Comparison of Clinical Outcomes, Resource Utilization, and Injury Patterns between Hospitalized Obese and Non-Obese Pediatric Patients with Traumatic Injuries

Benjamin J. Jarrett, Master of Public Health Candidate
June 2010

A Community Based Master's Project presented to the faculty of Drexel University School of Public Health in partial fulfillment of the Requirement for the Degree of Master of Public Health

Acknowledgments:

Many thanks to the emergency department faculty at St. Christopher's Hospital for Children as well as a special thanks and remembrance to Dr. Raemma Luck, for without her inspiration this study would have remained just a thought. Also thanks to Dr. Evan Weiner for allowing me to use his office and for his continued support. Further Thanks to:

Dr. Hernando Perez (advisor)
Dr. Jennifer Taylor
Huong Ngo
Diane Weathers

Table of Contents

Abstract…………………………………………………………4

Introduction-Objectives.…………………………………………5

Background……………………………………………………..7

Methods and Subjects…………………………………………….11

Results…………………………………………………………..15

Discussion……………………………………………………….25

Conclusion and Recommendations………………………………28

References……………………………………………………….30

Appendix A……………………………………………………...33

Appendix B……………………………………………………...35

Appendix C……………………………………………………...41

Abstract:

Comparison of Clinical Outcomes, Resource Utilization, and Injury Patterns between Hospitalized Obese and Non-Obese Pediatric Patients with Traumatic Injuries.

Benjamin J. Jarrett, MPH candidate, Dr. Raemma Luck MD MBA, Dr. Evan J Weiner MD.

Background: Children within the US are experiencing very high rates of obesity. Currently almost 31.9% of children have BMI's that exceed the 85th percentile and 16.3% of children are greater than the 95th percentile in BMI's. There have been several studies which indicate that obese children receive differences in care both surgically and medically from their non-obese counterparts. Other literature suggests that obese adults require more resources and have worse outcomes after traumatic injuries than non-obese adults. Most studies fail to look at the differences that occur in children who have been admitted to a hospital due to a traumatic injury.

Objectives: The goal of the study was to conduct a retrospective chart review/analysis of admitted pediatric trauma patients to St. Christopher's Hospital for Children looking for variations in complications, resources, and injury patterns that may exist between obese and non-obese patients.

Methods: Records for all admitted trauma patients between January 1st 2003 and December 31st 2008 were obtained and analyzed for eligibility in the study. A total of 175 records were included in the study. Specific data regarding the patients were then input into Excel and SPSS for statistical analysis. Patients were placed into one of four separate BMI percentile categories. The data was then cross analyzed using SPSS to explore for variations among groups.

Results: For all of the variables that were analyzed among BMI percentiles there were no statistical differences. All p-values were greater than 0.05. There were no differences with respects to outcomes, lengths of stay, resources such as labs and radiological exams, or injury patterns after statistical analysis among study groups. Marginal significance was observed in patient complications ($p=0.07$).

Conclusions: The statistics in this study suggest no difference among the groups, however due to the small sample size and the wide variation in injury severity score (ISS) as well as injury type it is not possible to conclude indefinitely on the status of the aforementioned problem. The potentiality for there to be differences exists pending on the completion of a larger study with more patients and a narrower bracket of injury severity scores.

Introduction and Objectives:

This study aimed at creating a thorough comparison between obese and non-obese pediatric patients who suffered traumatic injuries to see if there are differences that exist in the overall length of stay (LOS), the number of resources utilized, and the patterns of injury that occur at St. Christopher's Hospital for Children. Patients between the ages of 2 and 18 that were admitted between January 1st 2003 and December 31st 2008 via the trauma service with injury severity scores ≥9 were included in the study. Primary outcome measures were the overall length of stay, the number of radiologic examinations and labs, and the specific injury type. Secondary outcomes included the overall number of comorbidities, the number of surgical procedures, the number of hospital associated complications, as well as the number of days spent in the intensive care unit. All of the above measures are indicative of the overall number of hospital resources needed during hospitalization. They also serve as general predictors for hospitalization associated expenditures in obese children

We hypothesized that that obese children will have had longer lengths of stay, greater numbers of complications, higher readmission rates and will have utilized more hospital resources than their lean counterparts with similar injury severity scores. These hypotheses are based on the findings form studies of adult trauma patients. If a difference actually exists, clinicians and other healthcare practitioners will be able to refine their management options. Results of the study should bring about a greater understanding of the management of childhood injuries especially in the obese pediatric population. The following definitions will be used in this study:

- LOS as the total number of hospital days
- ICU stay will be calculated as number of days in the intensive care unit.

