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The Investigation of Risk Factors for Upper Respiratory Infections Among College Students

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Introduction

Upper respiratory tract infections and cold-like illnesses are common sources of morbidity among college students. The emphasis of hand-washing and reducing the dispersal of aerosol droplets by covering coughs and sneezes reduces the spread of the common cold. However, less emphasis is placed on other risk factors for reducing cold-like illness such as: stress level and physical activity (Doyle and Cohens 2009). An increase in stress and a decrease in physical activity are common among college students (Nichol et al 2005). For this reason, the present study analyzed the effects of stress and physical activity on the incidence of upper respiratory infections among college students.

To date, a number of studies have examined the effects of stress and physical activity using a variety of methods. However, much of the current literature is centered around the impact of stress and physical activity on adult and children, with little emphasis on college aged individuals. Therefore, the present study primarily examined the impact of stress and physical activity on the incidence of upper respiratory infection among college students, a population not well studied in this regard. Based on an extensive review of the existing scholarly literature I hypothesized that individuals that engaged in moderate levels of physical activity would have a healthier body mass index, lower reported levels of perceived stress, and fewer upper respiratory

infections when compared to sedentary individuals. A loose correlation between a healthy body mass index and fewer upper respiratory infections was expected. If a correlation is present between physical activity, and perceived stress levels, body mass index, and upper respiratory infection, it would further confirm the importance of incorporation of physical activity into a daily routine not solely for the prevention of chronic diseases associated with obesity but for reducing the incidence of colds.

Literature Review

Stress, Body Composition, Physical Activity and Upper Respiratory Infection

Upper respiratory infections and colds are common sources of morbidity among college students. Researchers collaborated from different facilities in Minnesota to conduct a study using a cohort of college students from the University of Minnesota. Investigators distributed surveys to the entire student body and received more than 4,000 responses. Of the students that completed the survey, 91% indicated suffering from at least one cold. Colds accounted for an increase in days absent, and sub-par performance on class work and exams (Nichol et al 2005). Morbidity from upper respiratory infection was responsible for a decrease in academic performance and potentially an increase in stress.

As a whole, college students experience a great deal of stress. The type of stress experienced by students may come from a variety of different modes including: academic, interpersonal, financial, health related and self-imposed. (Misra and McKean, 2000) Regardless of the area of origin of stress, a number of studies have shown an association between chronic stress and poor eating habits, along with an increased number of infections. (Torres and Nowson, 2007; Flagas et al 2009)

Chronic life stress is associated with a change in eating habits. Researchers from Deakin University examined the effects of chronic life stress on unhealthy eating habits, and their relative contributions to obesity. Researchers noted individuals who experienced daily stress had an increased tendency to consume energy rich foods, such as those high in fat and sugar. A variety of external and internal factors affect ones appetite and food preference. A brief period of extreme stress induces a "fight or flight" response. The momentary stress of compromised personal safety was generally coupled with appetite suppression. However, prolonged stress did not induce appetite suppression, but instead increased consumption of energy rich foods. Researchers examined a number of different cohorts, noting alterations in food consumption depending on the type and degree of stress the group was affected by. Overall, an increase in energy rich food consumption was noted among college students preceding exams. Researches indicated findings of a positive correlation between stress-induced food consumption and obesity (Torres and Nowson, 2007).

An increase in caloric intake coupled with a decrease in caloric expenditure, in essence a decrease in physical activity, has resulted in an increasingly overweight society. Obesity is linked to hypertension, coronary heart disease, non-insulin dependent diabetes, and stroke. Along with a multitude of co-morbid diseases obesity reduces the immune system's ability to ward-off infection. Using a mouse model, Alexia Smith from the University of North Carolina, demonstrated obesity-induced alterations of the immune system's function, following exposure to the influenza virus. Following inoculation, obese mice showed an increase in morbidity and mortality. The innate immune response, along with cell mediated immunity was significantly decreased in obese groups when compared to control groups. (Smith, 2007) Alterations of normative immune response induced by an increase in adipose tissue, suggest a possible

correlation between body mass index, and increase number and severity of upper respiratory infections.

Physical activity is known to be an important factor in weight management. Researchers at the Alfa Institute of Biomedical Sciences Department of Medicine, conducted a large cohort study using hospitalized patients to determine if obesity increased the prevalence of infections among patients. Results from the study concluded that while obese patients acquired an increased number of infections with more severe outcomes, patients with the lowest body mass index were similarly affected. Similar rates of infection were noted among patients with low or high body mass index, when compared to patients within the normal body mass index rage. An increased rate of infection in individuals with low body mass index may have been due to malnutrition or chronic wasting syndrome; while an increase in infection in individuals with high body mass index was likely due to a number of factors which contribute to an increase in nosocomial infections in obese patients. However, the increase in severity and prevalence of infection was only statistically significant in obese patients. Researchers believe the outcome was likely due to chronic inflammation, commonly seen in obese people, which alters immune response. Scientists also noted that obesity negatively affects respiratory function, because of the effects of adipose tissue on metabolic function. Furthermore, there are many co-morbid conditions related to obesity that adversely affect the immune systems, increasing the risk of upper respiratory infections (Falagas et al, 2008).

