IMPACT OF OBESITY ON CARDIAC INCIDENCES

ABSTRACT

This research paper will address the impact and influences of obesity on cardiac incidences through an Integrated Theoretical Framework. This growing epidemic continues to prompt both medical and research professionals to examine the extent of the prevalence of obesity in association with risk factors of cardiac incidences. These risk factors include, but are not limited to hypertension, diabetes, sleep apnea, cardiac remodeling and obesity as an independent cardiovascular risk factor. Resources covered in this paper utilized a series of research techniques including Double-blind Studies, Randomized Study Designs and Longitudinal Cohort Studies. Documented sources such as the Framingham Heart Study and pertinent publications from the Harvard School of Medicine, the CDC, and the European Journal of Clinical Investigation as well as other prominent journals will support the theory that although there is evidence that Body Mass Index alone is a poor argument that obesity is a single confounder for cardiac incidences, there is statistical and analytical evidence that obesity has an adverse impact on cardiac incidences.

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The Impact of Obesity on Cardiac Incidences

Even though there is evidence that BMI alone is a poor argument that obesity, as a single confounder, increases cardiac incidences; there is statistical evidence from the Framingham Heart Study as well as other studies that suggest a direct link between the risk factors related to obesity and cardiac incidences. The growing epidemic of obesity in the nation today has an effect in multiple circles of cultures and dimensions. The affects of obesity is a physical dynamic that has a rippling influence that continues from generation to generation with costly outcomes. The relationships of risk factors that continue to arise from obesity are linked to increased risk factors for cardiac incidences. This connection is founded upon the association between obesity and multiple disorders including but not limited to hypertension, diabetes, and dyslipidemia. The Framingham Heart Study along with many documented studies has evidenced a direct link between the risk factors of obesity and the increased impact they have on cardiac incidences.

The definition of obesity, or what is considered over-weight, has been a much-debated topic in both the medical field and society in general. In essence, the social definition of obese is having too much body fat. It is also considered a chronic disease or disorder much like diabetes and high blood pressure. And, as in the case with most chronic diseases, obesity comes with long term physical health consequences as well as repercussions related to emotional and mental health. It is also considered one of the leading causes of preventable deaths in the United States (Harvard School of Public Health, 2009, April 27).

What had once been utilized as a basis for interpretation for the value of over-weight or obese did not take into consideration an individual's body frame or bone structure. The more

recent favored measure of obesity or body weight is the Body Mass Index. What is defined as Body Mass Index (BMI) is weight in kilograms divided by height measured in meters squared. Even with this much accepted form of defining obesity, the Body Mass Index fails to take into account the distribution of body fat across the body.

According to an article published by the CDC in 2009 there were 33 states with a prevalence of obesity that was greater than 25% with 9 of those states having equal to or greater than 30 % prevalence of obesity. The following chart depicts those findings (CDC, 2010).

2009 State Obesity Rates

State	%	State	%	State	%	State	%
Alabama	31.0	Illinois	26.5	Montana	23.2	Rhode Island	24.6
Alaska	24.8	Indiana	29.5	Nebraska	27.2	South Carolina	29.4
Arizona	25.5	Iowa	27.9	Nevada	25.8	South Dakota	29.6
Arkansas	30.5	Kansas	28.1	New Hampshire	25.7	Tennessee	32.3
California	24.8	Kentucky	31.5	New Jersey	23.3	Texas	28.7
Colorado	18.6	Louisiana	33.0	New Mexico	25.1	Utah	23.5
Connecticut	20.6	Maine	25.8	New York	24.2	Vermont	22.8
Delaware	27.0	Maryland	26.2	North Carolina	29.3	Virginia	25.0
Washington DC	19.7	Massachusetts	21.4	North Dakota	27.9	Washington	26.4
Florida	25.2	Michigan	29.6	Ohio	28.8	West Virginia	31.1

2009 State Obesity Rates (continued)

State	%	State	%	State	%	State	%
Georgia	27.2	Minnesota	24.6	Oklahoma	31.4	Wisconsin	28.7
Hawaii	22.3	Mississippi	34.4	Oregon	23.0	Wyoming	24.6
Idaho	24.5	Missouri	30.0	Pennsylvania	27.4		

The above information is collected through the CDC Behavioral Risk Factor Surveillance System (BRFSS).

The growing epidemic of obesity is increasing the number of cardiac events specifically due to links found with multiple disorders such as hypertension, coronary artery disease, diabetes mellitus, LV hypertrophy, LA enlargement, and congestive heart failure. With over 65% of the population overweight and 31% of those considered obese, there is definitive evidence to believe a direct association between obesity and the increase in cardiac incidences exists (Rafla, S.M., 2010).