- Readmissions: Patients admitted to the hospital within 2 weeks after discharge with a problem arising from the primary traumatic injury, this will be counted as a complication.
- An infection will be counted if there is a documented infection by physical exam with additional laboratory or radiological evidence (confirmed by microbiological culture, or suspected through increased white cell counts and fever).
- Complications that will be monitored include urinary tract infections (UTI's from any catheter related pathogen), pneumonia, decubitus, ulcer and wound infection as defined by the Pennsylvania Trauma System Foundation

Furthermore, we hypothesized that moderately to severely injured obese children are exposed to more radiographic and laboratory testing compared to their non-obese counterparts with similar injury severity scores. We also hypothesized that obese patients have more chest and extremity injuries and less head or abdominal injuries than their non-obese counterparts with similar injury severity scores. The primary outcome measure will be a comparison of the number of radiographic and laboratory tests between obese and non-obese pediatric patients. The number of radiographs ordered will be counted, not the number of individual views obtained. Likewise, the number of laboratory tests or panels ordered and not individual results will be counted. Secondary measures of interest include comparison of types and patterns of injuries between obese and non-obese patients. Other discrepancies that may exist between the two groups will also be analyzed such as the blood glucose level and blood pressure on admittance.

The results of the study are aimed at bringing a greater understanding of the resources required to provide high quality care for this population as well as at making apparent the differences that may exist with treatment between the two groups. There is also the potentiality that this study will act as a springboard for future research regardless of the results.

Background:

In the US, the prevalence of obesity has more than doubled in the past 20 years with 16.3% of the pediatric population exceeding the 95th percentile for BMI and 31.9% within the 85th percentile.[1] One study noted that there are significant differences in surgical and medical treatment in obese children.[2] However, there is a paucity of data regarding clinically relevant outcomes between obese and non-obese patients sustaining severe traumatic injuries in the pediatric population. One paper published in 2006 compared the outcomes in obese and non-obese pediatric trauma patients.[3] Findings of this study suggest that obese children and adolescents with traumatic injuries have more complications and have longer lengths of stay (LOS) in the intensive care unit (ICU) than their non-obese counterparts. They also sustain less severe head injuries. Their findings also suggested no difference in mortality rates between the two groups.

A review of the adult population literature also shows disturbing patterns. As early as 1991, Choban noted an increase in mortality as well as an increased number of pulmonary complications among obese blunt trauma patients.[4] Similarly, a more recent study conducted by Christmas and colleagues found that obesity contributes significantly to pulmonary complications after blunt trauma and surgery.[5] The obese group also experienced more wound complications, bacteremia, pneumonia and nosocomial infections in both studies. Many studies have corroborated these findings within the last 5 to 6 years. In 2004, Bercault published a retrospective review of medical/surgical ICU patients and found that obese patients were four times more likely to suffer complications of any kind in the ICU.[6] In 2005, Byrnes performed a retrospective review of 1179 trauma patients and found that those with a BMI>35.5 (in adults this is greater than the 95th percentile or obese) had longer hospital stays, spent more time in the ICU, and were more likely to need mechanical ventilation compared to those with a BMI<35.5.[7] In another review by Brown in 2005, it was demonstrated that those with a BMI>30 were more likely to develop acute respiratory distress syndrome, acute myocardial infarction, acute renal failure, and multiple system organ failure; however, it is unclear whether or not similar patterns would be seen in pediatric patients.[8] Although these latter two studies defined obesity in slightly different terms, both demonstrated that an elevated BMI in trauma patients is associated with increased in-hospital morbidity. These two studies, and several others, also looked at mortality rates in obese trauma patients and compared them to that of their lean counterparts noting similar conclusions. A case control study by Neville, in 2004, showed that obese victims of blunt trauma were six times more likely to die than lean patients with similar injuries.[9] In the study by Brown, there was a trend toward increased mortality in the most seriously injured obese patients. In the study by Byrnes, there was a stepwise increase in mortality when those with an ISS>20 were stratified by BMI.

