; and Weidner, 1993). Pedersen et al. (1996) sumed up the fact that there are very few studies which compare upper respiratory tract infection in large groups of moderately active individuals.

What is Moderate Activity?

Research does not give a clear definition as to what moderate intensity activity is and at what point it tends to enhance immunity. Smith (1994) attributes this lack of research to the fact that there are no research guidelines and standards in this area. For the scope of this study moderate activity will be divided into low moderate activity and moderate activity as defined in Chapter I. Moderate activity has been defined based on American College of Sports Medicine (1995) recommendations that a person should exercise aerobically three to six times per week for twenty to thirty minutes. The American College of Sports Medicine has recently added to their position stand that aerobic activity in bouts of ten minutes at a time adding to twenty minutes is sufficient in attaining physical fitness benefits (Pollock et al, 1998). Aerobically exercising means using large muscle groups such as the arms and legs to initiate movement with increased oxygen consumption.

There has been some research in this area; however, results are inconclusive and difficult to separate due to variability within the studies. A study by Kajiura, MacDougall, Ernst, and Younglai (1995) concluded that more research was needed in order to define optimal intensity and duration of exercise for enhancing immune function. According to Moyna et al. (1996, 217), "Our findings suggest no measurable effects on resting immune status in males and females who undertake regular exercise in order to improve overall health status". Nieman (1992) reported that runners training 96 km per week or more are twice as likely to experience infectious symptoms than those running 32 km per week. He suggested frequent but moderate amounts of activity for optimal health. Another important finding was a study done by Nieman and Nehlsen-Cannarella (1990) in which a group of sedentary, obese women started walking 45 minutes five times per week for 15 weeks. The results showed that the sedentary controls reported twice as many upper respiratory tract infection symptoms as the exercising group. This study is of particular importance because the exercise was moderate. In these subjects serum immunoglobulins increased 20% and NK cell activity increased significantly. There was a study conducted comparing elite Danish cyclists in which the cyclists showed about 7% more NK cell activity than sedentary controls (Pedersen et al., 1996). With these results it must be noted that only 2% of cellular immunity can be found in the blood and measurement of one type of cell does not ensure enhancement of immunity.

Surveys show that moderate exercisers do perceive themselves with an enhanced immunity. Runners World conducted a survey showing 61% of 700 recreational runners felt that they had contracted less colds now than before they started to run, and only 4% felt they experienced more. Another survey showed of 170 runners, 90% reported that they rarely get sick. Also, a survey of 750 masters athletes showed 76% perceive themselves as more resistant to illness than sedentary persons (Nieman, 1997). Nieman et al. (1992) reported that the incidence of the common cold was nearly 30% lower in a group who walked 40 minutes five times a week for 12 weeks during the fall season than in sedentary controls. Heath et al. reported that running less than 16 km per day gave the lowest odds ratio for contracting infection, yet the ratio more than doubled in those running more than 27 km per day (as cited in Pedersen and Bruunsgaard, 1995).

Why Does Moderate Activity Cause Immunoenhancement?

Science has not provided a clear cut reason as to why moderate activity enhances immunity. It appears that enhancement is due to the increase in NK cells which is related to increases in epinephrine and cortisol (Swain et al., 1998). Unlike during high intensity or high volume exercise, stress hormones that depress immunity are not elevated during moderate activity and this gives the immune system an extra "boost" with which to fight infection (Nieman, 1997).

Conclusion to Moderate Activity and Immunity

While most professionals conclude that there is enhanced immunity with moderate activity, there is very little evidence to support this theory. Many of the studies that have been done vary in their definition of moderate activity. Perhaps future research should clearly define moderate activity so that researchers may gain a clearer understanding as to what amounts and types of activity do enhance immunity.

Sedentary Lifestyles and Immunity

Definition and Position

A sedentary lifestyle is when a person engages in no regular physical activity. Sedentary lifestyles are thought to be part of the cause of many health problems including heart disease, hypertension, hypercholesterolemia, and possibly increased chances of infection (Nieman, 1993 and Wiedner, 1993).

What Does a Sedentary Lifestyle do to Immunity?

The effects of physical activity on immunity can be explained by a "J curve" where sedentary individuals are at average to high risk of infection. Evidence supporting the J curve theory can be found in studies comparing sedentary individuals to other physically active groups. In a study done by Moyna et al. (1996) the sedentary control group had significantly lower levels of T cells, T helper cells, T-suppressor, and NK cells. They also showed decreased plasma epinephrine and norepinephrine as compared to physically active subjects. The sedentary group engaged in no regular exercise, while the exercising group reported at least 30 minutes of aerobic activity three times per week. Nieman reported that 32 sedentary individuals were more likely to experience upper respiratory infections than 12 conditioned athletes (as cited in Pyne, 1994). Nieman et al. (1995) found that aside from NK cell activity, there was little difference between marathon runners and sedentary controls when comparing immunity. From these studies, it appears that sedentary individuals may exhibit lower immune function than moderately active people, but immune function slightly higher than overtrained athletes.

There has been some research in the area of bed rest deconditioning in order to help with people who are bed ridden and people engaging in long term spaceflight. This is not the best measure of immunity in comparison with inactivity because most people are not completely immobile. It was found in many of these studies that immune function was decreased; however, because of improper hygienic practices it is difficult to conclude that the inactivity was the sole reason for decreased immunity (Greenleaf, Jackson, Lawless, 1994).