The medical and medical research community has established a correlation between obesity and the acquisition of nosocomial infections among obese patients. However, the presence of a relationship between community acquired infections and obesity is less clear. Following the H1N1 epidemic, Reetta Huttunen and Jaana Syrjanen conducted a review

consisting of post-secondary data to determine if there was a relationship between obesity and morbidity/mortality from the H1N1 influenza virus. Reports from a diverse group of hospitals and health care clinics showed an increase in mortality among obese patients that contracted the H1N1 virus. Along with an increase in mortality, obese patients accounted for the vast amount of intensive care unit stays, resources, and prolonged visits. Researchers also noted a decrease in obese patients immune response to influenza vaccines. Presently, there is limited data regarding many other community acquired infections and weight, most likely due to the height and weight of all individuals treated in health care clinics not being recorded, though a trend may be anticipated due to alterations in cellular immunity (Huttnen and Syrjanen 2013).

Presence of external stressors not only alters behavioral patters such as food consumption, but adversely affects the body as a whole. The medical community commonly believes, that psychological stress increases the severity of the common cold. Researchers at the Department of Preventative Medicine at the University of Santiago de Campostela Spain, conducted a study to determine whether an actual correlation exists between psychological stress and the common cold. Researchers considered several factors based on the hypothesis that stress can alter the function of the immune system. Factors examined included, external stressors may promote negative health habits (smoking, drinking, and poor diet), and stress may also amplify the perception of symptoms. Authors of the study examined a cohort of adults over the course of a year, and measured the prevalence and severity of infections suspected to be the common cold in relation to stress levels. The focus of the investigation was not on the immune response in the presence of stress, but rather on the development of clinical illness and the signs and symptoms a cold-like illness. (Takkouche et al. 2001).

They confirmed that there was a relationship between stressful events and an increased incidents of the common cold. When stressful events such as deadlines and daily chores were combined with an increased level of perceived stress, the prevalence of the common cold increased, compared to just stressful events and low levels of reported stress. Subjects who indicated the highest levels of stress were four times more likely to contract the common cold than those subjects who indicated the least amount of stress. Positive external factors were inversely correlated with incidence of the common cold. The study did not show a significant correlation between smoking, alcohol, and poor diet and the frequency of infection from the common cold. The authors of the study defined the term 'stress' as any process in which external demands (stressors) surpass the adapted ability of the organisms, and the source of unwanted biological and psychological changes. (Takkouche et al. 2001). According to this working definition, physical stressors would be an equally applicable use of the term stress.

Research has well documented the effects of psychological stress management in adults. However, few studies have investigated effective means of stress management in young adults, specifically college students. A study conducted by researchers at the Keck School of Medicine in Los Angeles, California was designed to specifically analyze the effects of the incorporation of physical activity on perceived stress levels in college students. Of the 814 students which participated in the study, sixty percent reported high levels of stress, and the use of ineffective coping mechanisms. Overall the study reported significant findings of a inverse relationship between physical activity levels and stress burden, which suggests the importance of the incorporation of physical activity into a daily routine, especially as a form of stress management in college students. (Nguyen-Michael et al, 2006)

Similarly, the researchers at the American College of Sports Medicine conducted a cohort study to determine potential strategies to reduce the occurrence of upper respiratory infections, using perceived stress levels as variables. Results concluded that levels of physical activity was inversely proportional to the number of infections, which indicates that moderate levels of physical activity may act as an immunoprotectant. Physical activity also decreases perceived stress levels; which when individuals reported high levels of perceived psychological stress an increased number of infections was also reported. The findings reiterate the adverse effects that stress imposes on the immune system and the use of physical activity as a means of stress reduction and subsequently a reduced number of colds (Fondell et al. 2011).

Earlier studies further confirm the positive effects of the incorporation of physical activity as a means of stress management and cold prevention. William Karper and Allen Goldfarb noted that in earlier research, physical activity showed a moderate inverse correlation for contracting an upper respiratory infection. To determine if these effects were uniform throughout the ages, Karper and Goldfarb from the University of North Carolina conducted a small study using elderly adults to determine if moderate exercise reduced the number of acute upper and lower respiratory infections. Although the study examined the effects of moderate physical activity on elderly adults, the implications of the research transverse across all ages. Subjects that completed the year long exercise regimen, which consisted of light weights, mild cardiovascular work outs, and stretching several times a week, reported fewer cold and milder symptoms than control groups. The group participating in regular physical activity also reported improved psychological well being. The results suggest that although exhausting physical activity is classified as an external stressor, moderate levels of physical activity may be

beneficial in reducing other forms of stress, thus enhancing immunity (Karper and Goldfarb, 1994).