Children, however, have fewer pre-existing co-morbidities as compared to adults. Obese children may have higher rates of asthma, diabetes or hypertension rates than non-obese children but lower rates than the adult popultion. The definition of obesity also differs in children from that of the adult population. In adults, the National Institute of Health and the World Health Organization define obesity as those with BMI $\geq$ 30kg/m^2 and non-obese as < 30kg/m^2.[10] Therefore, the results from these studies may not be applicable to the pediatric population.

According to the American Academy of Pediatrics and the Centers for Disease Control, children's weight are classified according to the following table .[11,12,13]

Underweight	BMI-for-age < 5th percentile
Normal	BMI-for-age 5th percentile to < 85th percentile
At risk of overweight	BMI-for-age 85th percentile to < 95th percentile
Overweight/Obese	BMI-for-age $\geq$ 95th percentile

Table 1.

However, the Institute of Medicine defines obesity as those children with BMI-for-age $\geq$ 95th percentile and overweight as those between 85th to 95th percentile, contrary to the CDC's definition. Our study will stratify children according to their BMI-for-age according to the CDC's definitions of BMI-for-age percentiles. We will define obesity as children with BMI-for-age $\geq$ 95th percentile with severe obesity as those with BMI-for-age $\geq$ 99th percentile. Patients at risk for becoming obese are those with BMI values between the 85th and 94th percentiles. The BMI charts and BMI-for-age percentile charts are available for children from 2 years to 20 years of age and can be found at *http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm and http://www.cdc.gov/growthcharts/.*

In order to compare severity of injuries between obese and non-obese children appropriately, we the New Injury Severity Score (ISS). The New ISS is currently used as a standard predictor of injury severity, morbidity and mortality. This score is calculated during hospitalization, usually in the emergency department during initial resuscitation and the primary and secondary assessments, and remains constant once all injuries are identified.[14] The new ISS is derived from the sum of the squares of the Abbreviated Injury Score (AIS) for the three most severely injured regions. The maximum score is 75 (75 being un-survivable). Although it has some limitations, the ISS has been shown to be a valid predictor of mortality, length of stay in the hospital and cost of care. A patient with an ISS score of >15 is generally considered to have severe trauma. We used an ISS score between 9-14 to define patients with moderate injuries and greater than 14 to define more severe injuries. All patients with an injury severity score greater than 9 were included in this study.

Another injury severity scoring system that could potentially be used is the PRISM (Pediatric Risk of Mortality) score. This is an intensive care scoring system that incorporates many factors, including; cardiovascular and neurologic parameters, acid-base, as well as electrolyte and hematologic values. Although a better predictor of resource utilization than ISS, PRISM underestimates mortality.[15,16] Therefore, the ISS will be used in this study as PRISM is generally used for patients in the ICU and many of the patients in this study will not have been admitted to the ICU.

Methods and Subjects:

The initial process began with the acquisition of the records for all of the trauma patients between January 1st 2003 and December 31st 2008. The trauma registry data provided a starting point for matching of patient records that met all of our criteria. The next step was to go through the registry data which contained patient medical record numbers, dates of admittance, age and injury severity score, and to identify all those who had injury severity scores of 9 or greater, and who were between our age limits of 2 and 18 years of age. For the entire 5 year period we evaluated there were approximately a total of 4250 patients that were seen by the trauma service. This number was narrowed down to 1099 records that met the study age and Injury Severity Score (ISS) criteria. An initial estimate of the number of patient charts that would be needed to identify statistically significant differences was 175 records. Our IRB application requested only 175 records based on this power calculation thus were were limited to this number of records in our study. However, approximately 400 records were analyzed for other specific criteria between January 1st 2003 and August of 2005. From these records all but the final 175 were excluded due to specific criteria. The patient records were not used if there were no height and weight, if they had been transferred from an outside hospital without record of the number and type of laboratory or radiologic exams that were performed or if no record existed in the Horizon Patient Folders electronic record system.

