Spring 4-21-2004

The Prevalence of Low Back Pain and its Association with Body Mass Index

Lance Beebout
Augsburg College

The Prevalence of Low Back Pain and its Association with Body Mass Index

By

Lance Beebout

Thesis Submitted in Partial Fulfillment

Of the Requirements for the Degree

Of Master of Science

Physician Assistant Studies

Augsburg College

May 2004

CERTIFICATION OF APPROVAL

This is to certify that the Master's Thesis of

Lance J Beebout

has been approved by the Thesis Review Committee for the Master of Science in Physician Assistant Studies degree.

Date of Oral Defense: 4/21/04

Heather Bidinger, PA-C, MMS

Dawn B. Ludwig, PA Dept. Chair

FAMILY EDUCATION RIGHTS AND PRIVACY ACT REQUIRMENTS

In accordance with the Family Education Rights And Privacy Act, Augsburg College is required to advise students in advance that their projects will be made publicly available as part of the curriculum requirements.

Please sign below to indicate that you have been informed of this requirement and agree that your project will be made available as a research source for the academic community through the college's library.

Lance J Beebout

Lance Beebout   4-21-04

Signature   Date

ABSTRACT

The Prevalence of Low Back Pain and its Association with Body Mass Index

Background: The question of whether obesity is a risk factor for the development of low back pain (LBP) has been the subject of considerable research. To date no clear consensus has been made concerning this highly debated issue. The purpose of this study is to determine whether overweight individuals, BMI $\geq$ 25, reported higher incidences of LBP over the course of one year while accounting for other known risk factors for the development of LBP.

Methods: This non-experimental study design utilized an eleven question survey to gather data from sixty-one undergraduate day-program Augsburg College students enrolled in required physical education course work.

Results: Results indicated that overweight individuals, accounting for other known risk factors, reported low back pain over the course of the past year 1.94 times more than individuals of normal weight. A chi-square test with a confidence interval (p=0.014) provided support that the association observed was not due to random chance. Despite the strong association a cause and effect relationship could not be established due to the design of the study.

Conclusions: This study found overweight individuals to report experiencing LBP in the past year at rate nearly twice high as normal weight individuals. However with this being said there is no clear picture from this and past research that can determine if there is a true cause and effect relationship between obesity and LBP. Until such a carefully constructed study is achieved isolating these two specific variables the question of whether obesity causes low back pain cannot be clearly answered.

TABLE OF CONTENTS

LIST OF TABLES AND GRAPHS

Chapter One: Introduction

Introduction/Background

Low back pain (LBP) is acknowledged as the leading occupational injury in the United States (Guo, Tanaka, Halperin 1999). LBP does not discriminate among sex, race, or age. However, some groups of individuals were found to have an increased risk for the development of LBP. Preliminary findings suggest that individuals, who are either overweight or habitual smokers, might be placing themselves at a higher risk for the development of LBP. These are just preliminary findings and a considerable amount of research is still needed to validate either assumption. Additional risk factors, such as age, sex, and occupation are also being studied for their association to LBP. The benefit of identifying risk factors that lead to the development of LBP cannot be underestimated given the devastating effect that LBP has on the American work force.

The question of whether obese individuals are predisposed to higher incidences of low back pain has been a subject of considerable research. Even with the vast body of research that has been conducted and continues to be conducted on the topic of obesity and LBP, no clear answer has yet been established. The major down fall in past research has been a lack of specific studies which account for other possible contributing factors to the development of LBP (Heliovarra 1987).

Obesity is not only a potential risk factor for the development of low back pain but has been linked to the development of several life threatening medical conditions such as diabetes mellitus, coronary heart disease, stroke, and hypertension (Centers for Disease Control, 1999). According to Flegal, Carroll, Ogden, and Johnson (2002) the prevalence of obesity in the United States has risen from 14.5% in 1980, to 22.9% in 1994, and to 30.5% in 1999-2000. With such an alarming rise in the prevalence of obesity in the United States, a concerted effort by both the medical community and the media is needed to educate the American population on the medical consequences of obesity.

The focus of this study was to evaluate for potential correlations between body mass index (BMI) and the incidence of LBP. Subjects enrolled in required physical education courses at Augsburg College, located in Minneapolis MN, were used in the study. College students were used because a young population of both men and women was deemed necessary based on the literature reviewed. According to Ovieto, Rand, Lev, Wiener and Nehama (1994) individuals in early adulthood have a reduced probability that any reported LBP is a result of repetitive lifting, effects of habitual smoking, exposure to vibrations caused by vehicles and machinery, and degenerative changes of aging. College students, in general, are in their early adulthood and thus are deemed relatively free from accumulative factors mentioned by Ovieto, et. al.

Purpose/Importance of the Study

The purpose of this study was to examine for correlation's between BMI and LBP. Did individuals with body mass indices greater than or equal to 25 kg/m^2 experience an increased incidence of lower back pain compared to individuals with body mass indices less than 25 kg/m^2?

The specific objectives were to....

1. Quantify demographic and medical information obtained from the study population including; gender, age, height, weight, calculated BMI, smoking status, history of spinal injury requiring hospitalization, and known spinal abnormalities.
2. Assess the point prevalence of LBP as it relates to BMI.

3. Determine whether individuals with BMI's greater than 25 kg/m² reported a higher incidence of LBP in the past twelve months compared to individuals with BMI's less than 25 kg/m² with and without known risk factor for LBP.
4. Assess the duration of LBP in individuals that reported experiencing LBP in the past twelve months compared to BMI; excluding participants that smoke, have a history of spinal injury requiring hospitalization, and who have a diagnosed spinal abnormality.
5. Quantify the pain experienced by individuals who were currently experiencing pain at the time of completing the survey and compare that level of reported pain to BMI.

The end goal of this study was to contribute to the knowledge base of information on the topic of obesity and low back pain. Researching potential risk factors for the development of low back pain, especially preventable risk factors like smoking and obesity, are extremely important. According to Guo, et al. (1999), low back pain is the leading occupational injury in developed countries. The financial health cost savings by reducing the primary occupational injury in the United States via preventative measures has enormous potential and is further discussed in Chapter 2.

Operational Definitions

- Body Mass Index (BMI): body weight in kilograms divided by height in meters squared.
- Herniated disk: a rupture of the fibrocartilage surrounding an intervertebral disk, releasing the nucleus pulposus that cushions the vertebrae above and below. The resultant pressure on spinal nerve roots may cause considerable pain and damage the nerves (Anderson 1998).
- Kyphosis: an abnormal condition of the vertebral column, characterized by increased convexity in the curvature of the thoracic spine as viewed from the side (Anderson 1998).

- Lordosis: an abnormal anterior concavity of the lumbar part of the back characterized by a "sway back" appearance when viewed from the side. (Anderson 1998).
- Low Back Pain (LBP): defined as pain located between the twelfth thoracic rib and the coccyx lasting greater than twenty four hours in duration according to Lake, Power, and Cole (2000).
- Scheuermann's disease: an abnormal skeletal condition characterized by a fixed kyphosis that develops at puberty and is caused by wedge-shaped deformities of one or several vertebrae (Anderson 1998).
- Schmorl's nodes: are considered to be vertical disc herniations through the cartilaginous vertebral body endplates (Anderson 1998).
- Scoliosis: lateral curvature of the spine as viewed from the posterior side of the body (Anderson 1998).
- Spinal Bifida Occulta: defective closure of the laminae of the vertebral column in the lumbosacral region without hernial protrusion of the spinal cord or meninges (Anderson 1998).
- Spinal Stenosis: a narrowing of the vertebral canal (Anderson 1998).
- Spondylolisthesis: the partial forward dislocation of one vertebra over the one below it, most commonly the fifth lumbar vertebra over the first sacral vertebra (Anderson 1998).
- Spondylosis: a condition of the spine characterized by fixation or stiffnees of a vertebral joint (Anderson 1998).

All BMI Classifications are according to the latest guidelines from the National Heart, Lung, and Blood Institute:

Classification of Overweight and Obesity by BMI

	Obesity Class	BMI (kg/m^2)
Underweight		<18.5
Normal		18.5 - 24.9
Overweight		25.0 - 29.9
Obesity	I	30.0 - 34.9
Moderate Obesity	II	35.0 –39.9
Extreme Obesity	III	40

World Health Organization. Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation of Obesity. Geneva, 3-5 June 1997.