Conclusion to Immunity in Sedentary People

Given that there are no studies specifically designed to measure immune levels in sedentary individuals, it is difficult to conclude that sedentary individuals are at greater risk of infection. Yet, the studies that used sedentary controls would indicate a decreased immunity in those individuals. More research should be done in this area.

Other Factors Which Affect Immunity

The Psychological Effects of Exercise in Relation to Immunology

Many people who exercise regularly report that it makes them "feel better". Is there any scientific significance to this? According to LaPerriere et al. (1994) there is a relationship between physical fitness and mental health. It is crucial that exercisers wishing to take advantage of this benefit of exercise keep their exercise at moderate levels because overtraining has the opposite effect. Aerobic exercise triggers certain physiological functions which are thought to be responsible for decreased anxiety and depression. Both aerobic activity and decreased feelings of anxiety and depression are responsible for an increased release of endogenous opioids. Endogenous opioids are neuropeptides such as B-lipotropin, B-endorphin, and Met-enkephalin which all aid in feelings of well-being. An increase in endogenous opioids is responsible for immune normalization or increases in the number of lymphocytes and NK cells. It is thought that exercise and psychoneuroimmunology work together (LaPerriere et al., 1994). Fry et al. (1994) reported that overtraining has the opposite effect on mental health. Overtraining can actually cause lethargy and depression. Some of this stress in elite athletes may be due to the stress of competition and may not only be a result of physically overtraining. In 1985 a study was performed with college students in which a cardiovascular fitness program was administered and a control group was established. The results showed a significant improvement in cardiovascular fitness, anxiety, and psychological well-being in the exercising group (Goldstein et al., 1985).

Gender and Immunity

Most of the studies reviewed used male subjects. Women are thought to have overall higher counts of leukocytes than men (Smith, 1994). If this is not controlled for in a study comparing cellular levels among various groups then the results may be affected. In order to more clearly understand the differences between male and female immunity, the present study tested for gender effects.

Other Factors Affecting Immunity

There are so many factors which influence immunity in humans. For example, immunity may change due to nutrition, lifestyle, stress levels, seasonal variations, lack of sleep, exposure to viruses or unknown pathogens, and various day to day differences

(Kajiura et al., 1995). Within this study gender, type of housing, attitude, smoking, and team participation were considered as possible effectors.

Conclusion of the Literature Review

There are many opportunities for further research in the area of physical activity and immunity. Several studies have concluded that overtraining causes immunosuppression. Many researchers also feel that moderate amounts of activity cause immunoenhancement, yet there is little scientific evidence to support this statement. There is somewhat conclusive evidence that a sedentary lifestyle results in immunosuppression. It is important to note that there is a specific relationship between exercise and pyschoneuroimmunology. Aside from this, things such as nutrition level, stress level, and seasonal variations may directly affect immunity. It seems that future research may need to control for all of these factors or look at the "big picture" by perhaps considering larger numbers of subjects and evaluating a general population in everyday situations. Also, it may be that picking apart certain cellular components of the immune system is not a good measure of immunity. Venous samples can only account for 2% of the total number of leukocytes within the immune system. This does not mean that studying cellular immunology is useless; however, development of a new measurement of immunity may be necessary.

CHAPTER III

METHODOLOGY

Introduction

The average adult has one to six colds per year (Weidner, 1993). With each cold comes missed days of work, missed days of school, and the uncomfortable symptoms of a cold or upper respiratory infection. Given these negative factors, it is easy to see why a reduction in the number of colds per year would appeal to the population. Recent research has suggested that the number and symptoms of upper respiratory infections may be reduced by engaging in regular moderate physical activity. This study was designed to further understand the relationship between physical activity and resistance to the common cold or upper respiratory infection. A description of the subjects, the survey, the data collection procedures and data analysis are included in this chapter.

Subjects

All subjects were students enrolled at Eastern Illinois University (EIU) during spring semester, 1998. Eastern Illinois University is located in east central Illinois and has an enrollment of approximately 10,000 undergraduate and graduate students. Surveys were distributed to students who were enrolled in courses selected by the following procedures. First, a list was obtained of all department chairs at EIU. Every fifth department chair was contacted and asked to distribute surveys to a class in his or her department. It was thought that having a variety of departments involved would eliminate bias towards one major. For example, students in graphic design might as a whole have different physical activity patterns than physical education students. Secondly, instructors teaching HST 2000, Human Health were asked to participate by giving surveys to their classes. Finally, instructors teaching PED 2850, Fitness For Life were asked to participate by giving surveys to their classes. These two lower level classes were chosen because they were elective classes that fulfill EIU general education requirements, and are taken by students from a wide variety of majors. Surveys were completed by 593 students.

Survey Development

A pilot study was conducted during fall semester of 1997 in order to discover possible problems with the study and to receive feedback on the survey. Subjects for the pilot study were 20 EIU graduate students in the physical education department. The results showed a significant difference in number of symptoms between sedentary and active individuals; yet there was no significant difference ($P<.05$) in number of colds.

The survey was revised by adding demographic questions (age, gender, class year, type of housing, smoking status, and athletic team participation). Also included in the survey was a section asking participants to identify their current physical activity level as closely as possible. Finally, subjects were asked to indicate their cold symptoms and severity of their cold symptoms experienced during the previous four weeks (Appendix A). A model developed by Meschievitz, Schultz, and Dick (1984) was used on the survey to evaluate symptoms which might accompany the common cold. Definitions of the five levels of physical activity were based on several surveys in the June, 1997 supplement of Medicine and Science in Sport and Exercise.