With the association of obesity to such disorders as hypertension and diabetes, both increasing in prevalence, there is also reason to believe that obesity is an independent cardiovascular risk factor. In a study published by the American Journal of Cardiology in 2010, evidence was documented in an attempt to evaluate treatment patterns and options among high-risk vascular patients relative to their Body Mass Index. The study included 7,357 high-risk vascular out patients broken into 3 groups according to their Body Mass Index (BMI): Normal weight (BMI<24.9 kg/m), overweight (BMI 25 to 29.9 kg/m...), and obese (BMI >30 kg/m...). Other data collected relevant to the study included rates of attainment for contemporary

guideline targets of blood pressure (<140/90 or <130/80 mm Hg in the presence of diabetes) and lipids (low-density lipoprotein [LDL] <2.5 mmol/L [96.7 mg/dl] and total cholesterol [TC]/high-density lipoprotein [HDL] ratio <4.0). Of the 7,357 patients, 1,305 (17.7%) were normal weight, 2,791 (37.9%) over-weight, and 3,261 (44.4%) obese, as determined by the BMI. The outcome of this study evidenced that obese patients were younger, more likely to have hypertension and diabetes ($p<0.001$ for trend), had higher baseline blood pressure, TC, LDL cholesterol, triglyceride levels and TC/HDL ratio, and lower HDL cholesterol. They were also more likely to be treated with antihypertensive agents ($p = 0.002$), angiotensin-converting enzyme inhibitors ($p= 0.024$), angiotensin receptor blockers ($p <0.001$), and high-dose statin therapy ($p=0.001$). Regarding the multivariable analyses, obese patients were less likely to attain the blood pressure (odds ratio 0.77, 95% confidence interval 0.66 to 0.90, $p = 0.001$) and TC/HDL ratio (odds ratio 0.48, 95% confidence interval 0.42 to 0.55, $p <0.001$) targets but not in the case of the LDL targets (odds ratio 0.89, 95% confidence interval 0.78 to 1.03, $p = 0.11$) (Bhan, V., Yan, R., Leiter, L., Fitchett, D. Langer, A., Lonn, E., Tan, M. Silagy, S., Goodman, s. & Yan, A., 2010).

Additional statistical evidence linking BMI to risk factors of cardiac incidents can be seen in the results of an analysis published by *Echocardiography* in 2005 entitled "Impact of Body Mass Index on Markers of Left Ventricular Thickness and Mass Calculation: Results of a Pilot Analysis." This study was conducted utilizing 122 patients referred for transthoracic echocardiography along with a prospective pilot study using a 3:1 randomization approach with participant's demographics obtained via questionnaire. The groups were divided as Group 1- 80 obese (BMI was>30 kg/m²), Group II-16 overweight (BMI between 26 and 29 kg/m²), and Group III-26 normal BMI (BMI<25 kg/m²) participants. Although the evidence resulted in showing no difference in left ventricular wall thickness, end

systolic cavity dimension, fractional shortening or pulmonary artery systolic pressure there was evidence that obese individuals showed increased left ventricular end-diastolic cavity dimension, left ventricular mass/height and left atrial diameter. These findings lead to the belief that it is possible that these events in conjunction with obesity are a pre-cursor to cardiac events (Krishnan, R., Becker, R. J., Beighley, L. M., & López-Candales, A., 2005).

These studies evidence a direct link between the various risk factors produced by obesity and the increased risk of cardiac incidences. This process folds into studies evaluating the association of obesity with cardiac autonomic abnormalities. When speaking of the cardiac autonomic system it is referenced with the understanding that the cardiac nervous system is divided into extrinsic and intrinsic components. Though these types of studies are still in their infancy, it is important to note that there is a rising concern and consideration regarding the dynamic of obesity associated with cardiac autonomic abnormalities.