Assumptions and Limitations

As a result of limitations, researchers are often required to make assumptions regarding the information they collect. This study was no different. The first assumption was that all survey questions were completed with accurate information from each participant. Insuring that all information given on the surveys was accurately reported by the study participants would have been a cumbersome and impractical task. As with all surveys the validity of the results are dependent on the accuracy of subject reporting.

Secondly, the concept of pain was extremely subjective. The study requested that subjects quantify their perceived level of LBP utilizing a numerical pain scale. A score of one represented minimal pain and a score of ten represented the worst pain ever experienced. Discrepancies in reported levels of pain are a common limitation with any objective pain assessment. The study assumed that subjects reported their level of pain accurately.

The study used BMI as a measuring technique to assess an individual's body fat. BMI has been proven to be an accurate measure of an individual's body fat composition according to the National Heart, Lung, and Blood Institute (World Health Organization Consultation of Obesity 1997). A specific limitation of using BMI as a measuring tool was that BMI has a tendency to overestimate body fat in individuals who are very muscular, and underestimate body fat in individuals who have lost muscle mass. Despite this small inconsistency, the study acknowledges BMI to be an accurate measuring tool to assess body fat composition.

Voluntary subject participation was an additional critical assumption. Sixty-eight surveys were dispersed with a goal of a seventy-five percent return rate. A return rate of seventy-five percent out of 68 surveys administered would account for 2.9% of the entire estimated undergraduate enrollment. Subject participation is vital to all research utilizing human subjects.

Accuracy of subject reporting, subjective pain assessment, subject participation, and body fat composition via BMI, were the potential limitations in this study. However, the assumptions and limitations of this study were minimal and were not perceived to significantly compromise the validity of the research.

Summary

The remaining chapters consist of a literature review, research design and methodology, data analysis, and a composite discussion of the research results. The literature review was comprised of the most recent research in the field of low back pain and obesity. A portion of the literature review also addresses additional research regarding other possible etiologies for the development of low back pain. The research design section addresses methodology, study instrumentation, population sample and data collection and analysis design.

Chapter Two: Literature Review

Introduction

The topic of whether there is an association between body weight and low back pain (LBP) has been the focus of much research in the past few decades. Even with the body of research that has been conducted and continues to be conducted on the topic, no clear answer has yet been established. This literature review provides the most current information on obesity in relation to LBP. Information on LBP was gained through the categories of; economic impact/prevalence, risk factors, and association to obesity. Much research is still needed before a concrete conclusion, regarding whether obesity and LBP are intertwined, can be delivered to the medical community.

Obesity

Obesity is a huge and growing economic burden for the US health care system consuming 433.6 billion dollars annually in direct and indirect health care cost in 1999 and was directly accountable for 3.5 billion dollars in total health care cost related to LBP (Centers for Disease Control, 1999). Refer to Appendix A, table one for an analysis of obesity costs in relation to co-morbidities. Approximately 127 million adults in the U.S. are overweight which accounts for 64.5% of the entire United States adult population over the age of twenty and sixty million of these 127 million people are obese with nine million suffering from extreme obesity (American Obesity Association, 2003). According to Flegal, et. al (2002) the prevalence of obesity in the United States has risen from 14.5% in 1980, to 22.9% in 1994 and to 30.5% in 1999-2000. These statistics equate to a four-percent rise in obesity every five years with no apparent signs of a plateau or reverse trend in the near future.

Obesity is not just an economic burden but is also a significant contributor to the development of many health related disease states, such as diabetes mellitus, coronary heart disease, hypertension, and stroke (Appendix A,Table two). According to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), the cost of lost productivity related to obesity (BMI greater than or equal to 30) among Americans ages 17-64 was $3.93 billion in 1994 and estimated to increase with the continually rising rate of obesity. The NIDDK also reported 39.3 million lost workdays, 62.7 million physician office visits, 239.0 million restricted activity days, all of which were related to obesity. With such an alarming rise in obesity and the economic burden associated with the condition a significant effort by the medical community needs to be made to combat this disease.

Low Back Pain/Prevalence

Life-time prevalence of LBP in the United States ranges from 60% to 90% with an annual incidence of approximately 5% (Orvieto, et al. 1994). Taylor and Curran (1985) conducted The Nuprin Pain Report in which the researchers interviewed by phone 1,254 adult volunteers concerning low back pain. Through the telephone interview they found that fifty-six percent of the respondents reported some back pain, duration of at least one day, in the preceding year. A study by Murphey and Courtney (2000) reported that approximately 10% of the cases of LBP caused more than 80% of the total cost for LBP because of the potential chronic nature of the condition. Despite this ominous statistic prognosis for individuals that experience low back pain is encouraging with 90% recovery in less than three months with rest as the primary means of treatment (Toda Y, Segal, Toda T, Morimota and Ogawa 2000). Only small proportions of individuals suffering with LBP ever require surgical intervention. According to Atlas and Deyo (2001) individuals with neurological symptoms from lower back injuries or disease are the most likely candidates for surgery intervention. They also reported that vertebral compression fractures and vertebral herniation were the most common cause for surgical intervention in individuals with back injuries.

The etiology of most individual episodes of LBP is not well understood. A small proportion of cases can be contributed to infection, inflammation, vertebral fracture, vertebral abnormalities, or cancer. However most episodes of LBP can only be classified as non-specific with no convincing underlying explanation of the episode other than a musculoskeletal strain/sprain and fortunately resolve spontaneously without medical intervention (Jayson, M.V. 1970).

A large volume of research has been conducted to evaluate whether there is a correlation between obesity and lower back pain and yet no concise answer has surfaced because of inconsistent research findings. These inconsistencies are addressed throughout the remainder of the literature review. More conclusive research on the topic of obesity and LBP is needed before a definitive answer can be ascertained.

Low Back Pain & Obesity

Current literature regarding the topic of obesity and low back pain has brought forth multiple discrepancies regarding obesity as a potential etiology for LBP. A sizable amount of current medical literature supports a correlation between obesity and low back pain while a considerable amount of research does not. With such a drastic division in data supporting either notion, the debate on obesity and LBP is far from over.

Orvieto et al. (1994) examined whether there was an association between body mass index and the prevalence of low back pain in approximately one quarter of a million male military recruits. Orvieto et al. were careful to filter out recruits that had congenital conditions that have been established as causative factors for low back pain, such as kyphosis, scoliosis, Scheuermann's disease, spondylosis, and spondylolisthesis. The researchers excluded recruits with documented spinal surgeries or spinal injuries. The study revealed a statistically significant relationship ($p < 0.0001$), showing that obese recruits had an increased prevalence of low back pain compared to normal weight recruits.

A large population based Danish twin studied conducted by Leboeuf-Yde, Kyvik, and Bruun (1999) found mixed results after conducting their research on obesity and LBP. Of the 29,424 twin subjects studied, in which 3,751 were monozygotic (identical) twin pairs, an overall positive correlation ($p<0.009$) was found between BMI and LBP especially in the group reporting LBP in excess of thirty days in the course of one year. However when monozygotic twin pairs with different body mass indices were compared, no correlation between BMI and LBP was evident. These findings showed that a monozygotic twin with a high BMI (>25) did not experience an increased risk for developing LBP compared to his/her monozygotic twin sibling with a normal BMI (20-24), (Leboeuf-Yde, 1999). A question raised through their research is why was there a positive correlation found between BMI and LBP in the overall study of twin subjects but when monozygotic twin pairs with dissimilar BMI's were compared to each other no correlation was found? Leboeuf et al. could not account for this discrepancy in the data analysis.

Leboeuf-Yde et al. (1999) in their study added crucial knowledge to the field of research on obesity and LBP. The study used a large population base, which made it possible to control for some extraneous factors, such as age, gender, type of work, and smoking status. The large number of monozygotic twins also made it possible to use a twin control method, which is a powerful method for studying different effects of extraneous factors that can potentially confuse a true association between BMI and LBP. Even with the large population base and the use of twin subjects Leboeuf-Yde et al. (1999) concluded that further information is needed to reach a final conclusion concerning obesity and its relationship to LBP, specifically whether obesity precedes LBP or LBP precedes obesity.