Data Collection

Data collection occurred between February 12 and March 1, 1998. This time period was chosen for survey distribution because of the following reasons. First, students had been back to school from Christmas break for nearly a month. Also, allergies were at a minimum since allergies are most rampant during fall and spring. Finally, stress levels of students should not be as elevated as at the very beginning of the semester or towards the end. Participating instructors were given the surveys in their mailboxes and the surveys were returned to the office secretary. There were two instructors who said they would participate but who did not return surveys. Some classes did not fill out all intended surveys. Yet, the returned surveys numbered 593, and usable surveys numbered 535. Instructions were printed on the survey itself, so instructors did not need to give any directions to participants.

Data Analysis

Survey data was entered into the EIU research computer system and analyzed using the Statistical Package for the Social Sciences (SPSS). Surveys were excluded if the subject was outside of the specified age range of 17-25. Surveys were excluded if they were incomplete. There were several surveys in which students had created sometimes as an option for whether they smoke. Their answers were changed to yes, since sometimes smoking is smoking. Surveys were also excluded if the subject reported a severe fever for cold symptoms since a cold would not include a severe fever. A symptom score was computed for each subject as the sum of the symptom severity ratings for the ten listed symptoms. Frequency counts and percentages were determined for each survey item. A one-way analysis of variance (ANOVA) was used to test for the effect of activity level on cold symptoms. A one-way ANOVA was also used to test for the effects of gender, housing type, team participation, and smoking status on cold symptoms. A chi square analysis was computed to test for effects of activity level on number of colds experienced in the month prior to the survey. Chi square analyses were also computed to test for the effects of gender, housing type, athletic team participation, and smoking status on number of colds.

CHAPTER IV

RESULTS

Introduction

This study examined the differences in immunity or resistance to the common cold / upper respiratory infection of students with various levels of habitual physical activity. Data was collected by survey (Appendix A). A Chi-square test was used to compare the number of colds to the level of activity of subjects. An ANOVA was used to analyze the number and severity of symptoms in comparison to activity level. Since certain demographic factors may have had an effect on number of colds and symptoms, these were also compared and analyzed.

Description of the Sample

Surveys were completed by 593 students. After excluding unusable surveys, the number dropped to 535. A description of the sample is given in Table 1.

Results

Mean Symptom Score

The mean symptom score (reflecting the incidence and severity of cold symptoms) for subjects of each activity level is shown in Table 2. An ANOVA was conducted to check for significant differences among the activity groups ($F=2.3$, $df=4$, $p=.0577$). The mean number and intensity of symptoms gradually decreased with increased physical activity, with the exception of the heavy exercise group. Moderate actives (subjects who chose group three for activity level) and moderate exercisers (subjects who chose group four for activity level) were hypothesized to have highest resistance to sickness. The data is very close to showing this. However, heavy exercisers (group five) had a slightly lower

Table 1: **Demographic Information for the Sample**

Question Asked	Possible Answers	Number of Subjects	Percentage
Gender	Female	307	52%
	Male	286	48%
Year in School	Freshman	216	36%
	Sophomore	105	18%
	Junior	136	23%
	Senior	87	15%
	Graduate	49	8%
Age	17-25	556	93%
	Any Other Age	37	6%
Type of Housing	House	74	12%
	Apartment	140	24%
	Dormitory	326	55%
	Greek Court	36	6%
	With Parents	13	2%
	Other	4	1%
Smoking Status	Yes	144	24%
	No	449	76%
Athletic Team Status	Yes	106	18%
	No	487	82%

symptom mean than moderate actives. Moderate exercisers did in fact have the least reported number and severity of symptoms. A symptom score of 7 indicates that the subject is reporting an occurrence of a cold. This means that moderate exercisers are the only group on average not reporting occurrence of a cold. It is also important to note that there is somewhat of a J-curve appearance to the data which supports the relationship between physical activity and immune function reported in the literature by Nieman and others (See Figure 1).

Table 2: **Mean Cold Symptom Score by Physical Activity Classification**

Group	**Classification**	**n**	**Mean Symptom Score**
1	Sedentary	27	9.07
2	Light Actives	73	8.26
3	Moderate Actives	141	7.91
4	Moderate Exercisers	198	6.69
5	Heavy Exercisers	85	7.53

Number of Colds

A Chi Square analysis was calculated for activity level and number of colds subjects experienced within the month prior to survey distribution (X_2 (N=524)=17.28, p=.14). The survey classified number of colds into groups so that subjects had a choice of none, one, two-four, or that they had been sick continually since they returned from break. The data showed that the mean rating of colds was least for the moderate actives and the moderate exercisers and highest for the heavy exercisers (See Table 3). The J-curve (Refer to Figure 2) was also evident in the relationship between physical activity level and incidence of colds. The lack of significant differences in cold incidence am groups is possibly due to the grouping of 2-4 colds as one response on the s