Psychological stress reduces immunity, and subsequently increases one's susceptibility to infection. Once infected, illness and disease impose a degree of stress on the body. Researchers from the University of Minnesota Medical School directed a study which concluded that stress operates as a cofactor for the progression of a disease or infection. The study found that stress increases the severity of the signs and symptoms of infection, and that the immune system responds differently to different types of stressors (Peterson et al. 1991). From this study it is feasible to predict that psychological stress may be deleterious to a person, while moderate stress from physical activity may be beneficial.

Psychological stress is frequently attributed to an increase in perceived symptoms of afflictions. Similar to psychological stress, physical activity exerts stress on the body. Physical activity as a form of stress inducer emphasizes the importance of moderation. Moderate physical activity has shown to decrease stress, and subsequently upper respiratory infection (Flagas et al 2009).

Effects of Strenuous Physical Activity on the Acquisition of an Upper Respiratory infection

Exemplifying the importance of moderation, was a study conducted by David Nieman which tested the effects of frequent and strenuous physical activity and their relative effects on the upper respiratory system. Nieman, compared elite athletes, individuals who participated in moderate exercise, and sedentary people. The study showed individuals that engaged in exhausting physical activity had an increased number of upper respiratory infections when

compared to the other groups. Conversely, individuals that participated in moderate exercise showed a decrease in the number of infections when compared to sedentary individuals (Nieman, 1995). This study exemplifies the importance of moderation, and that the immune system responds differently to differing degrees of external stimuli.

To further examine the effects of physical activity, epidemiological data was collected and analyzed by Michael Gleeson. Gleeson, summarized the effects of physical activity on the immune system, and the altered susceptibility of infection. His examination of previous studies unveiled a correlation between individuals that engaged in moderate levels of physical activity and an increase in immunity, when compared to sedentary individuals, and those who engaged in strenuous physical activity. Gleeson reported that individuals who engaged in regular physical activity had a 29% decrease in upper respiratory infections, when compared to sedentary individuals. However, few studies have produced clinically significant finding. Conversely, Gleeson also noted that athletes experienced a 100-500% increase in acquiring an infection in weeks following an ultra endurance run. Thus far, few studies have conclusively determined a clinically significant link between exercise and induced immune suppression. (Gleeson, 2007)

Similar to what was previously observed with altered effects on pathogenicity depending of the type of stress, researchers in the Department of Medical Science at Uppsala University Hospital in Sweden worked to determine if the body's physiological response changes depending on the type of pathogen. Researchers examined the correlation between high-performance athletes and their susceptibility to bacterial, and viral infections, as well as myocarditis. As in other studies, examiners noted that athletes may be at an increased susceptibility to infection for a brief period following strenuous exercise. They also noted that athletes may be at an increased risk in a sports setting, because of increased droplet-borne pathogens. The risk level for acquiring

infections is generally higher in elite athletes than the average jogger. A number of bacteria and viruses have been known to cause myocarditis, and continuation of physical activity during infection may exacerbate and increase one's risk. Clinicians have long known that physical activity during an infection typically cause deleterious effects, and this was noted in both bacterial and viral infections. As with many other aspects in life, moderation appears to be key (Friman and Wesslen, 2000).

Causality: Why Strenuous Physical Activity may Negatively Affect the Body

Analysis of post-secondary data by Roy Shepard from the University of Toronto gave rise to possible causality of the increased number of infections observed among elite athletes. One of the proposed theories for the observed occurrence among elite athletes during times of intense training, athletes isolate themselves and focus solely on goal oriented tasks. Isolation and negligible time for leisure, increase psychological stress, which negatively effects the immune systems through the neuroendocrine pathways. Another proposed theory was during times of increased 'stress,' athletes become deficient in key micronutrients necessary for proper immune function. Finally, Shepard proposed that an increase in endotoxins in the gut may hinder the immune system in a manner similar to a heat stroke. The study proposed several factors for changes in immunity but there were not any conclusive explanations (Shephard 2000).

There are two different types of immunity, which may explain the differing responses to varying degrees of physical activity. The two overall types of immunity are innate (non-specific) and adaptive immunity. One of the components of innate immunity is the salivary secretory system. Researchers at Loughborough University tested salivary secretory immunoglobulin A response to sporadic exercise in wheelchair athletes. Investigators monitored athletes using sixty

minute treadmill sessions and by collecting unstimulated saliva samples. Researchers measured the levels of Immunoglobulin A (sIgA) and amylase, as well as oxygen uptake, and blood lactate concentrations in each subject. Immunoglobulin A and amylase levels increased during physical activity (Leitcht et al. 2011)..