Fanuele, Abdu, Hanscom and Weinstein (2002) looked at obesity and functional status in patients with spinal disease. The study evaluated whether obese patients with spinal disease experienced more functional disability compared to normal weight patients with spinal disease. Study patients were divided into four groups based on BMI. These four study groups were classified as normal, grade one obesity, grade two obesity and grade three obesity with respective BMI's of <25, 25.0-29.9, 30.0-39.9, and ≥ 40.0. Fanuele et al. reported that patients in all obesity classifications were more likely to experience radicular pain in comparison to non-obese individuals with a statistically significant positive correlation found between increasing BMI and reported radicular pain. Radicular pain is defined as pain involving the distribution of a spinal nerve. In addition the study found that obese individuals were more likely to be receiving worker's compensation than non-obese individuals, 9.6% vs 6.7% respectively.

The study by Fanuele et al (2002) indicates that obesity can lead to greater disability and pain for individuals dealing with spinal disease. This study strengthens the need to determine if obesity is a risk factor for the development of low back pain. Hypothetically, what if obesity is found to be both a causative factor in the development of LBP and a hindering factor in the healing process of LBP? Then the importance of stressing diet and exercise becomes even more pertinent.

The most comprehensive research study on the topic of body weight and low back pain was organized by Charlotte Leboeuf-Yde. Leboeuf-Yde (2000) conducted a systematic literature review of 56 journal articles that studied body weight and its association with low back pain. After analyzing all the studies, Leboeuf-Yde concluded that there was not enough evidence to determine whether there was a causal relationship between body weight and LBP. Leboeuf-Yde latter stated, "It is disappointing that such a large number of studies (at least 65 over the past three decades) on the link between body weight and LBP have not been able to deliver a clear answer"(p. 235). Leboeuf-Yde attributed the inconclusive findings to a lack of specific studies, in which the body weight and LBP variables were not better isolated from other confounding risk factors associated with LBP. These confounding risk factors were multiple and included job occupation, smoking status, age, gender, congenital spinal abnormalities, previous spinal injuries. Leboeuf-Yde also determined that studies using large sample sizes (n>3000) were more statistical reliable along with studies that used multivariate analysis to account for extraneous risk factors.

Research has also been conducted on whether LBP causes obesity instead of obesity causing LBP. A comprehensive cohort study by Lake, Power, and Cole (2000) did attempt to examine whether obesity was a cause or an effect of low back pain. Lake et al. found that women who were classified as obese at the age of 23 had an increase risk for developing low back pain when reevaluated 10 years later (adjusted OR =1.78), compared to women with normal body weights. Lake et al. also found that women with chronic back pain at age 23 gained more weight over the next ten years than did women without chronic back pain (7.39 kg vs. 6.29 kg). No significant correlations between body weight and low back pain were found in the male subjects. The study was unable to confirm whether obesity was a cause or an effect of low back pain. This study did report that increased body weight in women was found to increase medical complaints concerning low back pain.

Risk Factors Associated with LBP

Risk factors thought to be associated with LBP, other then obesity, have also been studied. Factors such as cigarette smoking, increased age, and congenital spinal abnormalities are thought to contribute to the development of low back pain. (Frymoyer 1998) It is important to address these risk factors when attempting to establish whether obesity is a potential causative factor for the development of LBP.

Growing evidence has surfaced correlating low back pain to habitual smoking. A study by Feldman, Rossignol, Shrier, and Abenhaim (1999) has even demonstrated that smokers as young as adolescents experience low back pain significantly more often than non-smokers of the same age. Feldman, et al. further revealed that there was a dose-response relationship between smoking and back pain, which meant that an increase in cigarette smoking by an adolescent led to a greater incidence for the development of lower back pain. Brot, Jorgensen, and Sorensen (1999) have hypothesized that cigarette smoking may directly affect the body's ability to properly metabolize calcium and vitamin D by interfering with the vitamin D-PTH system. This interference with the body's vitamin D-PTH system causes a decrease in bone mineral density. A decrease in bone mineral density could then hypothetically be the causative factor for the correlation between smoking and low back pain. Even with this growing body of research correlating smoking to an increase risk of low back pain, a systematic literature review of 41 journal articles conducted by Leboeuf-Yde (1999) found smoking should only be considered a weak risk indicator and not a cause of low back pain.

Throughout the literature, age was also a recurring factor associated with the development of low back pain. A study conducted by Fransen, Woodward, Norton, Coggan, Dawe, and Sheridan (2002) found that age directly correlated with the transition from acute to chronic occupational back pain. The study reported a dose-response relationship between age and the development of chronic low back pain, meaning that as age increased so did the incidence of chronic back pain. A study conducted by Tsuritani, Honda, Noborisaka, Ishida, Ishizaki and Yamada (2001) also supported this view. They found that increased age was associated with higher reports of low back pain in Japanese women as their age increased from 40 to 69.

Orvieto et al. (1994) conducted a massive retrospective cross-sectional study on BMI and LBP using approximately 250,000 male military recruits all 17-18 years of age. Any recruits who had a history of spinal surgery or whose medical draft physical examination revealed kyphosis, scoliosis, palpable muscle spasm, limited forward flexion, or even a minor neurological deficit were excluded from the study. Recruits based on routine back X-ray who demonstrated findings of single level narrowing of the disc space, Schmorl's nodes, Scheuermann's disease, spondylolysis/listhesis, or any forms of degenerative spinal disease were also excluded form the study. The remainder of the recruits who meet the criteria to participate in the study where divided into three groups based on BMI (Group A BMI < 20, Group B $20 \leq$ BMI ≤ 25, Group C BMI > 25). The study found a strong correlation ($p < 0.0001$) between increasing LBP prevalence with increasing BMI. The researchers were confident in their results because the young population group used was relatively free from the long standing effects of smoking, repetitive lifting, and exposure to vibrations caused by vehicles and machinery, all factors which accumulate with aging and could have confounded the results of the study.

A variety of congenital conditions have been found to predispose individuals to the development of LBP such as; Scheuermann's Disease, scoliosis, lordosis, spondylolisthesis, spina bifida occulta, and spinal stenosis. The spinal abnormalities affect the structural integrity of the vertebral column predisposing individuals to the development of LBP. (Anderson and Hall, 1995) Any condition that jeopardizes the structural integrity of the spine, in theory, might predispose individuals to an increased risk for developing LBP.

Prior studies on the topic of obesity and LBP give future researches insight on how to further provide meaningful information to this area of medical research. This study will utilize the strengths and weakness of the prior research literature to aid in the development of an accurate assessment on correlations between obesity and LBP.

Summary

It is apparent that future research is needed in the field of LBP. Even with the vast body of research on LBP, many questions still remain unanswered. With individuals expected to have a 60%-90% life-time incidence of LBP, research that addresses potential risk factors for developing LBP, such as obesity, is critically important. With 64.5% of the U.S. adult population labeled as overweight and a fair amount of research linking obesity to LBP a closer look at the connection is warranted in order to halt the progression of both conditions. Prevention of LBP, obesity, or any other medical condition, is typically more time and cost effective on the health care system versus treating a medical condition once it manifests.

The intent of this study was not to determine the exact causes of LBP. This study sought to determine whether obesity, a debated risk factor for LBP, was indeed a potential risk factor for the development LBP. The survey tool implemented in this study was drafted around the thoughts and ideas used by Orvieto et al. to help filter through confounding factors related to low back pain in the study participants. This philosophy was precisely why the survey asked questions of age, prior congenital spinal abnormalities, previous back surgery's, and smoking status. In response to the literary reports correlating increasing age with a higher incidence of low back pain, this study conducted research on 18-25 year college students. The young age of the study participants reduces the likelihood that any reported LBP was a result of the previously mentioned extraneous factors. Questions of age, prior congenital spinal abnormalities, back surgery's, and smoking status aided in performing multivariate analysis to help filter out extraneous factors that could obscure potential correlation's.

Chapter Three: Methodology

Description of the Methodology

The study used a non-experimental methodology. The quantitative data received from the completed surveys was used to evaluate low back pain (LBP) and obesity in college age students. The collected data was then analyzed for correlation's between LBP and obesity using the SSPS statistical package.

Design of the Study

The design of the study sought to determine whether obesity, a debated risk factor for LBP, was linked to LBP. Augsburg College students enrolled in required physical education courses were given a short voluntary survey (Appendix B) to complete after having read the consent form (Appendix C). After completing the survey, students were asked to place their survey in a nine-inch by twelve-inch manila envelope. When all completed surveys were placed in the manila envelopes the administering faculty members sealed the envelopes and brought them to the main office of the Department of Health and Physical Education, where they were picked up by the researcher on a later date.