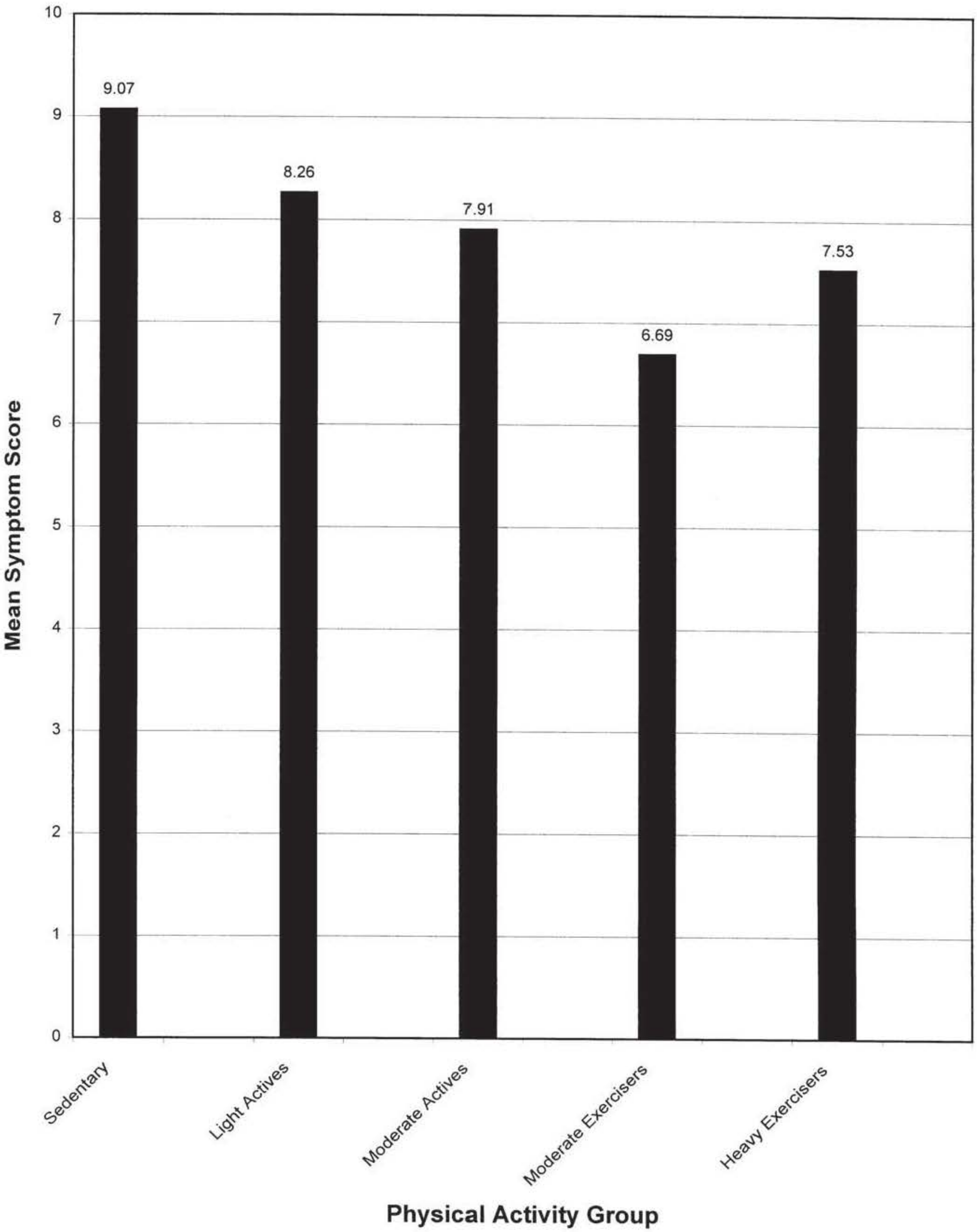

Figure 1: **Mean Symptom Score by Physical Activity Group**

Table 3: **Mean Rating of Colds by Activity Classification**

Activity Classification	n	Mean Rating of Colds
Sedentary	27	1.78
Light Actives	73	1.73
Moderate Actives	141	1.70
Moderate Exercisers	198	1.68
Heavy Exercisers	85	2.04

Relationship of Other Factors to Immune Function

The mean symptom score for subjects of each subgroup (gender, class year, housing, smoking status, and athletic participation) is shown in Table 4. An ANOVA was conducted for each subgroup to check for significant differences among the number of cold symptoms subjects had developed four weeks prior to survey distribution. The ANOVA conducted for gender showed a significant difference in number of symptoms between females and males (F=26.8, df=1, p<.0000). Females reported significantly more symptoms than males. Research has suggested that women have a stronger immunity than men; however, this study found the opposite. One negative to giving a survey, is that the surveyor is on their own. It is possible that the men did not admit to as many symptoms. The discussion section presents further speculation. The ANOVA conducted for class/year did not show a significant difference in number of symptoms reported (F=.38, df=4, p=.8226). There was also no significant difference in the type of housing subjects lived in and the number of symptoms that they reported (F=.66, df=5, p=.6519). The ANOVA conducted for smoking status did showed a significant difference, revealing that those subjects who smoke reported significantly more cold symptoms than those who do not smoke (F=16.38, df=1, p=.0001). The discussion section presents speculation as to why. Finally, there was a significant difference between subjects who participate on an