Salivary secretory immunoglobulin A is the most abundant immunoglobulin in saliva and other mucosal secretions. Immunoglobulin A plays a major function in the mucosal immune system. Salivary secretory immunoglobulin A is a factor in the "first line of defense" against foreign pathogens (colds and viruses). Secretion of sIgA can be controlled by the parasympathetic and sympathetic nervous system. Moderate exercise is associated with sympathetic nervous system activity; thus, physical activity could enhance the secretion of the proteins found in saliva. Investigators noted a decrease in sIgA secretion rates when atheltes engages in strenuous exercise. This study suggested that moderate exercise may increase an individual's resistance to infection, conversely strenuous exercise may decrease immunity for a brief period of time (Leitcht et al. 2011).

Similarly, David Neiman conducted an experimental study to test the alteration in blood content to determine the fundamental differences between blood concentrations in physically active groups and control groups. Natural killer cell activity, which mediates non-major histocompatibility complex against bacterial cells or virus, was chronically high in elite athletes. However, for at least six hours following a high intensity workout, natural killer cell levels are decreased by almost half, reducing host immunity for a short period of time. The elevation seen in elite athletes during periods between workouts could suggest an increased immunity, explaining many of the observed results in the previous experiments reviewed. Neutrophils are phagocytes in innate immunity. No long term differences were observed between groups. Levels

of neutrophils were also decreased in individuals following intense physical activity. Neiman predicted that initial decrease in neutrophil numbers following intense physical activity was most likely cause for the increase in upper respiratory infections among elite athletes. The study also analyzed B and T lymphocyte numbers as well as salivary immunoglobulin A, but Neiman determined the results to be inconclusive (Nieman, 1997).

Physical activity signals various changes in the blood. In accordance with previous studies, researchers from All-Russian Institute of Physical Culture and Sport Moscow aimed to determine the effects of physical activity on blood sample concentrations. To monitor the changes, researchers collected blood samples from patients following timed exercise on a standard treadmill. Investigators added microchips to titers to monitor changes in gene expression. Results concluded that natural killer cells were the most sensitive to physical activity. Researchers believed that the changes in the natural killer cells contribute to improved immunity in physically active individual (Shleptsova et al. 2010).

Moderate Physical Activity and Upper Respiratory Infection

Determining if physical activity can function as a immunoprotectant, is of clinical significance. Researchers at the University of Copenhagen conducted a review to determine the mechanisms contributing to exercise stimulated immune system changes and the clinical significance of disease prevention. Physical activity represents a quantifiable model for physical stress. Researchers analyzed several parameters altered by physical activity including: lymphocyte subpopulations and proliferation, natural killer cells, antibody production, mucosal immunity, neutrophil function, hormone response, and some infections. Data from previous studies indicated that neutrophil concentrations increased significantly during moderate

exercise, and decreased below prevalues following prolonged physical activity. The intensity of the exercise altered the number of circulating cells more than the duration of the activity. This study further emphasizes the importance of moderate physical activity as an immunoprotectant; a decrease in neutrophils (white blood cells which non-specifically engulf pathogens) would appear to decrease innate immunity and increase the risk of infection (Pedersen and Hoffman-Goetz, 2000).

Researchers at the University of Illinois conducted a study to determine if cardiovascular activity improved antibody responses in sedentary elderly adults that received the influenza vaccine. Examiners compared interventions of moderate intensity physical activity to flexibility and balance intervention. Researchers measured hemaglutination inhibition, seroprotective response and anti-influenza antibody titer in response to the influenza vaccine. Cardiovascular intervention resulted in an increase in seroprotection, but flexibility intervention showed no significant difference. Although seroprotection levels varied among subjects, there were no reported differences in respiratory infections. Exercise intervention resulted in decreased general illnesses. Researchers noted that these results were concurrent with previous studies. This suggested that exercise may provide a protective response when interventions are implemented prior to exposure with a foreign pathogen (Woods et al 2009).

Researchers at Washington State University, conducted a similar year-long study to test the effects of moderate exercise on the risk of contracting a cold or other respiratory tract infection. Investigators conducted a study using postmenopausal (overweight/obese, nonsmoking and sedentary) women in the Seattle area. Researchers arbitrarily assigned subjects a moderate-intensity work-out or a control group. To monitor cold prevalence, subjects answered questionnaires every three months. Control groups reported a three times higher risk of

contracting a cold than experimental groups. Researchers concluded that moderate exercise can reduce the prevalence of the common cold in postmenopausal non-smoking women that were previously sedentary. Results were analogous to several other studies which suggested that conditioning prior to exposure decreased the risk of contraction of an infectious disease (Chubak et al 2006).