The Augsburg College Institutional Review Board approved the research project, including the written survey and consent form, for use of human subjects on June 4, 2003. The Institutional Review Board (IRB) approval number is 2003-32-2 and can be found in the IRB approval letter (Appendix D). Approval was also obtain by Dr. Ann Garvey (Appendix E), Associate Dean for Student Affairs, and Dr. Marilyn Florian (Appendix F), Health and Physical Education Department Chair.

Instrumentation

A written survey was chosen as the instrument being used to gather data. The survey was designed to specifically identify trends between BMI and LBP. As discussed in Chapter Two the survey was drafted around the thoughts and ideas used by Orvieto et al. related to low back pain. The survey consisted of eleven questions, and was to take no longer than ten minutes to complete. The results of the pilot study, which utilized five participants, indicated only one issue regarding a grammatical mistake and no issues with comprehension. As a result no contextual changes were made to the survey. Validity data for the pilot study was unobtainable due the small sample size.

Sample of Population

The survey was given to daytime-undergraduate Augsburg College students enrolled in required physical education courses. Augsburg College is located in Minneapolis Minnesota with Fall 2003 enrollment of 1778 daytime-undergraduate students. The survey was administered to sixty-eight students by the faculty of the Augsburg College Department of Health and Physical Education during the fall semester of 2003. Anticipated return rate was 75% based on the controlled classroom environment in which the survey was administered. A goal return of 75% out of the distribution of 68 surveys would account for 2.9% of the entire daytime-undergraduate enrollment. This population was chosen because of its typically young and healthy profile, which was deemed necessary in this research design to limit confounding variables. According to Ovieto, et al. (1994), individuals in early adulthood have a reduced probability that any reported LBP is a result of repetitive lifting, effects of habitual smoking, exposure to vibrations caused by vehicles and machinery, and degenerative changes of aging.

Data Collection and Analysis

The surveys were collected by the class proctor and were picked up by the researcher at a latter date. The information in the completed surveys was organized into separate statistical variables which included; smoking status, previous spinal injury, medically diagnosed spinal abnormalities, LBP, and BMI. BMI for each subject was calculated using the height and weight recorded on the written survey. The data gathered was categorized as ordinal (reported pain), nominal (gender, smoking status, previous back injury, medically diagnosed spinal abnormalities), or continuous (age, weight, height, BMI) to facilitate statistical analysis. These variables were then classified as either dependent or independent and entered into the SSPS statistical package.

Low back pain was assigned as the dependent variable. BMI was assigned as the primary independent variable. Age, smoking status, previous spinal injury, and medically diagnosed spinal abnormalities were all assigned as independent variables used as clarifying factors in assessing trends specifically between BMI and LBP. Study participants who reported a medically diagnosed spinal abnormality or a different qualifying abnormality were excluded in the second statistical analysis. A crosstabulation chi-square test was conducted using the study participants calculated BMI and degree of LBP. There were four possible combinations between the variables, BMI and LBP. A study participant could have LBP and a BMI over 25, LBP and a BMI under 25, no LBP and a BMI over 25, and no LBP and a BMI under 25. The frequencies of all four combinations were calculated using the SSPS package. A mean average of the BMI was calculated in participants who reported LBP. The second analysis utilized a layered crosstabulation chi-square test and reduced the possibility that any correlation's found between BMI and LBP were influenced by other independent variables. A relative risk analysis was also used to demonstrate the calculated risk, if any, for participants having low back pain while being classified as overweight according to BMI. Trends between BMI and LBP were assessed for both positive and negative correlations using the results of the statistical analyzes.

Study participants that reported experiencing lower back pain at the time of filling out the survey were asked to rate the level of pain on a scale from one to ten, one representing minimal pain and ten representing the worst pain ever experienced. The numeric value given for the level of pain was then compared to the participant's BMI. BMI and reported low back pain score was then examined for correlations. Correlations were also assessed between BMI and the duration of reported LBP. Demographic and medical information obtained from the complete survey will be analyzed for mean average and frequency of occurrence. Participant age, BMI, smoking status, spinal history, and gender will be included utilizing this analysis.

The SPSS statistical package was use to analyze for correlations between BMI and LBP. The goal of this study was to discover if a correlation between BMI and LBP exists. The statistical methods previously stated were intended to provide an appropriate foundation to achieve this goal.

Chapter 4: Results

In this chapter, the results of the study are described utilizing the completed surveys. A total of sixty-eight surveys were administered with sixty-one surveys completed corresponding to a response rate of 89.7%. Each research question in this chapter is presented and then the findings are discussed.

Research Question 1. Quantify demographic and medical information obtained from the population being studied including; gender, age, height, weight, calculated BMI, smoking status, history of spinal injury requiring hospitalization, and known spinal abnormalities.

Gender/ Age

The gender diversity in the population study was nearly equal between men and women. Of the sixty one complete surveys 52.5% were female and 47.5% were male.

The average age of the participants was 18.85 years with the most common reported age being 18 years old. The range of age was between 18-25 years.

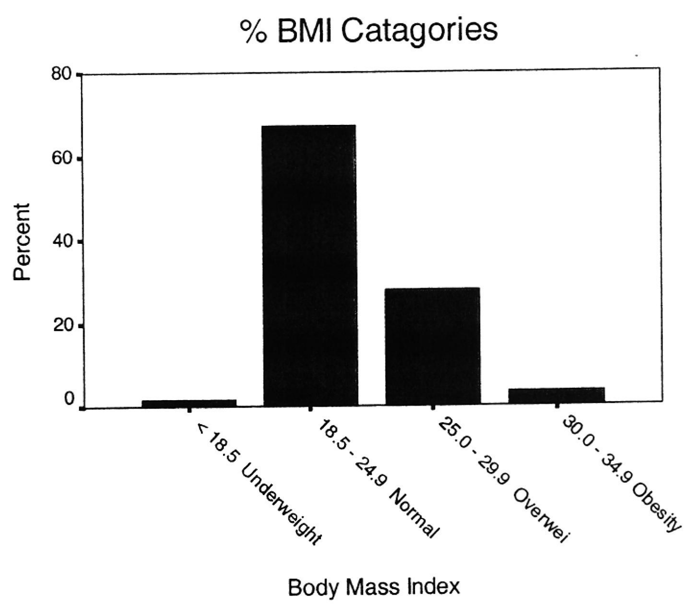
Height/Weight/BMI

The average height and weight were 67.7 inches and 153.2 lbs respectively with no distinction made between male and female participants. The average calculated BMI was 23.4. Of the study participants, 1.6% had a BMI < 18.5, 67.2% had a BMI between 18.5-24.9, 27.9% had a BMI between 25.0-29.9, 3.3% had a BMI between 30.0-34.9, with participants with a BMI greater than 35.0 (See Table 1 and Graph 1). A total of 19 individuals, accounting for 31.1% of the total population surveyed, had calculated BMI ≥ 25 which indicates being overweight. Of the 19 individuals with a BMI ≥ 25, ten were male in gender and nine were female.

Table 1: BMI Distribution of Study Participants

Obesity Class	BMI CATAGORY	Frequency	Percent
	< 18.5 Underweight	1	1.6 %
	18.5 - 24.9 Normal	41	67.2 %
	25.0 - 29.9 Overweight	17	27.9 %
I	30.0 - 34.9 Obesity	2	3.3 %
II	35.0-35.9 Moderate Obesity	0	0.0 %
III	≥ 40 Extreme Obesity	0	0.0 %
	Total	61	100.0 %

Graph 1: BMI Distribution of Study



Smoking Status

Eight individuals, constituting 13.1% of the participants, reported smoking at the time of survey. Of the reported eight smokers five were female and three were male.

Spinal History

Of the sixty-one participants none reported ever having a spinal injury requiring hospitalization. Seven participants did report having a diagnosed spinal abnormality. Of the seven reported spinal abnormalities there were five reports of scoliosis, one report of a herniated disk, and one report of infantile spina bifida which combined comprised 11.5% of the total population surveyed.

Research Question 2. Assess the point prevalence of LBP in the study population as it relates to BMI.

Low Back Pain at the time of survey completion was reported in 36.1% of the participants. Participants with a BMI ≥ 25 comprised 59.1% of the total study population reporting current LBP (See Table 2). Utilizing the chi-square test no associations were found linking point prevalence of reported LBP to BMI. The results of this particular data analysis may be misleading given that the sample sizes for the two BMI groups reporting LBP is less than twenty.