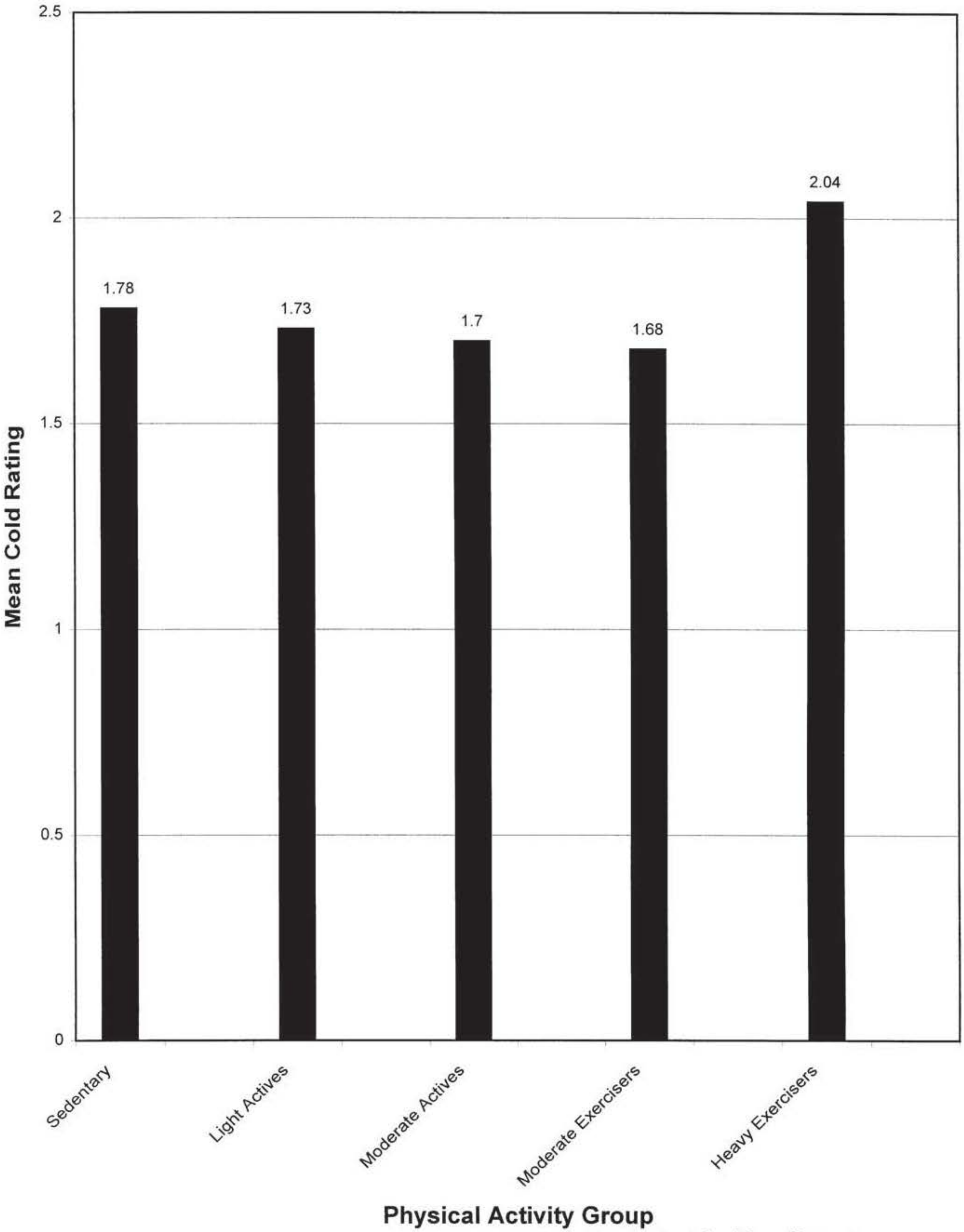

Figure 2: **Mean Cold Rating by Physical Activity Group**

athletic team and those who do not. Subjects who participate on an athletic team had significantly fewer cold symptoms (F5.16, df=1, p=.0235). This will be discussed further in the discussion section.

A Chi Square analysis was calculated for all of these same subgroups and number of colds subjects experienced within the month prior to survey distribution. No significant differences were found (See Appendix B for results of these analyses.). Again this could be due to grouping on the survey of 2-4 colds as one response, or they might have the same number of colds, but differences in severity of symptoms. Table 5 gives mean rating of colds for each subgroup.

Table 4: **Mean Symptom Score by Subgroup**

Subgroup	Category	n	Mean Symptom Score
Gender	Female	276	8.6
	Male	259	6.3
Class Year	Freshman	209	7.6
	Sophomore	100	7.5
	Junior	122	7.8
	Senior	80	7.2
	Graduate	24	6.5
Housing	House	48	7.3
	Apartment	122	8.0
	Dormitory	315	7.5
	Greek Court	35	7.3
	With Parents	13	6.2
	Other	2	3.0
Smoking Status	Yes	135	9.1
	No	400	7.0
Athletic Team	Yes	98	6.4
	No	436	7.8

Table 5: **Mean Rating of Colds by Subgroup**

Subgroup	Category	n	Mean Rating of Colds
Gender	Female	276	1.8
	Male	259	1.7
Class Year	Freshman	209	1.8
	Sophomore	100	1.8
	Junior	122	1.6
	Senior	80	1.6
	Graduate	24	1.4
Housing	House	48	1.7
	Apartment	122	1.7
	Dormitory	315	1.8
	Greek Court	35	1.8
	With Parents	13	1.7
	Other	02	1.0
Smoking Status	Yes	135	1.8
	No	400	1.7
Athletic Team Status	Yes	98	1.7
	No	436	1.8

Discussion

The data from this study suggests that immunity is highest with activity groups such as the moderate actives and the moderate exercisers, with moderate exercisers being most resistant to infectious symptoms according to the ANOVA (p=.0577) calculated for activity level and symptoms. Although the Chi Square analysis was not significant at the .05 level of significance, there is possible significance to the data presented in Table 6. This table shows that heavy exercisers reported the most amount of colds.