The aspects of the patient records that were analyzed were the emergency room records at St. Christopher's Hospital for Children, the discharge summaries, the progress notes, laboratory and x-ray orders as well as results, nurse's assessments, and surgical notes. The ER records were used to indicate the patients admitting diagnoses, their injury patterns, their admitted blood pressures, and their admitted Glascow Coma Score (GCS). The discharge summaries were used in order to portray a sufficient picture of the injuries severity, illustrate any mentioned complications, the total number of surgical procedures and the finalized admitting diagnosis. Progress notes were a useful source of minor complications such as minor fevers, potential drug interactions, decubitus ulcers (pressure sores), and a general day to day portrayal of the patient's condition; is the patient getting better or worse, are there hidden complications with this patient's hospitalization and has there been any institution of a sepsis protocol? Laboratory and x-ray data were gathered for both quantitative reasons (the total number of labs and radiologic exams ordered) and qualitative reasons. If there were spikes in the white blood cell count, along with fever, administration of antipyretics, and notable results with microbiologic cultures (bronchoalveolar lavage, stool, blood, sputum, nasal washings, wound specimens etc) it could be sufficiently concluded that the patient had developed a potential complication/hospital acquired infection. The surgical notes were read thoroughly to look for any potential surgical complications during the procedure and the overall number of procedures that were performed during each patient's hospitalization were all pieces of data that were noteworthy. Lastly, the nurses' assessments clearly stated the past medical history of the patient and the significant comorbidities as well as the height and weight of the patient.

Throughout each patient record, specific elements within each of the aforementioned sections were placed into a data collection tool using Microsoft Excel. The data collection tool included the following; medical record number, dates of hospitalization, injury severity score (ISS), Glasgow Coma Score (GCS), age, ethnicity, length of stay (LOS), intensive care unit LOS, admitted blood glucose, admitted blood pressure, admitted liver function enzymes (if present), regions of injury, injury specifics (i.e. exactly what happened to the patient for future reference), number of laboratory tests performed, number of radiologic exams performed (X-rays, CT, and fluoroscopy, MRI's were not included due to the lack of radiation exposure), number of procedures, the procedure types, potential comorbidities (ranging from asthma to more severe disorders such as sickle cell disease, Marfan's syndrome and any significant life impacting disorder, seasonal allergies were not included as a comorbidities), complications (infections, surgical and post-surgical complications such as the necessity to repeat a fracture reduction due to inadequate initial reduction or slipping of intramedullary nails etc, severe electrolyte disturbances or nutrition issues due to inadequate in hospital nutrition supplementation), and lastly the patients height and weight in meters and kilograms.

Once the data for 175 patient records was obtained, the BMI percentiles were calculated using the CDC's BMI-for-age percentile charts. Individual patients were placed into one of four initial categories; obese-BMI-for-age >95th percentile, at-risk BMI-for-age <95th to 85th percentiles, normal BMI-for-age from the 5th percentile to the

85th percentile, and lastly underweight individuals were <5th percentile. Each of these categories was cross-analyzed using t-tests (difference in means) in SPSS. However, before statistical analysis, simple descriptive graphs were created to illustrate subtle differences that exist among within the study population. Also using SPSS, an analysis of variants (ANOVA) was performed where graphs of potential trends were created and simple statistical comparisons of means were performed. Finally, the obese patients were compared to all non-obese patients (at-risk, normal, and underweight patients) to see if there were an significant differences along the parameters of LOS, ICU-LOS, blood glucose, blood pressure, number of procedures, complications, comorbidities, complications and the patterns of injury. Secondarily, the two extremes, obese and underweight were compared to the at risk and normal individuals to see if there were trends at the extreme ends of the BMI-for-age percentiles along the same parameters as previously mentioned. Other categories that were created and analyzed were; (group 1) obese and at-risk vs. (group 2) normal and underweight individuals, (group 1) obese patients vs. (group 2) normal weight patients, and lastly (group 1) obese patients vs. (group 2) underweight and normal patients.

Results:

The BMI-for-age percentile status for the study population is shown in figure 1. These results show that 7% (13 patients) of the population was underweight, 45% (79 patients) were normal weight, 19% (34 patients) were at risk for overweight, and 29% (50 patients) were overweight/obese.