Table 2. Currently Experiencing Pain vs BMI Group

			BMI groups		Total
			BMI under 25	BMI over 25	
Currently experiencing pain	no	Count	29	10	39
		% within Currently experiencing pain	74.4%	25.6%	100.0%
	yes	Count	13	9	22
		% within Currently experiencing pain	59.1%	40.9%	100.0%
Total		Count	42	19	61
		% within Currently experiencing pain	68.9%	31.1%	100.0%

Research Question 3. Determine whether individuals with BMI's greater than 25 kg/m² report a higher incidence of LBP in the past twelve months compared to individuals with BMI's less than 25 kg/m² both with and without known risk factor for LBP.

Low back pain lasting longer than twenty four hours occurring in the past twelve months was reported in 55.7% of the population. Participants with a BMI ≥ 25 reported LBP within the past year 78.9% of the time as compared to participants with a BMI < 25 who reported LBP within the past year 45.2% of the time (See Table 3). The relative risk of a participant reporting LBP lasting longer than twenty four hours with a BMI ≥ 25 is 1.75 times higher than that of a participant with a BMI < 25.

Table 3.

BMI Groups vs Back pain lasting longer than 24 hours in past twelve months

			Back pain lasting longer than 24 hours in past twelve months		
			no	yes	Total
BMI groups	BMI under 25	Count	23	19	42
		% within BMI groups	54.8%	45.2%	100.0%
	BMI over 25	Count	4	15	19
		% within BMI groups	21.1%	78.9%	100.0%
Total		Count	27	34	61
		% within BMI groups	44.3%	55.7%	100.0%

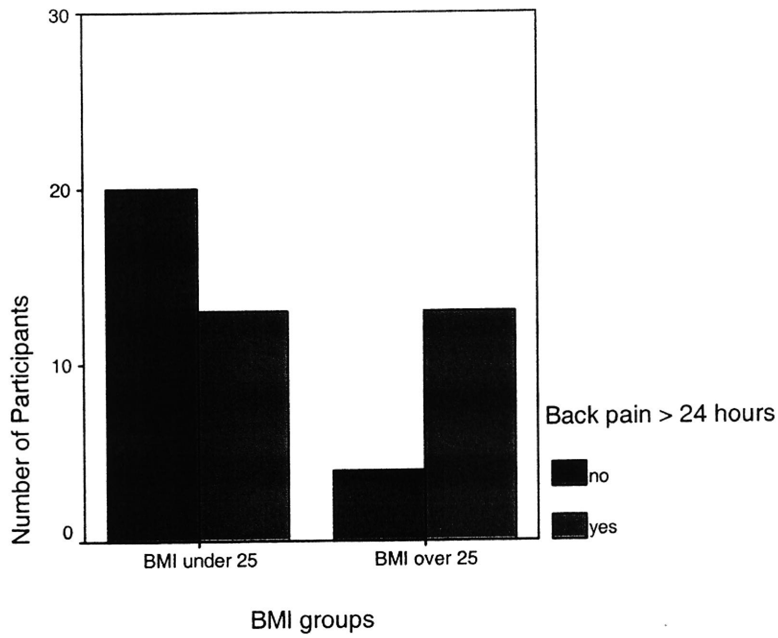
The same analysis was performed after excluding individuals who reported smoking, had a history of spinal injuring requiring hospitalization, or had a diagnosed spinal abnormality. With the above factor excluded in the analysis, participants with a BMI ≥ 25 reported LBP within the past year 76.5% of the time as compared to participants with a BMI < 25 who reported LBP within the past year 39.4% of the time (See Table 4 and Graph 2). Now accounting for the eliminating risk factors mentioned above the relative risk of a participant reporting LBP last longer than twenty four hours with a BMI ≥ 25 increased from 1.75 to 1.94 times higher than that of a participant with a BMI < 25. A layered crosstabulation chi-square test was utilized because of its ability to organize and determine if observed frequencies are significantly different from expected frequencies between multiple variables. The layered crosstabulation chi-square test revealed a strong relationship between BMI and reported back pain lasting longer than twenty-four hours. The Chi-Square confidence interval for the relationship between BMI and LBP was (p=0.014), with a Phi value of .314. The Chi-Square confidence interval and the Phi value show that the association between the two variables above is not due to chance and a strong association between the two variables exits. The Phi value utilized in this analysis is a symmetrical measure used to indicate strength of association between variables and when found to be > 0.3 as was the case a strong association between variables can be confidently reported.

Table 4.

BMI Groups vs Back pain lasting longer than 24 hours in past twelve months factor for smoking status, diagnosis of spinal abnormality, and back injury requiring hospitalization

						Back pain lasting longer than 24 hours in past twelve months		
Back injury requiring Hospitalization	Diagnosis of spinal abnormality	SMOKE				no	yes	Total
no	no	Non Smoker	BMI groups	BMI under 25	Count	20	13	33
					% within BMI groups	61%	39%	100%
				BMI over 25	Count	4	13	17
					% within BMI groups	24%	76%	100%
			Total		Count	24	26	50
					% within BMI groups	48%	52%	100%

Graph 2: BMI groups vs reported low back pain lasting longer than twenty four hours.



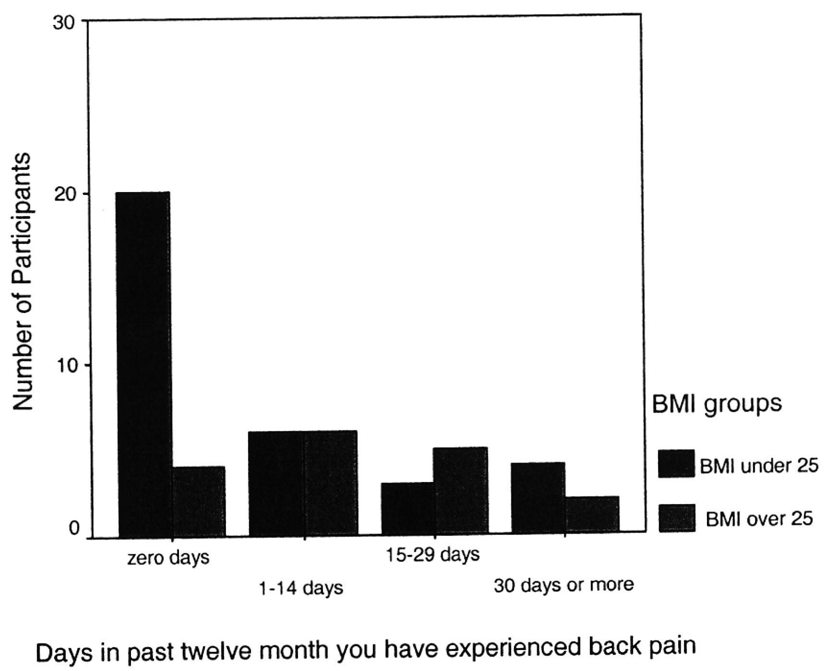
Research Question 4. Assess the duration of LBP in individuals that reported experiencing LBP in the past twelve months compared to BMI excluding participants that smoke, have a history of spinal injury requiring hospitalization, and who have a diagnosed spinal abnormality.

All results were calculated after excluding participants that smoked, had a history of spinal injury requiring hospitalization, and who had a diagnosed spinal abnormality. Participants reported zero days of low back pain over the course of a year 46% of the time (See Table 5 and Graph 3). Participants with a BMI ≥ 25 reported at least one day of LBP 76.5 % of the time while participants with a BMI < 25 only reported this occurrence 39.4 % of the time. Utilizing the Chi-Square test no statistical significant associations were found linking duration of LBP to calculated BMI. However, participants with a BMI < 25 were 2.45 times more likely to report never experiencing LBP lasting longer than twenty fours hours compared to participants with a BMI ≥ 25.

Table 5. BMI group vs duration in past twelve month experiencing back pain.

Back injury requiring Hospitalization	Diagnosis of spinal abnormality	SMOKE				Days in past twelve month you have experienced back pain: zero days	1-14 days	15-29 days	30 days or more	Total
no	no	non-smoker	BMI groups	BMI under 25	Count	19	7	3	4	33
					% within BMI groups	57.6%	21.2%	9.1%	12.1%	100%
				BMI over 25	Count	4	6	5	2	17
					% within BMI groups	23.5%	35.3%	29.4%	11.8%	100%
			Total		Count	23	13	8	6	50
					% within BMI groups	46.0%	26.0%	16.0%	12.0%	100%

Graph 3: BMI Groups vs Duration of Low Back Pain in Past Twelve Months



Research Question 5. Quantify the pain experienced by individuals who are currently experiencing pain at the time of completing the survey and compare the level of reported pain to BMI.