Table 6: **Percentages of Reported Number of Colds by Activity Level**

Activity Level	No Colds	One Cold	Two to Four Colds	>Four Colds
Sedentary	52%	3.5%	15%	7%
Light Actives	41%	47%	11%	5%
Moderate Actives	45%	43%	8%	7%
Moderate Exercisers	51%	34%	11%	4%
Heavy Exercisers	32%	48%	16%	4%

Since this was a survey, it is possible that not all questions were answered with complete honesty. No questions in the survey asked for perceived stress level, which is a great factor in the equation of human immunity. However, when developing the survey it was considered that this time of year would be the least stressful for students. Also, gender, class year, smoking status, team participation and housing were considered on this survey. Women reported significantly more symptoms than men ($p<.0000$). The reason is not certain. It is thought that perhaps men were not completely honest with their answers. Another possible reason is that of the persons that reported smoking, 56% of them are female, which means that it may have been the smoking that made the significant difference and not that they were female. Also, it should be noted that activity levels of males and females show differences (See Table 7). Nearly twenty three percent of females reported heavy exercise, while only ten percent of males report heavy exercise. Smokers also reported significantly more symptoms than non-smokers ($p=.0001$). Research supports that smoking does increase chances of infection. This data also shows that eighty three percent of non-smokers chose the most active three groups, while seventy one percent of smokers chose the most active three groups. Finally, subjects who participate on an athletic team reported significantly fewer symptoms (p=.0235). These subjects are

Table 7: **Percentage of Males/Females by Activity Level**

Activity Level	Men(%)	n	Women(%)	n
Sedentary	7%	19	3.2%	8
Light Actives	17.3%	47	10.3%	26
Moderate Actives	28.7%	78	25.0%	63
Moderate Exercisers	36.8%	100	38.9%	98
Heavy Exercisers	10.3%	28	22.6%	57

more active. Also, eighty eight percent of the smokers do not participate on a team, while nearly twelve percent of smokers do participate on a team. Perhaps it is not only activity level, but lifestyle habits of team participants that also aids in reduced risk of infectious symptoms.

It is suggested that further research be done in this area. It is important that standard guidelines be established in this research area in order to increase objectivity and validity of studies. Standard definitions are needed as to what sedentary, moderate, and heavy activity are. Also, definitions of what a cold is or criteria for how many symptoms a cold is composed of are needed. For this study it was established that a cold was when all airways are blocked or affected. Symptoms were appropriately included. Activity levels were determined based upon several surveys which assessed level of physical activity.

It is true that physical activity has many other positive benefits which would suggest regular adherence to an exercise program; however, it is possible that immunity is yet another reason to exercise. Previous studies have shown that physical activity may be beneficial to the human immune system. Many professionals would support the statement that moderate amounts of physical activity are most beneficial to the immune system.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

It has become apparent that humans have the ability to affect their own health with modifications in lifestyle, vaccinations, and precautions such as cleanliness and hand washing. Evidence is building which would lead to the conclusion that moderate aerobic activity will aid in resistance to sickness. Since the immune system is complex and standard definitions have not been established, answers are slow in coming. It is evident that high intensity exercise and overtraining lead to immunosuppression. It is thought that sedentary individuals put themselves at greater risk of infection. This study was performed in order to gain a better understanding of the relationship between activity and resistance to sickness. Perhaps this can only be done by researching one population at a time. For example, this study used persons aged 17-25 who were students at Eastern Illinois University.

Selected classes took a survey designed to determine habitual physical activity level and incidence of upper respiratory tract infections within the last month. Surveys were completed by 593 students. An ANOVA revealed that increased activity level leads to a decreased number and severity of cold symptoms ($p=.0577$). However, there was no significant difference in number of colds in relation to activity level.

Recommendations

Based on the results of this study and the literature review, the following recommendations are suggested:

1. Future studies should evaluate stress level since excessive stress may be a possible deterrent to health.

2. Future studies should try to enhance external validity in order to apply findings to the outside world by incorporating more field studies or epidemiological studies in addition to laboratory studies.

3. Specific definitions of activity levels should be established by researchers.

4. More research should be done on a general population since many studies use elite athletes as subjects.

5. More research should be done using both male and female subjects.

6. More research should be done on the topic of moderate activity and immune levels. There seems to be a lack of information to support the hypothesis that moderate amounts of activity enhance immunity.

7. Special consideration should be given to time of year because of allergies and seasons with higher bouts of infections and colds.

8. Consideration should be given to those things which effect immunity such as stress level, age, smoking, sleeping patterns, nutrition, environment, and season.

9. Longitudinal studies need to be established in order to understand the long term effects of exercise on immunology in humans.

10. Observation and recording infectious episodes rather than having the subject record infectious episodes may alleviate the problem of untruthful surveys.

11. Number of colds should be broken down into 0. 1, 2, 3, 4, 5, etc. rather than none, 1, 2-4, or > than four.

References

Berglund, B. and Hemmingson, P. (1990). Infectious disease in elite cross-country skiers: a one-year incidence study. Clinical Sports Medicine, 2, 55-58.

Booth, R. J. (1993). Exercise, overtraining and the immune response: a biological perspective. New Zealand Journal of Sports Medicine, 21, 42-45.

Fitzgerald, L. (1988). Exercise and the immune system. Immunology Today, 9, 337-339.

Fitzgerald, L. (1991). Overtraining increases the susceptibility to infection. International Journal of Sports Medicine, 12, 55-58.

Fry, R. W., Grove, J. R., Morton, A. R., Zeroni, P. M., Gaudieri, S., & Keast, D. (1994). Psychological and immunological correlates of actue overtraining. British Journal of Sports Medicine, 28, 241-246.