In Summary

Each of the previous studies examined the effects of a stressor on the immune system. In all, stress of any kind, whether it be psychological stress or induced physical stress, acted negatively on the overall functioning of the immune system and thus resulted in an increased number of upper respiratory infections. When subjects engaged in moderate levels of physical activity, perceived stress levels were reduced along with the number of colds acquired by the subjects. College students specifically are under an inordinate amount of stress, which may provoke unhealthy dietary habits and a reduced amount of time spent engaging in physical activity, thus leading to an increase in the incidence of infection from the common cold.

Limitations of The Literature

Presently there are copious amounts of research on the individual effects of stress, physical activity, and factors contributing to the contraction of an upper respiratory infection. However, the combined effects of physical activity and how it relates to stress, body mass index, and upper respiratory infections has yet to be thoroughly explored. The effects of perceived stress levels and their relative contributions to self-reported colds in college students is also an area with minimal data. The less than plentiful amounts of conclusive data in these areas has led to the current questions under inquiry.

Perceived stress and physical activity

Incorporation of physical activity has long been suggested as a mean of stress management. The correlation of physical activity and stress management, has been well documented amongst adults and adolescents, but less so in collegiate students. It was reported by the Keck School of Medicine that less than half of all college students engaged in the recommended amounts of daily physical activity. The reports of college students showed a loose, negative correlation between physical activity and perceived stress levels (Ngyen-Micheal, 2006). Researchers at the University of Santiago de Campostela reported a fourfold increase in self-reported colds among individuals with high levels of perceived stress. Perceived stress also increased the reported duration and severity of colds (Takkouche et al. 2001). Along with a multitude of positive psychological improvements, the incorporation of physical activity into a daily routine was shown by the researchers of the Stanford University of Medicine, to significantly decrease workforce absenteeism (Taylor et al. 1985).

Physical activity, protective immunological benefits, and negative effects of physical activity

Physical activity can both positively and negatively affect the functioning of the immune system and alter its susceptibility to infection. A J-shaped curve has been reported in a number of studies regarding physical activity and the susceptibility of infection. This suggested that moderate levels of physical activity may enhance the functioning of the immune system, while exhausting levels of physical activity may impair its function. While there is only a minute amount of evidence that suggested a clinically significant difference between sedentary and reasonably active individuals while, there is a plethora of epidemiological evidence that supports

the association of moderate exercise and decreased infections.(Gleeson, 2007) Researchers in the Department of Epidemiology, at the Norman J. Arnold School of Public Health reported 29% fewer upper respiratory infections in individuals who engaged in at least two hours per day of physical activity, when compared to sedentary individuals. (Mattews et al. 2002) Conversely, the researchers at the School of Public Health at the Loma Linda University reported at 100-500% increase in self reported colds in ultra-endurance athletes following a competition. (Neiman, 1999) Similar observations were seen in humans engaging in a study conducted by David Neiman. Neiman tested the effects of frequent and strenuous physical activity and their relative effects on the prevalence of upper respiratory infection. The study showed individuals engaging in exhausting physical activity had an increased number of upper respiratory infections when compared to other groups. Individuals that participated in moderate exercise showed a decrease in the number of infections when compared to sedentary individuals. Although none of these reported cases of alterations in upper respiratory were clinically confirmed, the results are typical, indicting the importance of duration and intensity of physical activity.

A number of studies have indicated an increase in immune function with moderate physical activity, while conversely reporting a decrease in immunity with increasing duration and intensity of physical activity. While the degree to which an individual engages in physical activity appears to be important, so does the timing of when they incorporate physical activity into their routine. Researchers from the United States Army Medical Research Institutes of Infectious Disease analyzed the significance of the time of infection and the time of incorporation of physical activity. Mice were used as model organisms to test their experiment. Exercise conditioning prior to inoculation decreased susceptibility of the mice to inoculated pathogen. When exercise was implemented following inoculation, mortality rates were

increased. Researchers speculate that a single bout of exercise in healthy subjects may raise the number of peripheral blood natural killers, and therefore increase immunity(Illback, 1991).

Relationship between perceived physical activity and healthy body mass index

Body mass index (BMI) is a widely used indicator for obesity, despite its known limitations (De Schutte, 2011). Standard body mass index parameters include upper and lower quartiles of 18.5 (underweight), 18.5-24.5 (normal), 25.0-29.9 (overweight), 30+ (obese), as defined by the National institutes of health (CDC, 2011). Even with many of the discrepancies with the use of Body Mass Index as an indicator for obesity, research conducted by individuals working for the Academic Division of Ochsner Clinic Foundation found over a 68% correlation between obese participants and their respective BMI (De Schutte,2011). As an alternate method for determining relative fitness, researchers at the Center for Community-Based Research, used self-reported assessment surveys to gage relative fitness. At the start of the project roughly 91 percent of participants perceived themselves as physically active, while approximately half of all participants were considered clinically overweight or obese (Kaphings, 2007). Alternatively, researchers at The American Society for Clinical Nutrition found that a low body mass index (lean body) was positively correlated in individuals who engaged in physical activity (Baecke, 1982).