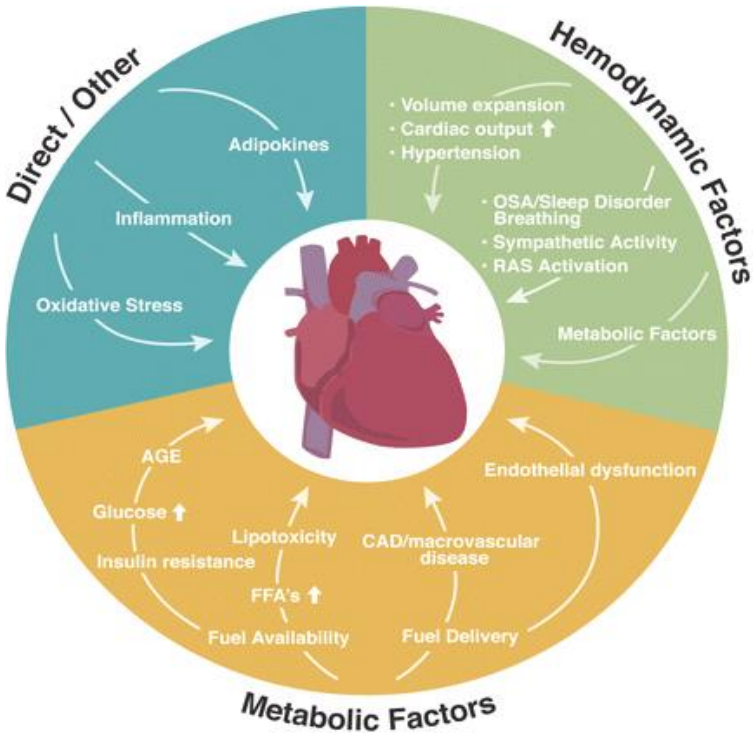
In 2009 the European Journal of Clinical Investigation published an article describing the findings of a study conducted to explore the issue of the body mass index and the alterations of cardiac autonomic function as well as what potential part various metabolic and hormonal issues contribute, if at all, to any alterations that are found. In this study, 68 normoglycemic (having normal blood glucose levels) and normotensive (having normal arterial blood pressure) women (mean age of 40 ± 3 years), were divided according to their BMI with 15-normal body weight (control group), 15-overweight, 18-obese and 20-morbidly obese. The data was acquired by using 24-hour Holter device recordings, and several body measurements as well as metabolic and hormonal considerations. The results of this study indicated an increase in heart rate and the Heart Rate Variability was decreased in the morbidly obese group compared to the normal/control group. In overall population a negative association linked body fat mass to heart

rate variability indexes. Based on an analysis of this study the results indicated morbidly obese women with normal blood glucose and normal blood pressure have increased Heart Rate and low Heart Rate Variability which indicates an abnormal cardiac autonomic function as well as an increased risk factor for adverse cardiovascular events. The study also indicated that the other factors considered that are often related to obesity, metabolic and hormonal, did not evidence themselves as having an independent impact on the Heart Rate Variability (Sztajzel, J. J., Golay, A. A., Makoundou, V. V., Lehmann, T. O., Barthassat, V. V., Sievert, K. K., & ... Bobbioni-Harsch, E. E., 2009).

This information is also quantified by a previous study published by the International Journal of Obesity in 2008. To summarize this study, 1437 participants were categorized as underweight--n=74, normal weight--n=588, overweight--n=313, obesity I--n=390 and obesity II--n=72. Cardiac autonomic function was determined by Standard Deviation (normal to normal-SDNN) intervals as well as Risk Ratio (RR) intervals along power spectrum in low and high frequency. The determination of the findings were that overweight and obesity participants were at a higher risk for altered Cardiac autonomic function independent of factors related to cardiovascular risk (Wu, J. S., Lu, F. H., Yang, Y. C., Lin, T. S., Huang, Y. H., Wu, C. H., & ... Chang, C. J., 2008).

Because obesity is a risk factor for left ventricular hypertrophy and excess cardiovascular disease as evidenced in the previously mentioned studies cardiac remodeling has become a serious concern among medical professionals nationwide. It is important to understand the accumulated data and the impact it represents in relation to obesity and the risk of cardiac incidents.

Obesity is widely accepted as an associated factor in the development of increased risk factors related to atherosclerosis; but there is growing evidence of structural and functional changes to the heart that occur due to obesity. These changes, also known as cardiac remodeling, are being associated with more obvious forms of cardiac malfunction and heart failure. In cases of obesity over 60% of participants show evidence of hypertension which gives reason to believe that hypertension plays a leading role in left ventricular hypertrophy directly related to obesity. Many of these closely related physical disorders associated such as hypertension, diabetes, sleep apnea and left ventricular hypertrophy appear to be impacted by obesity. The following diagram presented in an article published in the APS-Physiological Reviews is an excellent example of how obesity and these disorders affect the heart (Abel, E. D., Litwin, S. E, and Sweeney, G., 2008).



Two other studies published in the Journal of Nutritional and Environment Medicine and the Southern Medical Journal evidence data that are directly related to the concern of the amount of influence obesity exerts on cardiac incidents. The first article published in 2003 by the Southern Medical Journal determined an affirmative link between the impact obesity has on the heart and the cardiovascular system as a whole (Lavie, C. J., Milani, R. V., & Messerli, F. H., 2003). The study published in the Journal of Nutritional and Environmental Medicine in 2005 utilized Student t-tests, Fisher's exact test, Chi-Square with Pearson correlation and logistic regression data garnered from a prospective, double-blind, randomized clinical intervention trial to determine that despite there was no association between age and pre-hospital survival there was significant evidence of negative impact association between body weight and the outcome (survival verses non-survival) of pre-hospital cardiac arrest (Vukmir, R. B., 2005).