Goldwater, B. C. & Collis, M. L. (1985). Psychologic effects of cardiovascular conditioning: a controlled experiment. Psychosomatic Medicine, 47, 174-181.

Greenleaf, J. E., Jackson, C. G. R., & Lawless, D. (1994). Immune response and function: exercise conditioning versus bed-rest and spaceflight deconditioning. Medicine, Training and Rehabilitation, 5, 223-241.

Guyton, A. C., & Hall, J. E. (1996). Textbook of Medical Physiology (9th ed.), Philadelphia: W. B. Saunders Company.

Hoffman-Goetz, L. & Pedersen, B. K. (1994) Exercise and the immune system. Immunology Today, 15, 382-387.

Jaret, P. (1993). From here to immunity. The Walking Magazine, 8, 43-44.

Kajiura, J. S., MacDougall, J. D., Ernst, P. B., Younglai, E. V. (1995). Immune response to changes in training intensity and volume in runners. Medicine and Science in Sport and Exercise, 27, 1111-1117.

LaPerriere, A., Ironson, G., Antoni, M. H., Schneiderman, N., Klimas, N., and Fletcher, M. A. (1994). Exercise and psychoneuroimmunology. Medicine and Science in Sport and Exercise, 26, 182-190.

Mackinnon, R. S. (1996). Immunoglobulin, antibody, and exercise. Exercise Immunology Review, 2, 1-35.

Mahler, D. A., Froelicher, V. F., Miller, N. H., and York, T. D. (1995). ACSM's Guidelines for Exercise Testing and Prescription (5th ed.), Baltimore: Williams and Wilkins.

Mazzeo, R. S. (1994). The influence of exercise and aging on immune function. Medicine and Science in Sport and Exercise, 26, 586-592.

Meschievitz, C. K., Schultz, S. B., and Dick, E. C. (1984). A model for obtaining predictable natural transmission of rhinoviruses in human volumteers. The Journal of Infectious Diseases, 150, 195-201.

Moyna, N. M., Acker, G. R., Weber, K. M., Fulton, J. R., Robertson, R. J., Goss, F. L., & Rabin B. S. (1996). The effects of incremental submaximal exercise on circulating leukocytes in physically active and sedentary males and females. European Journal of Applied Physiology, 74, 227-233.

Nash, M. S. (1994). Exercise and immunology. Medicine and Science in Sports and Exercise, 26, 125-127.

Nieman, D. C., Buckley, K. S., Henson, D. A., Warren, B. J., Suttles, J., Ahle, J. C., Simandle, S., Fagoaga, O. R., and Nehlsen-Cannarella, S. L. (1995). Immune function in marathon runners versus sedentary controls. Medicine and Science in Sport and Exercise, 27, 986-992.

Nieman, D. C., (1992). Exercise, immunity and respiratory infections. Exercise and Disease, 4, (39), 1-6.

Nieman, D. C. (1993). Exercise, upper respiratory tract infections, and the immune system. Medicine and Science in Sport and Exercise, 25, 128-139.

Nieman, D. C. (1997). Moderate exercise boosts the immune system. Health and Fitness Journal, 1, 14-19.

Nieman, D. C. and Henson, D. A. (1994). Role of endurance exercise in immune senescence. Medicine and Science in Sport and Exercise, 26, 172-181.

Nieman, D. C., Henson, D. A., Gusewitch, G., Warren, B. J., Dotson, R. C., Butterworth, D. E., and Nehlsen-Cannarella S. L. (1993). Physical activity and immune function in elderly women. Medicine and Science in Sport and Exercise, 25, 823-831.

Nieman, D. C., Johansen, L. M., Lee, J. W., and Arabatzis, K. (1990). Infectious episodes in runners before and after the Los Angeles Marathon. The Journal of Sports Medicine and Physical Fitness, 30, 316-328.

Nieman, D. C., Miller, A. R., Henson, D. A., Warren, B. J., Guswithch, G., Johnson, R. L., Davis, J. M., Butterworth, D. E., & Nehlsen-Cannarella, S. L. (1993). Effects of high vs. moderate intensity exercise on natural killer cell activity. Medicine and Science in Sport and Exercise, 25, 1126-1134.

Pedersen, B. K., &Bruunsgaard, H. (1995). How physical exercise influences the establishment of infections. Sports Medicine, 19, 393-400.

Pedersen, B. K., Rohde, T., & Zacho, M. (1996). Immunity in athletes. The Journal of Sports Medicine and Physical Fitness, 36, 236-245.

Pollock, M. L., Gaesser, G. A., Butcher, J. D., Despres, J. P., Dishman, R. K., Franklin, B. A., & Garber, C. E. (1998). The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Medicine and Science in Sport and Exercise, 30, 975-991.

Pyne, D. B. (1993). Exercise, training, and the immune system. Sports Medicine, Training and Rehabilitation, 5, 47-64.

Rohde, T., Maclean, D. A., Hartkopp, A., & Pedersen, B. K. (1996). The immune system and serum glutamine during a triathlon. European Journal of Applied Physiology, 74, 428-434.

Shephard, R. J., Rhind, S., & Shek, P. N. (1994). Exercise and the immune system. Sports Medicine, 18, 340-369.

Shephard, R. J., and Shek, P. N. (1994). Potential impact of physical activity and sport on the immune system - a brief review. British Journal of Sports Medicine, 28, 247-255.