Methodology

The data for the present study was collected through an anonymous web based survey distributed to the student body of Coastal Carolina (approximately 9,000 students). The survey included standard demographic questions, open ended height and weight portions, along with questions about type, duration, and levels of physical activity. The survey also incorporated

perceived stress questions based on the perceived stress scale, derived by Sheldon Cohn Ph.D. (Cohn, 1988) The survey was distributed to the student body of Coastal Carolina University via a mass distribution e-mail. Prior to the distribution of the survey, the survey was submitted and approved by the Institutional Research Board of Coastal Carolina University. The study was entirely confidential and voluntary, while students could enter their e-mail address into a random drawing for a $50 gift card. The possibility of winning a gift card was used to persuade students to participate in the study.

After one week, the survey was closed to all students. Once the survey was closed, the data was analyzed. Descriptive statistics such as percents and averages were performed for all completed surveys. Inferential statistics were used to determine differences between groups (Anova) and relationships among variables (Regression Analysis). Additionally, relationships between physical activity and perceived stress; and the number of upper respiratory infections and perceived stress levels were also analyzed.

Results

From the approximately 9,000 baccalaureate students of which the survey was distributed, 675 students voluntarily completed the survey. Descriptive statistics were calculated from the information of the completed surveys (Table 1). Among those that completed the study 70% were female and 30% male. The groups of male and females were combined and body mass indexes were calculated. Based on the reported heights and weights of the students; 5% had a body mass index of less than 18.5 (underweight), 33% had a body mass index of 18.6-24.9 (normal), 46% reported a BMI of 25.0-29.9, and 16% had a BMI equal or greater than 30 (obese). The majority of students reported being physically active, while only 30% reported not

engaging in physical activity regularly. Of the students that reported being physically active, 14% indicated they engaged in some form of physical activity one to two times per week. While 50% of students reported they participated in physical activity two to three times per week. The remaining students reported partaking in physical activity either five to seven times per week, or more than seven times per week averaging 30% and 6% respectively. Students perceived stress levels were also inquired. The majority of students, 70% reported being stressed sometimes or fairly often. While only 2% reported never feeling stressed, 12% of students almost never feeling stressed, and the remaining 17% of students feeling very stressed. Of the students surveyed 78% of students said they engaged in physical activity as a form of stress relief.

Demographics of the Student Population

	Number	Percent		Number	Percent
Gender			**Number of colds**		
Male	169	25%	None	68	10%
Female	506	75%	1-2 times	373	55%
BMI			3-5 times	189	28%
<18.5	32	5%	5+ times	45	7%
18.6-24.9	226	33%	**Times/ Week Physically Active**		
25.0-29.9	309	46%	1-2 times	67	14%
>30	108	16%	3-4 times	235	50%
Physically Active			5-7 times	139	30%
Yes	470	70%	7 + times	28	6%
No	205	30%	**Exercise as a Stress Reducer**		
Stress			No	144	21%
Never	12	2%	Occasionally	266	39%
Almost Never	78	12%	Yes	265	39%
Sometimes	235	35%			
Fairly Often	236	35%			
Very Often	114	17%			

Table 1: The table displays descriptive statistics of the sample population of students.

Body mass index of students was compared to their relative stress levels, number of colds, and the frequency in which they engaged in physical activity. There was a significant difference in body mass index between students who reported never feeling stressed and all other students. The students that reported never feeling stressed were in the upper quartile of body

mass index (>30). There was not a significant difference between body mass index and any of the other variables: number of colds, frequency of physical activity.

A Tukey Analysis of Stress and Body Mass Index

BMI			
Tukey HSD a,b			
Stress Level	N	Subset for alpha = 0.05	
		1	2
Very Often	114	24.6	
Fairly Often	236	24.7	
Sometimes	235	25.4	
Almost never	78	27.0	
Never	12		38.1
Sig.		0.789	1

Table 5. There is a significant difference in BMI between the students who reported never having stress and all other students, compared to: Experiencing stress very often ($p < 0.001$), Experiencing stress fairly often ($p < 0.001$),Experiencing stress sometimes ($p < 0.001$), Experiencing stress almost never ($p = 0.004$)

The students perceived stress levels and their number of colds in 2012 were analyzed with respect to their frequency of physical activity. A general linear model showed the presence of a significant inverse correlation (p value:< 0.001) with respect to the students physical activity level and their relative perceived stress. Further analysis of the variables and association of physical activity and stress, male and female groups were compared. A significant difference (p value: 0.011) between the two groups was present. The group of sampled males displayed a more linear relationship between physical activity and stress, while females which engaged in physical activity more than seven times per week had a slight increase in reported stress levels (Figure 3, table 3, table 4). There was not a significant difference in the number of colds students experience and their frequency of physical activity.