The most common pain score was three, on a one to ten pain scale, with 36% of the participants reporting this level of pain. Thirty-nine participants did not report any current pain at the time of survey. The highest pain score reported was seven out of ten. This occurred twice with both reports being found in the BMI group > 25. When reported level of pain was compared to BMI $\geq$ 25 versus BMI < 25 using the chi-square test no statistically significant association was found between the variables. Reported level of pain did not correlate with body mass index.

Summary

This Chapter presented the findings of body mass index and its associations to low back pain in sixty-one participants enrolled in Augsburg College Physical Education course work. Chapter 5 will discuss the findings and their relevance to the medical community along with comments on individual research questions.

Chapter 5: Discussion

This chapter discusses the results of the study in light of past research, implications and limitations of the research, and recommendations for future research in the study of low back pain and obesity.

Implications

Research Question 1: Quantify demographic and medical information obtained from the population being studied including; gender, age, height, weight, calculation BMI, smoking status, history of spinal injury requiring hospitalization, and known spinal abnormalities.

Response rate for survey completion was 89.7%. The high response rate is assumed to be a result of the controlled classroom environment in which the survey was administered. Although given no penalty for non-participation, individuals may have felt pressure from either the instructor who administered the survey or from fellow classmates who were participating in the study to complete the survey.

In past research on low back pain and obesity, Orvieto et al. (1994) studied 250,000 male military recruits all 17-18 years of age. The military recruits were utilized for the research on LBP and obesity because it was theorized that a young population group is relatively free from the long-standing effects of smoking, repetitive lifting, and exposure to vibrations caused by vehicles and machinery. The Augsburg College undergraduate day program students used in this study were found to have an average age of 18.85 years. The young age of the college students is why they were selected to participate in this study. The average age of 18.85 in the college students is consistent with the young age of study participants recommended by Orvieto et al. in the research which he conducted on LBP and obesity.

It is estimated that 64.5% of the United States adult population is currently overweight according to the American Obesity Association (2003). Thirty-one percent of the Augsburg College participants surveyed were found to be overweight. This relatively low percentage compared to the national average is not unexpected given the young active age of the population surveyed.

Orvieto et al. (1994) also screened the military recruits past medical history excluding recruits from the study who had a history of spinal injury, kyphosis, scoliosis, Schmorl's nodes, Scheuermann's disease, spondlyololyis/listhesis, or any forms of degenerative spinal disease. These recruits were excluded to improve the validity of the study, which was specifically addressing BMI as a risk factor for the development of LBP in a young healthy population. Of the sixty-one Augsburg College participants none reported ever having a spinal injury requiring hospitalization. Seven participants did report having a diagnosed spinal abnormality and were excluded from the final analysis, which is consistent with the recommendations made by Orvieto et al. (1994) in their study on BMI and LBP.

Of the sixty-one participants surveyed, eight reported currently smoking. No distinction was made between gender of the reported eight smokers. In past research conducted by Feldman et al. (1999) it was demonstrated that smokers as young as adolescents experienced low back pain significantly more often than non-smokers of the same age. Guided by the research conducted by Feldman et al. the eight participants reporting smoking were also excluded in the final analysis along with the seven participants reporting history of a spinal abnormality. The goal of excluding these individuals in the final analysis was to achieve more reliable data comparing BMI and LBP by accounting for other possible risk factor for the development of LBP.

Research Question 2: Assess the point prevalence of LBP in the study population as it relates to BMI.

Past research has shown reported annual incidences of low back pain in the U.S. adult population to range from five percent (Orvieto, et al. 1994) to fifty-six percent (Taylor and Curran 1985). Low Back Pain in Augsburg College students at the time of survey completion was reported in 36.1% of the participants. A greater number of participants, 55.7%, reported LBP lasting longer than twenty-four hours in the course of the past year. The annual percentage of the Augsburg participants reporting at least one incidence of LBP in the past year is comparable to prior research.

Research Question 3: Determine whether individuals with BMI's greater than 25 kg/m² report a higher incidence of LBP in the past twelve months compared to individuals with BMI's less than 25 kg/m² both with and without known risk factor for LBP.

Current literature regarding the topic of obesity and low back pain has brought forth multiple discrepancies regarding obesity as a potential etiology for LBP. A sizable amount of current medical literature supports a correlation between obesity and low back pain while a considerable amount of research does not. A large-scale study by Orvieto et al. (1994) which utilized 250,000 male military recruits revealed a statistically significant relationship ($p < 0.0001$), showing that obese recruits had an increased prevalence of low back pain compared to normal weight recruits. In a different study conducted by Leboeuf-Yde et al. (1999), 3,751 monozygotic twin pairs with different body mass indices were compared with no correlation between BMI and LBP found. These findings showed that a monozygotic twin with a high BMI (>25) did not experience an increased risk for developing LBP compared to his/her monozygotic twin sibling with a normal BMI.

The research conducted with Augsburg College students revealed that participants with a BMI ≥ 25 reported LBP within the past year 78.9% of the time as compared to participants with a BMI < 25 who reported LBP 45.2% of the time. The same analysis was performed after excluding individuals who reported smoking, had a history of spinal injuring requiring hospitalization, or had a diagnosed spinal abnormality. With a confidence interval of p=0.014 and the above risk factor excluded in the analysis, participants with a BMI ≥ 25 reported LBP within the past year 76.5% of the time as compared to participants with a BMI < 25 who reported LBP 39.4% of the time. This study revealed that overweight Augsburg College participants, BMI ≥ 25, had an increased prevalence of low back pain compared to normal weight participants. These findings are consistent with the research conducted by Orvieto et al (1994), and indicate the potential need for weight reduction even in these young college students for prevention of back pain.

Research Question 4: Assess the duration of LBP in individuals that reported experiencing LBP in the past twelve months compared to BMI excluding participants that smoke, have a history of spinal injury requiring hospitalization, and who have a diagnosed spinal abnormality.

In a past study conducted by Leboeuf-Yde et al. (1999), in which 29,424 twin subjects were studied, an overall positive correlation was found between BMI and LBP especially in the subgroup reporting LBP in excess of thirty days in the course of one year. Although overweight Augsburg College participants were found to report nearly twice the rate of experiencing LBP in the past year no statistical significant associations were found linking increased duration of reported LBP to calculated BMI. These findings only show that participants with a BMI ≥ 25 reported experiencing LBP at twice the rate but did not endure a prolonged course of LBP as a result of being overweight. Overweight Augsburg College participants do not appear to experience prolonged back pain as was found in the study conducted by Leboeuf-Yde et al. These results only add to the confusion surround exactly what effect excessive body actual has on the development and duration of LBP.

Research Question 5: Quantify the pain experienced by individuals who are currently experiencing pain at the time of completing the survey and compare the level of reported pain to BMI.

In the literature reviewed on LBP and BMI there were no studies that specifically quantified the reported severity of LBP and compared it to BMI. This study, utilizing the Augsburg College participants, did attempt to determine if increasing BMI's correlated with an increase in severity of reported level of LBP using a numerical pain scale. It was found that no correlations exist between reported severity of LBP and BMI.

Limitations

The results from this study are limited by the small sample size of the Augsburg College participants. As a result of the small population, results or conclusions from this study may not represent national averages for obesity and LBP, but should be generalized to Augsburg College Students enrolled in Physical Educational course work. Small sample size also may have contributed to errors in the significance of data calculations due to several instances of sample size less than twenty for particular BMI groups.

As with all studies utilizing surveys to gather data the validity of the results is dependent upon accurate subject reporting. The survey implemented in the study involved questions concerning the participants past medical history and total number of days experiencing LBP in the past year, both of which require accurate recall of past events. Such recall of distant events may lead to inaccuracies in reported data. Participants who responded "yes" to current LBP were asked to quantify the severity of pain using a numerical pain scale. Discrepancy in reported levels of pain is a common limitation with any objective pain assessment. This study makes the assumption that subjects reported information accurately.