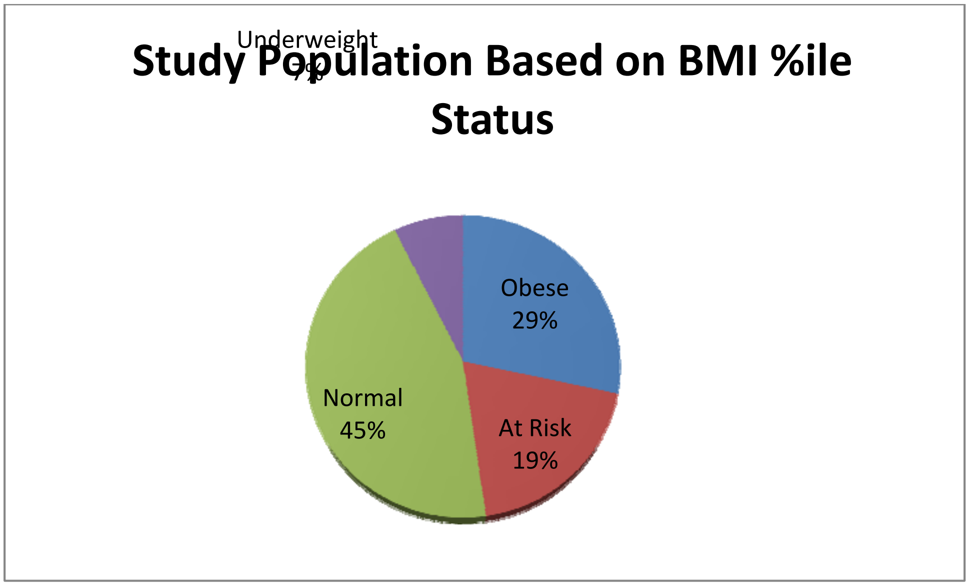


Figure 1.

Table 2 and Figure 2 show the mean LOS with the standard deviations for the four BMI-for-age percentile groups. The chart indicates that obese patients and underweight patients have a slightly higher mean length of stay than do normal and at-risk for overweight patients. The statistical analysis of this data can be seen in table 3.

Table 2.

BMIcategory	Mean	N	Std. Deviation
Obese	6.12	49	5.270
At RIsk	4.15	34	4.781
Normal	5.48	79	5.944
Underweight	6.00	13	4.564
Total	5.44	175	5.455

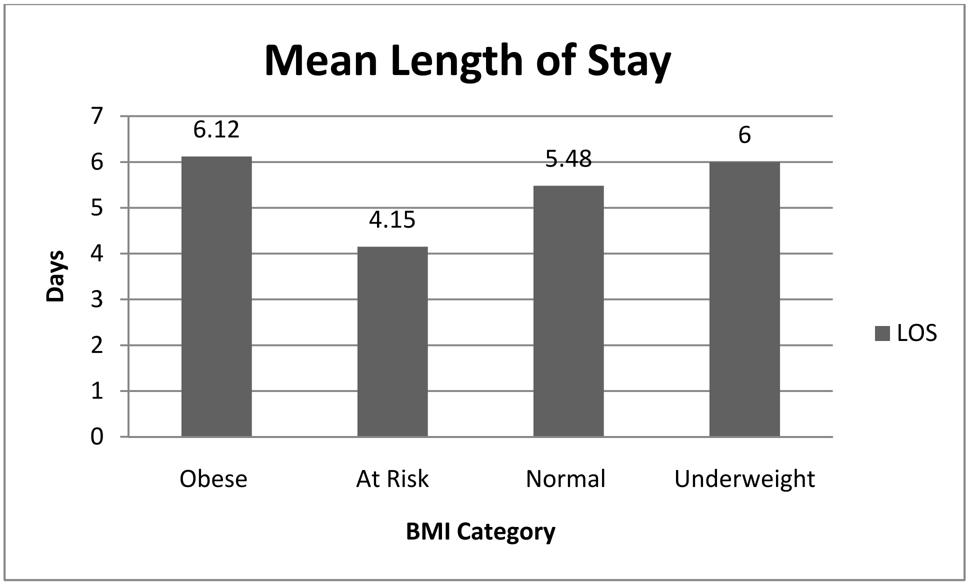


Figure 2.

The p-value for a significant difference among the four groups is 0.42 using an ANOVA in SPSS. Figure 3 illustrates the trend line for the mean of the overall lengths of stay within the four groups as well. As can be seen by the figure a potential trend may exist, just as figure 2 illustrates obese and underweight patients experience a slightly longer on average length of stay than do the at-risk and normal weight pediatric trauma patients.