Descriptive Statistics of Male Students and Self Reported Stress Levels and Number of Colds

Males			
Physical Activity		Stress Level	
1-2 time/wk	14%	Never	3%
3-5 times/wk	40%	Almost Never	25%
5-7 times/wk	36%	Sometimes	40%
>7 times/wk	10%	Fairly Often	25%
		Very Often	7%

Table 3: The relative percentages for the male students that reported their stress level and their relative number of colds for the year 2012

Descriptive Statistics of Female Students and Self Reported Stress Levels and Number of Colds

Females			
Physical Activity	Percent	Stress Level	Percent
1-2 times/wk	15%	Never	1%
3-4 times/wk	54%	Almost Never	7%
5-7 times/wk	27%	Sometimes	33%
>7 times/wk	4%	Fairly Often	38%
		Very Often	20%

Table 4: The relative percentages for the female students that reported their stress level and their relative number of colds for the year 2012

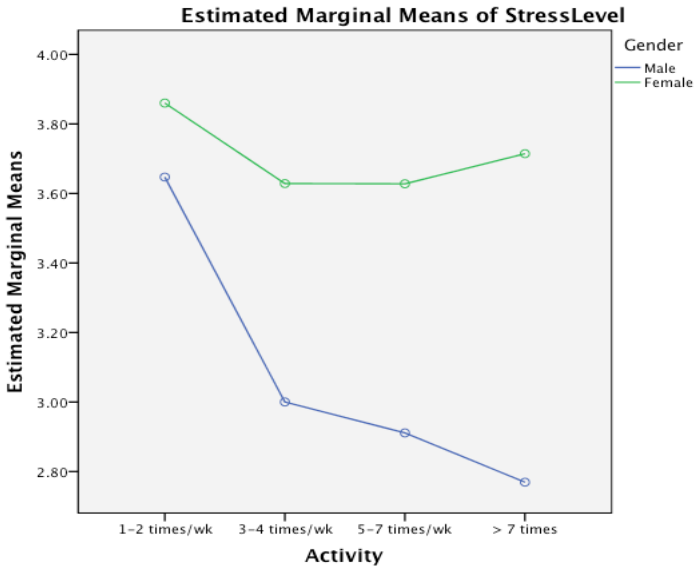

Figure 3: When the effects of physical activity on perceived stress levels were compared, there was a significant difference (p value: <0.001) between groups of males and females. There was also a significant inverse correlation(p value: 0.011) between physical activity and perceived stress.

Based on the number of reported colds for the year 2012 and the perceived stress levels of students, factorial design statistics were used to determine the presence or absence of a relationship. A general linear model showed the presence of a significant differences (p value: <0.001) between students stress levels and the number of colds they reported for the year 2012 (Figure 1, table 2). An increase in stress was positively correlated to an increase in the number of colds. The relationship between stress and colds was then reexamined to determine if there was a difference between groups of male and female students. Although there was not a significant difference between groups, there was a more apparent linear trend in women (Figure 2).

Number of Colds in the Year 2012

Stress Level	1-2 Colds	3-5 Colds	>5 Colds
Never	1.30%	0.30%	0.00%
Almost never	8.70%	1.60%	0.20%
Sometimes	22.00%	11.20%	2.00%
Fairly Often	19.40%	12.50%	3.00%
Very Often	10.00%	5.60%	2.30%

Table 2: Percentage breakdown for the number of students that reported their stress level and their relative number of colds for the year 2012

Students Reported Stress Level and Number of Colds 2012

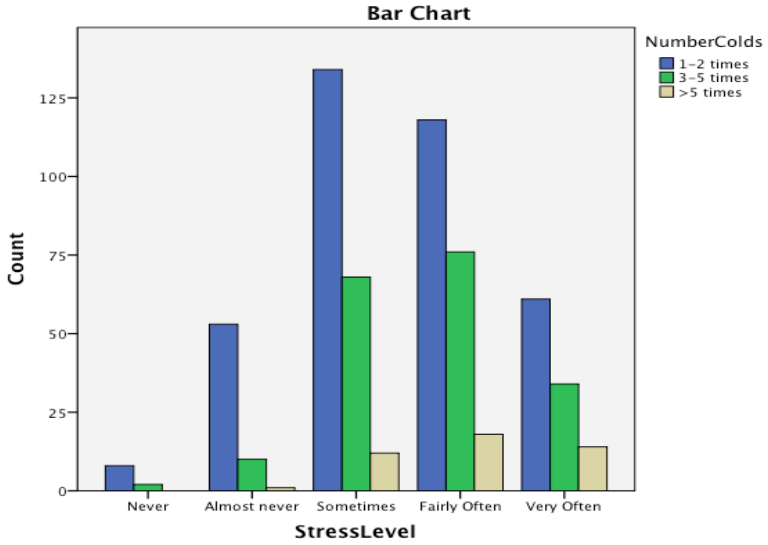

Figure 1: There were significant differences (p value: <0.001) between students stress level and the number of colds they reported having in the year 2012.