Smith, J. A. (1994). Guidelines, standards, and persepectives in exercise immunology. Medicine and Science in Sports and Exercise, 27, 497-506.

Swain, R. A. and Kaplan, B. (1998). Upper respiratory infections. The Physician and Sportsmedicine, 26, (2) 85-96.

Solomon, G. F. (1991). Psychosocial factors, exercise, and immunity: athletes, elderly persons, and Aids patients. International Journal of Sports Medicine, 12, S50-S52.

Verde, T., Thomas, S., and Shephard, R. J. (1992). Potential markers of heavy training in highly trained distance runners. British Journal of Sports Medicine, 26, 167-175.

Weidner, T. G. (1994). Reporting behaviors and activity levels of intercollegiate athletes with an uri. Medicine and Science in Sport and Exercise, 26, 22-26.

APPENDIX A

Please take a few minutes to fill out the following questions. Please do not put your name anywhere on this survey. Your answers will remain completely confidential. Your time and honesty are greatly appreciated!

Circle the appropriate answer:

1. **What is your gender?**
    1. **Female**
    2. **Male**
2. **What level of education are you currently at in college?**
    1. **Freshman**
    2. **Sophomore**
    3. **Junior**
    4. **Senior**
    5. **Graduate**
3. **What age group do you belong to?**
    1. **17-25**
    2. **Any other age**
4. **What type of housing do you live in?**
    1. **House**
    2. **Apartment**
    3. **Dormitory**
    4. **Greek Court**
    5. **With Parents in any type of housing**
    6. **Other**
5. **Since you have been back from break, about how many colds have you had? (Cold= When all airways are affected or blocked. Ex: If your only symptom is a sore throat, this is not a cold.)**
    1. **None**
    2. **One**
    3. **2-4**
    4. **I've been sick ever since I've been back from break!**
6. **In general, do you feel that you are a healthy person?**
    1. **Yes**
    2. **No**
7. **Do you smoke?**
    1. **Yes**
    2. **No**
8. **Do you participate on an athletic team or club?**
    1. **Yes**
    2. **No**
9. **If you answered yes to the previous question, which athletic team do you belong to?**

Cross Country	**Soccer**	**Football**	**Tennis**	**Track**	**Pink Panthers**
1	2	3	4	5	6
Basketball	**Wrestling**	**Baseball**	**Softball**	**Cheerleading**	
7	8	9	10	11	
Volleyball	**Swimming**	**Rugby**	**Golf**	**Cycling**	**Other:** ____________
12	13	14	15	16	17

-OVER-

Please Circle the Number which most closely describes your physical activity habits within the past year. These numbers are representative of a continuum, meaning that you may fall between an explained number, but PLEASE CHOOSE A NUMBER THAT IS ON THE CONTIN-UUM (DO NOT MAKE YOUR OWN #).

1	2	3	4	5

(1)= I engage in less active pastimes, <u>such as</u> watching television, playing cards, computer endeavors and hanging out with friends. I very rarely or never exercise if I have to. Most of the time I don't take part in activities which require me to sweat. I rarely have to exert myself physically.

(2)= I engage in mild exercise every once in a while. My pastimes include activities <u>such as</u> fishing, bowling, golfing, easy walking, archery, snow-mobiling and horseshoes. I don't regularly exercise aside from activities such as these. I usually don't take part in activities which require me to sweat, but once in a while I exert myself physically.

(3)= I sometimes engage in some of the above activities, but I also engage in activities which require me to sweat on a weekly basis (1 to 2 times per week). I usually participate in activities <u>such as</u> baseball, basketball, volleyball, or toning classes. <u>I usually do these types of activities one to two times per week for between 10-20 minutes.</u>

(4)= I sometimes engage in some of the above activities, but I also <u>regularly</u> (3 to 5 times per week) engage in activities which require me to sweat. I usually participate in activities <u>such as</u> fast walking, bicycling, volleyball, badminton, slow jogging, alpine skiing, dancing, weight lifting, aerobics, or Stairmaster for <u>between 20-60 minutes 3-5 times per week.</u>

(5)= I sometimes engage in some of the above activities, but I also <u>always exercise 5-7 days per week.</u> My pastimes include activities <u>such as</u> running, fast jogging, football, intense tennis, hockey, basketball, cross-country skiing, judo, roller skating or blading, vigorous swimming, vigorous long distance bicycling, Nordic Track, or intense aerobics classes usually for <u>40 minutes or more per session.</u>

Please read through the symptoms on the chart below. Using the scale below, circle the cor-responding number across from the symptoms which have bothered you *since you have been back from Christmas Break*. Please choose numbers which represent your symptoms at the *most severe* point.

SYMPTOMS	SYMP. NOT PRESENT	MILD	MODERATE	SEVERE
Nasal Dis-charge	0	1	2	3
Cough	0	1	2	3
Sneezing	0	1	2	3
Stuffy Nose	0	1	2	3
Sore Throat	0	1	2	3
"Worn Out"	0	1	2	3
Chilliness	0	1	2	3
Fever	0	1	2	3
Hoarseness	0	1	2	3
Watery or Burning Eyes	0	1	2	3

<u>THANKS!</u>

APPENDIX B

Data for Chi Square Analysis of Subgroups and Number of Colds

Gender: X2(N=535)=5.11, p=.1635

Class: X2(N=535)=19.37, p=.0800

Housing: X2(N=535)=11.18, p=.7396

Smoking Status: X2(N=535)=3.19, p=.3636

Team Participation: X2(N=535)=.99, p=.8034