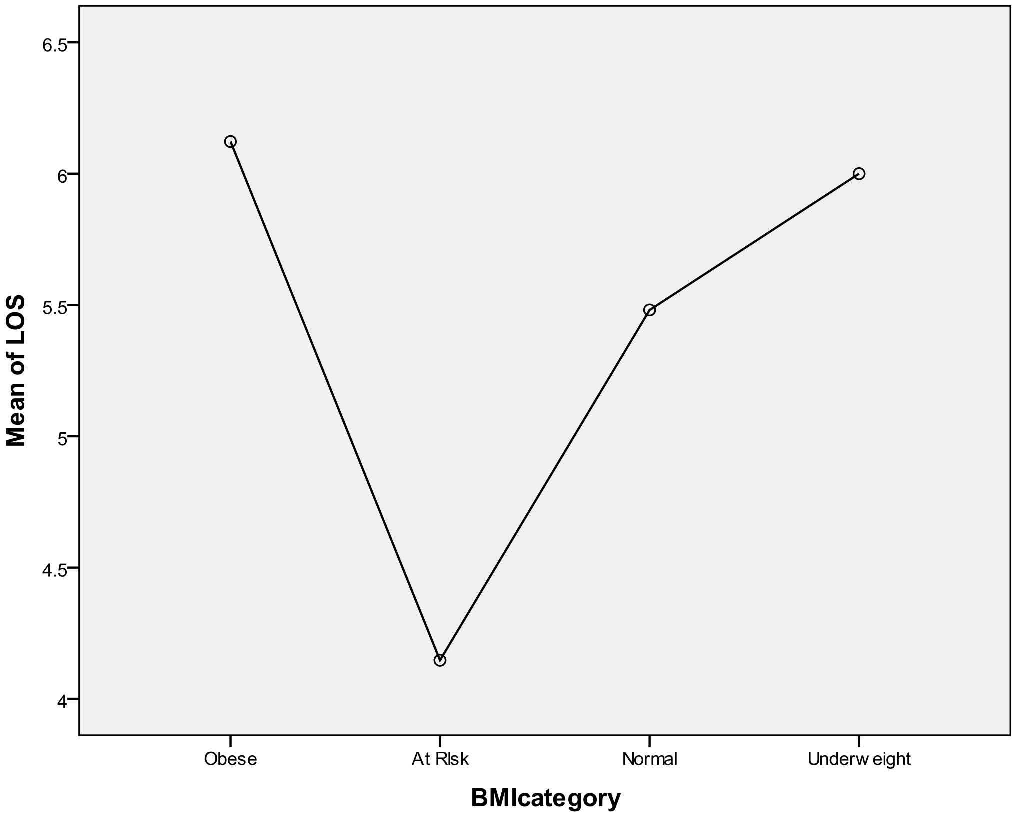
BMI-for-age groups and LOS (ANOVA)

LOS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	83.868	3	27.956	.939	.423
Within Groups	5093.252	171	29.785		
Total	5177.120	174			

Table 3.

Figure 3. Illustrates the BMI category vs. the Mean Length of stay.



The mean of the total number of labs within each group are shown by table 5 as well as figure 4 and figure 5. As can be seen by the figures, normal weight individuals experience a slightly larger number of average labs than to the other BMI-for-age groups. The overall p-value for is 0.94 and can be seen in table 6. Furthermore, the underweight and obese categories were combined and compared to a combination of the at risk and normal categories as a mode of analysis of the “extreme ends of the BMI spectrum. Figure 4 illustrates this correlation, and it demonstrates a curve that show the extremes having longer overall mean LOS.

TOTALLAB

BMIcategory	Mean	N	Std. Deviation
Obese	11.43	49	15.578
At RIsk	12.65	34	36.895
Normal	14.10	79	32.272
Underweight	11.00	13	12.510
Total	12.84	175	28.361

Table 4.