The Difference Between Male and Female Student's Stress level and Number of Colds

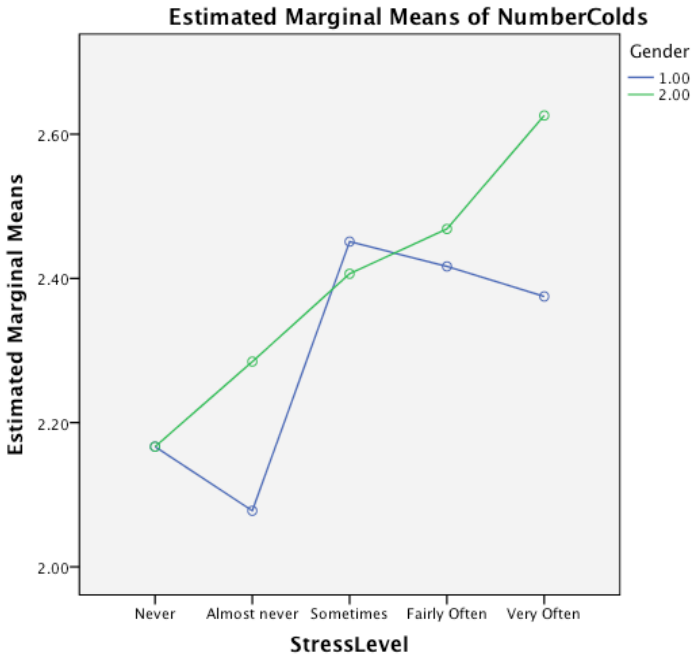

Figure 2: There was not a significant difference between male and female groups, although there was a more noticeable trend in women.

Discussions, Conclusions, and Limitations

Colds and stress were relatively common variables among the sample of Coastal students. Ninety percent of students reported having at least one cold the previous year, and 99% of students reported having some degree of stress. Although the study primary focused on the effects of physical activity and the risk of contracting an upper respiratory infection, there was not a significant difference in the number of colds contracted by groups which engaged in varying levels of physical activity. Based on the literature it was reasonable to expect a decrease in colds with an increase in moderate levels of physical activity. A number of studies showed a threshold for this trend in elite athletes training for an event, but the minimal number of students which trained for an event in 2012 was not predicted to have skewed the data. There are two more likely possibilities for the absence of a trend, either there is not a trend among students at Coastal, or the use of recall data was a limiting factor.

Although there was not a significant association between the frequency in which students engaged in physical activity and their relative number of colds, there was a significant correlation between physical activity level and stress. In Coastal students there was an inverse correlation in the students perceived stress levels and their frequency of physical activity. These results are analogous to much of the literature, indicating that engaging in physical activity is a healthy way to manage stress levels in adults and collegiate students alike. Interestingly, there was a more linear trend in male students. Female students showed a linear decrease in stress levels with an increase in days they were physically active, until their activity level exceeded seven times per week. One possible explanation for this, is female students may be more effected by the pressure to conform to societies version of beauty.

Incorporation of physical activity showed promising means of reducing stress. Students with lower reported stress levels also reported having fewer colds the previous year. There was a significant relationship between stress and the number of colds in 2012. When differences between groups of males and females were compared, there was not a significant difference. However, when plotted, females displayed a more linear trend. Interestingly, when body mass indexes were compared to relative stress levels, those students in the upper quartile of body max indexes indicated the lowest stress levels. Based on the previous significance in study, there are several likely explanations for this occurrence. The use of body mass index as a indicator of health and fitness has its limitations. A person could be muscular and not necessarily overweight and have a higher than average body mass index. This could mean that the students which indicated the lowest levels of stress, and were in the upper quartiles of body mass index were of athletic build, consistent with the previous findings. Another explanation is that students in the upper quartile of body mass index are content and not easily stressed.

Overall, the incorporation of physical activity into one's daily routine is a healthy means of controlling stress. Although the data did not directly indicate physical activity as a risk reducer for colds, physical activity was inversely associated with students stress level, and subsequently students stress levels were inversely associated with the number of colds. Although the data does not directly show a relationship between physical activity and the number of colds, there may be an more subtle relationship which needs further exploration.

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