Perhaps the most compelling argument regarding the growing epidemic of obesity and the manner by which it is increasing the number of cardiac incidences is evidenced through the Framingham Heart Study. This ongoing study is one of the most important epidemiological studies in American medicine. Its research expands beyond that of cardiovascular disease into areas of concern such as eye disease, osteoporosis, hearing disorders and much more.

The Framingham Heart Study began in 1948 under the direction of the National Heart Institute following 5, 209 adults from Framingham, Massachusetts. These individuals had not evidenced any signs or symptoms of cardiovascular disease nor had they suffered a stroke or heart attack. The intended goal was to better understand what circumstances would lead to cardiovascular disease, evolve and eventually end in a fatality among the general public. A second generation group of 5,124 was enrolled in the study in 1971 participating in similar examinations as the previous group enrolled in 1948. Recruitment efforts for a third generation

group began in 2002 with the off-spring from the second generation group. The first phase of testing for this third generation group was completed in 2005 with 4,095 participants (Framingham Heart Study, 2006, February).

The Framingham Study through the Boston University School of Medicine, published an article in 2002, presented evidence that being overweight and obese enhances various risk factors for Coronary Heart Disease that influences their impact. The study examined 1309 men and 739 women ranging in age from 30 to 74 years originally free of Coronary Heart Disease as the overweight group (BMI of 25 to 29); the obese group (BMI ≥ 30) was comprised of 375 men and 356 women. The original Framingham Study cohort was the sample at the 11th biennial examination, with their children at their initial examination. These participants were followed over a 16 year period producing the following data: of the overweight subjects, 188 men and 44 women experienced Coronary Heart Disease which evidenced an age adjusted rated with very little difference than slim subjects. However, the obese candidates, 72 men and 37 women, developed Coronary Heart Disease. This indicates a corresponding age adjusted risk ratio (the cumulative incidence between two groups) rate of 1.48 times that of lean men and 2.09 times that of lean women. It is important to understand that Risk Ratio, also known as Relative Risk is computed as Relative Risk = $\frac{PP\ exposed}{PP\ unexposed}$. This data evidenced that Coronary Heart Disease risk factors occurred in 21% of overweight men and in 16.4% of women; where being obese occurred in isolation of 12.8% of men and 8% of women. This produces a result of these clusters of ≥ 2 risk factors appearing in obese men with 56% and 62.4% in women (Kannel, W.B., Wilson, P.W., Nam, B.H., D'Agostino, R.B., 2002).

The Framingham Study has garnered a multitude of articles documenting evidence found through its research. This study has been used as the bases for extensive and ongoing research by professionals in the medical and research community across the country. Many colleges and universities have chosen to utilize various portions and components extracted from the Framingham Study as examples in combination with the educational process of their student body. This longitudinal study allows students the benefit of experiencing through example the different forms of clinical trials.

By utilizing the initial data taken from various portions of the study, students are able to experience and understand how to determine which study design is most effective for specific purpose and the meaning of the implications of Sample Size. They are also able to apply statistical techniques through the understanding of Point Prevalence, risk factors and effect modification. The extended value of this study enhances the understanding of the Central Limit Theorem, the Bayes' Theorem as well as the Chi-Square goodness-of-fit test and Chi-square test of independence.

Universities such as Ashford University have found this information useful in the course study of Bio-Statistics based on the multitude and variety of techniques applied by research professionals in the Framingham Study throughout the years. The advantages of having true research examples to apply techniques such as the ANOVA (analysis of variance) and applying methods for displaying Box-whisker Plots are hailed by many students. Developing critical skills required to utilize Excel to its fullest extent is just one of the many positive outcomes of using the Framingham Study as an example for students to learn. It has become a useful tool in the development of skills in the area of statistical analysis and understanding the research process in general.

The growing trends in the prevalence of overweight and obese individuals suffering from cardiac incidences continue to be a source of concern within the medical community. The issue is problematic in that it is often associated with other complications such as diabetes and hypertension which are not always the result of excess body fat. Although there is the option of therapeutic pharmacological treatments that can and are being used to off-set this growing epidemic, they have proven only moderate effective results. The main-stay remains a concerted effort to change behavior through life-style changes in the form of eating habits and exercise.

The role of obesity on cardiac incidences continues to be a source of trepidation for most all individuals across the country. Continued efforts in both the research and medical community to garner definitive evidence in causation are thwarted often due to physiological constraints. Despite that there is also evidence that Body Mass Index alone is a poor argument that obesity alone increases cardiac events, there is an inordinate amount of data to validate the belief that the growing prevalence of obesity and the ensuing risk factors brought on by obesity do increase the number of cardiac incidences.

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