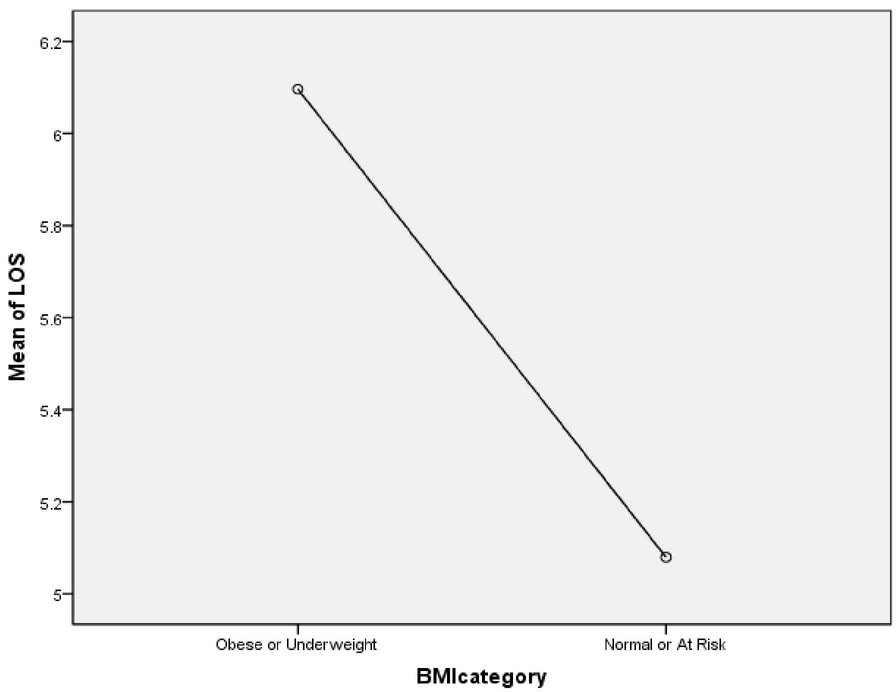


Figure 4. Combined extremes vs. normal and at risk categories.

When the combination of the extremes were analyzed using an ANOVA comparison of means the p-value came back to be 0.08. Comparison of the extremes with regards to the man of the total number of labs came back the same as with the normal t-test and ANOVA analysis.