Further limitations from this study involve the validity of the survey used to generate the results. The survey has never been used and was developed from a composite of questionnaires implemented in past research on the topic of low back pain and obesity. Replication of this study utilizing the same survey would increase the validity of the results acquired in this study.

Composite Discussion

The topic of whether there is an association between body weight and low back pain (LBP) has been the focus of much research in the past few decades. Even with the vast body of research that has been conducted and continues to be conducted on the topic, no clear answer has yet been established. This study was conducted in order to help clarify the discussion regarding low back pain and body mass index.

In this study, associations between low back pain and body mass index have been examined in various forms. The high incidence of LBP in this young college age population as a whole may be a result of heavy unilateral loads applied to the spinal column from backpacks which are carried by most high school and college students. Poor spinal posture while sitting for prolonged periods in classrooms potential may also explain the high incidence of reported LMP along with inaccuracies or comprehension errors when filling out the survey. This unexpected finding is an interesting topic for future research in the study of the etiology of low back pain.

Low back pain prevalence and past history of LBP were both found to be higher in overweight individuals as compared to normal weight individuals. This increase in prevalence of LBP in overweight participants may have resulted from the increase in joint load pressure to the vertebral column causing excessive compression to the facet joints and vertebral bodies of the spine as a consequence of the additional weight. Inactivity resulting in increased body weight and a decrease in muscular strength and tone involving the paraspinal and abdominal muscles may also result in an increase in LBP as a result of insufficient postural tone supporting the vertebral column. Previous unrecognized back injuries causing an increase in inactivity and subsequent weight gain may also explain the increased prevalence of LBP in overweight participants. Unfortunately the design of the study does not allow for cause and effect analysis and thus the discussion of exactly why overweight participants reported LBP is merely speculation. Although a strong correlation was found to exist between LBP lasting longer than 24 hours in the past year and BMI $\geq$ 25, further research is still need to fully address a cause and effect relationship.

The results of this study, together with a large volume of evidence which indicate that obesity may result in an increase in LBP, show that efforts at weight reduction and exercise may be successful in reducing the incidence of LBP. The role of diet and exercise in reducing weight has long been the standard for a safe healthy weight lose program and should be recommended to all individuals who are overweight. This recommendation is especially important for individuals who are overweight and suffer from LBP especially if the cause of LBP is due to poor postural tone.

Recommendations

Further study on low back pain and obesity may be pursued using larger sample sizes. A larger sample size may allow the results to be generalized to a larger population and give more validity to the significance of the data analysis. The survey used in this research was untested in prior research studies and could benefit from a larger pilot study before implemented into formal research.

Future research may be improved by objectively weighing and measuring study participants to be assured of accurate BMI calculations. Objectively measuring body fat composition with a skin caliper in addition to BMI calculations could potential filter through muscular individuals with low body fat composition who are erroneously classified as overweight. Review of past medical records could also facilitate the validity of reported spinal injury or disease.

The use of young participants in the study of LBP and obesity is recommended because of the reduced probability that any reported LBP is a result of repetitive lifting, effects of habitual smoking, exposure to vibrations caused by vehicles and machinery, and degenerative changes of aging. An ideal population for the study of LBP and obesity would consist of young, non-smoking, monozygotic twins without congenital back abnormalities.

Conclusions

Does excessive body weight increase the risk of developing low back pain? Past research has painted a clouded picture on the impact excessive body weight has on the development of low back pain. Many studies exist to support either notion regarding this medical debate. This study conducted with the participation of Augsburg College found overweight individuals to report experiencing LBP in the past year at rate nearly twice high as normal weight individuals. However with this being said there is no clear picture from this and past research that can determine if there is a true cause and effect relationship between obesity and LBP. Until such a carefully constructed study is achieved isolating these two specific variables the question of whether obesity causes low back pain cannot be clearly answered.

References

American Obesity Association: Obesity in the U.S. Retrieved on July 7 2003, from http://www.obesity.org/subs/fastfacts/obesity_US.shtml

Anderson, M.K., & Hall, S.J. (1995). Injuries to the Spine. In D. Balado, L. Stead, & R. Lukens (Eds.), Sports Injury Management (pp.547-549). Media, PA: Williams & Wilkins.

Anderson, E.L. (1998). Mosby's Medical, Nursing, & Allied Health Dictionary (5^{th} ed.). St. Louis, Mosby-Year Book, Inc.

Atlas, S. J., & Deyo, R. A. (2001). Evaluating and Managing Acute Low Back Pain in the Primary Care Setting. Journal of General Internal Medicine, 16(2), 121-130.

Brot, C., Jorgensen, N. R., & Sorensen, H. O. (1999). The influence of smoking on vitamin D status and calcium metabolism. European Journal of Clinical Nutrition, 53, 920-926.

Centers for Disease Control. (1999). Third National Health and Nutrition Examination Survey. Analysis by The Lewin Group.

Fanuele, C. J., Abdu, A. W., Hanscom, B., and Weinstein, N. J. (2002). Association between obesity and functional status in patients with spine disease. SPINE, 27, 306-312.

Feldman, D. E., Rossignol, M., Shrier, I., & Abenhaim, L. (1999). Smoking. A risk factor for development of low back pain in adolescents. SPINE, 24, 2492-2496.

Flegal, K. M., Carroll, M. D., Ogden, D. C., & Johnson, C. L. (2002). Prevalence and trends in obesity among US adults, 1999-2000. Journal of American Medical Association, 288, 1723-1727.

Fransen, M., Woodward, M., Norton, R., Coggan, C., Dawe, M., & Sheridan, N. (2002). Risk factors associated with the transition from acute to chronic occupational back pain. SPINE, 27, 92-98.

Frymoyer, J. W. (1998) Back pain and sciatica. New England Journal of Medicine, 318, 291-300.

Guo, H-R., Tanaka, S., & Halperin, W.E. (1999). Back pain prevalence in U.S. industry and estimates of lost workdays. American Journal of Public Health, 89, 1029-35.

Heliovaara, M. (1987). Body height, obesity, and risk of herniated lumbar intervertebral disc. SPINE, 12, 469-72.

Jayson, M.V. (1970). The problem with backache. Practitioner, 205, 615-621.

Lake, K. J., Power, C., Cole, J. T. (2000) Back pain and obesity in the 1958 British birth cohort: cause or effect? Journal of Clinical Epidemiology, 53, 245-250.

Leboeuf-Yde, C. (1999). Smoking and low back pain. A systematic literature review of 41 journal articles reporting 47 epidemiologic studies. SPINE, 24, 1463-70.

Leboeuf-Yde, C. (2000). Body weight and low back pain: A systematic literature review of 56 journal articles reporting on 65 epidemiologic studies. SPINE, 25, 226-237.

Leboeuf-Yde, C., Kyvik, O. K., & Bruun, H. N. (1999). Low back pain and lifestyle. Part II-Obesity: Information from a population-based sample of 29,424 twin subjects. SPINE, 24, 779-784.

Murphy, P. I., & Courtney, T. K. (2000). Low back pain disability: Relative costs by antecedent and industry group. American Journal of Industrial Medicine, 37, 558-571.

National Institute of Diabetes and Digestive and Kidney Diseases. Retrieved July 7 2003, from http://www.niddk.nih.gov/health/nutrit/pubs/statobes.htm#research.

Orvieto, R., Rand, N., Lev, B., Wiener, M., & Nehama, H. (1994). Low back pain and body mass index. Military Medicine, 159, 37-38.

Taylor, H., & Curran, N.M. (1985). The Nuprin pain report. New York: Louis Harris and Associates.

Toda, Y., Segal, N., Toda, T., Morimoto, T., & Ogawa, R. (2000). Lean body mass and body fat distribution in participants with chronic low back pain. Archives of InternalMedicine, 160, 3265-3269.

Tsuritani, I., Honda, R., Noborisaka, Y., Ishida, M., Ishizaki, M., & Yamada, Y. (2002). Impact of obesity on musculoskeletal pain and difficulty of daily movements in Japanese middle-aged women. Maturitas, 42, 23-30.

World Health Organization. Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation of Obesity. Geneva, 3-5 June 1997.

APPENDICES

Appendix A

Table 1. Obesity Costs in Relation to the Co-Morbidities (1999 dollars in billions)

Disease	Direct Cost of Obesity	Direct Cost of Disease	Direct Cost of Obesity as a Percentage of Total Direct Cost of Disease
Arthritis	$7.4	$23.1	32%
Breast Cancer	$2.1	$10.2	21%
Heart Disease	$30.6	$101.8	30%
Colorectal Cancer	$2.0	$10.0	20%
Diabetes (Type 2)	$20.5	$47.2	43%
Endometrial Cancer	$0.6	$2.5	24%
ESRD	$3.0	$14.9	20%
Gallstones	$3.5	$7.7	45%
Hypertension	$9.6	$24.5	39%
Liver Disease	$3.4	$9.7	35%
Low Back Pain	$3.5	$19.2	18%
Renal Cell Cancer	$0.5	$1.6	31%
Obstructive Sleep Apnea	$0.2	$0.4	50%
Stroke	$8.1	$29.5	27%
Urinary Incontinence	$7.6	$29.2	26%
Total Direct Cost	**$102.2**	**$331.4**	**31%**

Source: Centers for Disease Control. Third National Health and Nutrition Examination Survey. Analysis by The Lewin Group, 1999.

Table 2. Increased Risk of Obesity Related Diseases with Higher BMI

Disease	BMI of 25 or less	BMI between 25 and 30	BMI between 30 and 35	BMI of 35 or more
Arthritis	1.00	1.56	1.87	2.39
Heart Disease	1.00	1.39	1.86	1.67
Diabetes (Type 2)	1.00	2.42	3.35	6.16
Gallstones	1.00	1.97	3.30	5.48
Hypertension	1.00	1.92	2.82	3.77
Stroke	1.00	1.53	1.59	1.75

Source: Centers for Disease Control. Third National Health and Nutrition Examination Survey. Analysis by The Lewin Group, 1999.

Appendix B

Low back Pain Questionnaire

Please fill in or circle the appropriate answer to the follow questions:

1) What is your age? ________

2) What is your weight in pounds? _________

3) What is your height? Feet:____ Inches:_____

4) What is your gender? Male / Female

5) Do you currently smoke cigarettes? Yes / No

6) Have you ever had an injury to your back that required hospitalization? Yes / No

7) Have you ever been medically diagnosed with a spinal abnormality? Yes / No
   If yes, please name diagnosed abnormality ____________________________
   ____

8) Have you experienced low back pain, defined as pain located in the area between the twelfth rib and the tail-bone (refer to shaded area of Diagram A for clarification), lasting longer than twenty four hours in the past twelve months? Yes / No
   Yes, continue to question 9. No, survey completed.

Diagram A:

9) How many days in the past twelve months have you experienced low back pain?
   A. (1-14 days) B. (15-29 days) C. More than 30 days

10) Are you currently experiencing lower back pain? Yes / No
   Yes, continue to question 11. No, survey completed.

11) On a scale of one to ten how would you rate your current level of pain?

1 2 3 4 5 6 7 8 9 10

Minimal pain — Moderate pain — Worst Pain Ever Experienced

Appendix C

The Prevalence of Low Back Pain and its Association with Body Mass Index Consent Form

You are invited to be in a research study designed to examine potential correlations between body mass index and the development of lower back pain. You were selected as possible participants based on your age. The design of the study requires young participants. Prior research in the field of low back pain has revealed that individuals in early adulthood have a reduced probability that any low back pain experienced is a result of repetitive lifting, effects of habitual smoking and degenerative changes of aging. By recognizing that young individuals have a reduced likelihood of having low back pain attributed to these causes the researcher would appreciate your participation in this study.

This study is being conducted by Lance Beebout, a graduate student in the Augsburg College Department of Physician Assistant Studies.

Background information:
The purpose of this study is to examine if there is an association between body mass index and low back pain. Body mass index is a commonly used inexpensive and practical approach for assessing a person's body fat. Body mass index is calculated by utilizing an individual's actual or reported weight in kilograms and dividing this number by height in meters squared. By calculating a participant's body mass index and comparing these values to the reported level of low back pain, statistical analysis will be utilized to assess for correlations between the two variables.

Procedures:
If you agree to be in this study, you will be asked to complete an anonymous eleven question survey that should take up no more than ten minutes of your time. You will be asked to report your age, gender, height, weight, smoking status and answer various question regarding the health of your lower backs.

Risks and Benefits of Being in the Study:
There are few anticipated risks to you as a result of your participation in this study. You could, however, experience some discomfort if you are sensitive about questions concerning your body weight. Please contact The Center for Counseling and Health Promotion here at Augsburg College at (612) 330-1707 if at anytime you feel the need to seek counseling or support as a result of your involvement in the this study.

While there may be no immediate benefit to you as a result of your participation in this study, your input may provide valuable information about preventable risk factors leading to the development of low back pain that will be of future value to society.

Confidentiality:
The records of this study will be kept private. The information that you give on this survey will be recorded in anonymous form. All completed surveys will be kept in a locked file cabinet in

an office and will not be available to anyone but the researcher and the thesis advisor. In any sort of report that might be published, the researcher will not include any information that will make it possible to identify you.

Voluntary Nature of the Study:
Your decision whether or not to participate will not affect your current or future relations with the College. If you decide to participate, you are free to withdraw at any time without affecting those relationships. Incomplete surveys will not be utilized in the data analysis.

Contacts and Questions:
If at any time you have questions or would like the results of this study at its completion, please contact:

Lance Beebout
Department of Physician Assistant Studies at Augsburg College.
2211 Riverside Avenue, Campus Box 149
Minneapolis, MN 55454

If you have any concerns about your participant in this study, please call or write:

Heather Bidinger MMS, PA-C
Department of Physician Assistant Studies at Augsburg College.
2211 Riverside Avenue, Campus Box 149
Minneapolis, MN 55454 (612) 330-1592

Your completion and submission of the survey represents your consent to serve as a subject in this research study.

This research project has been approved by the Augsburg College Institutional Review Board for the Protection of Human Subjects.

Appendix D

Institutional Research Board
Augsburg College
Box 107

June 4, 2003

To: Lance Beebout

From: Norma C. Noonan, Chair

I am pleased to inform you that the IRB has approved your application for the project: **The Prevalence of Low Back Pain and Its Association with Body Mass Index.**

___ _ as submitted

__x_ _ as revised with the additional form(s)/changes

__ with the following conditions:

Your IRB approval number which should be noted in your written project and in any major documents alluding to the research project is as follows:

2003-32-2

I wish you success with your project. If you have any questions, you may contact me: 612-330-1198 or noonan@augsburg.edu.

c. Dr. Heather Bidinger

Appendix E

AUGSBURG
C•O•L•L•E•G•E

October 17, 2002

Lance Beebout
1965 Silver Bell Rd. Apt. 305
Eagan, MN 55122

Dear Lance:

This letter concerns your proposed research project. Specifically, you propose to distribute a short questionnaire to students enrolled in required physical education course work at Augsburg College.

You indicated that you have contacted Marilyn Florian, Health and Physical Education Department Chair, about distributing the questionnaire to these students.

My letter is intended to convey my support for this project. My letter of support is needed for your request to the Internal Review Board (IRB).

Please note that Marilyn and the other faculty in the Health and Physical Education Department will be the ones to ultimately approve the distribution of your questionnaire.

Best wishes for success in your study. I hope you will share the results, as appropriate and as approved by IRB.

If you need additional information, please call me at 612-3301168 or contact me by e-mail at garvey@augsburg.edu.

Sincerely,

Ann Garvey
Associate Dean for Student Affairs

2211 Riverside Avenue • Minneapolis, MN 55454 • Tel. (612) 330-1000 • Fax (612) 330-1649

Appendix F

AUGSBURG
COLLEGE

December 3, 2002

Lance Beebout
1965 Silver Bell Road #305
Eagan, MN. 55122

Dear Lance,

The Augsburg College Health and Physical Education Department has reviewed your request to disperse a questionnaire to students in Lifetime Activity classes during Fall 2003. We will be pleased to allow you to have students complete the questionnaire in Lifetime Activity classes on the first day of class, which will be September 3 & 4 or October 27 & 28, 2003.

Please determine the classes in which you plan to distribute the questionnaire and contact the appropriate instructor in advance of the first day of class to schedule this. I am happy to contact the instructors if you make the list of classes available to me.

We are interested in your study and would like to obtain a copy of the results, if possible. Good luck with your research thesis.

Sincerely,

Marilyn P. Florian

Marilyn P. Florian
Health and Physical Education Department Chair
(612)330-1248
florian@augsburg.edu