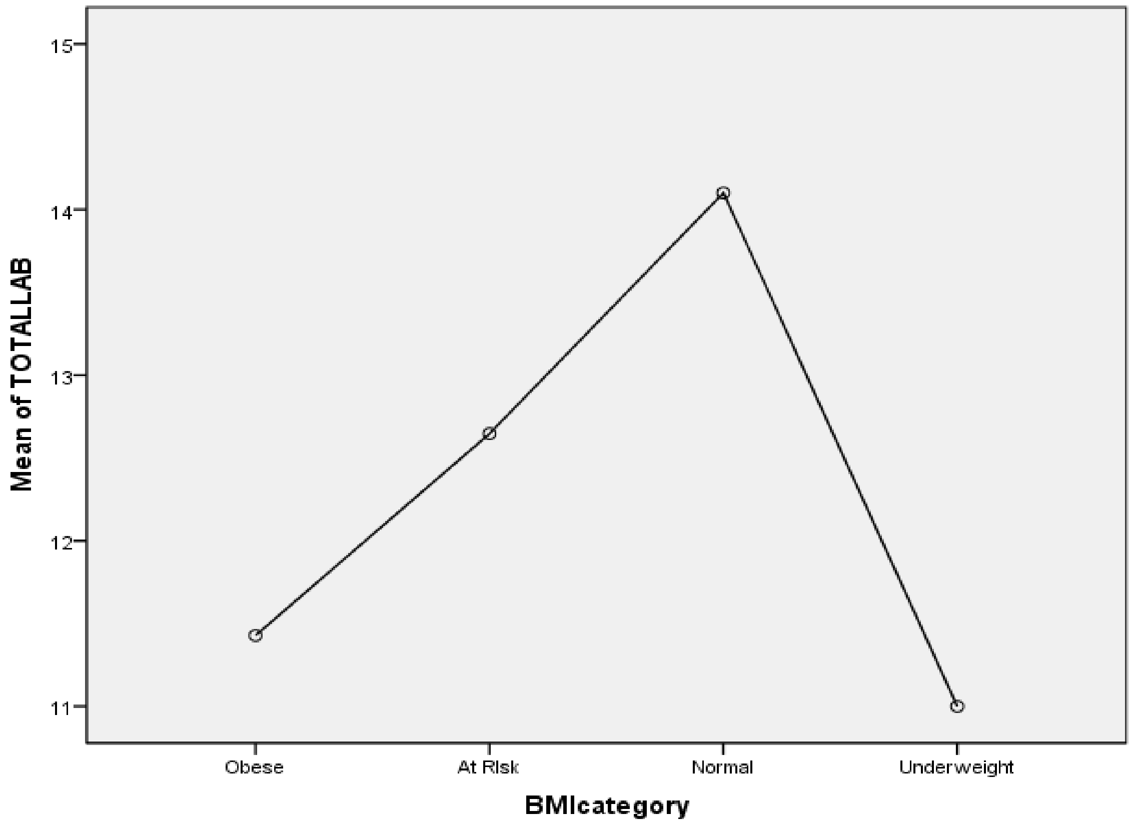


Figure 5.

BMI-for-age category vs. Mean total of labs (ANOVA)

TOTALLAB

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	268.565	3	89.522	.110	.954
Within Groups	139682.955	171	816.859		
Total	139951.520	174			

Table 5.

Table 6, Figure 6, and Figure 7 illustrate that normal and underweight individuals received more radiological examinations that do their more obese counterparts in the at-risk and obese categories. On Average, underweight individuals receive approximately

1 additional radiologic examination than do the obese pediatric trauma patients. The p-value for the differences in radiological examinations is 0.43 and can be seen in table 7.

TOTALRAD vs, BMI for-age Category

BMIcategory	Mean	N	Std. Deviation
Obese	4.16	49	2.911
At RIsk	3.68	34	4.571
Normal	5.11	79	5.897
Underweight	5.23	13	3.370
Total	4.58	175	4.800

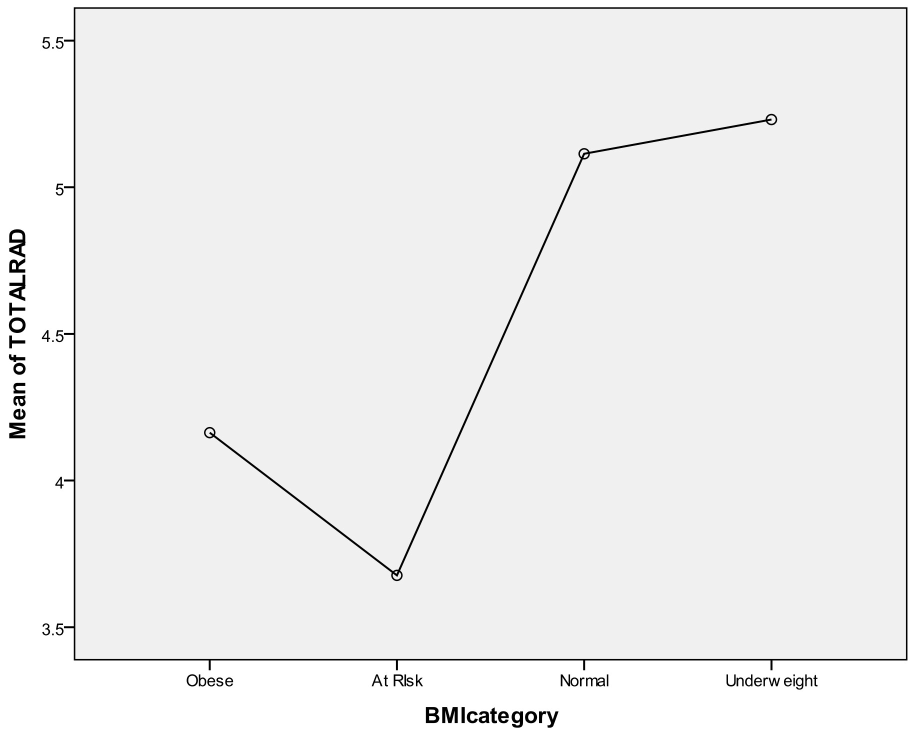
Table 6.

BMI-for-age Category vs. Mean Total Radiological Exams (ANOVA)

TOTALRAD

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	64.291	3	21.430	.929	.428
Within Groups	3944.417	171	23.067		
Total	4008.709	174			

Table 7.



BMI Category vs. Mean Total Number of Radiologic Exams

Figure 6.

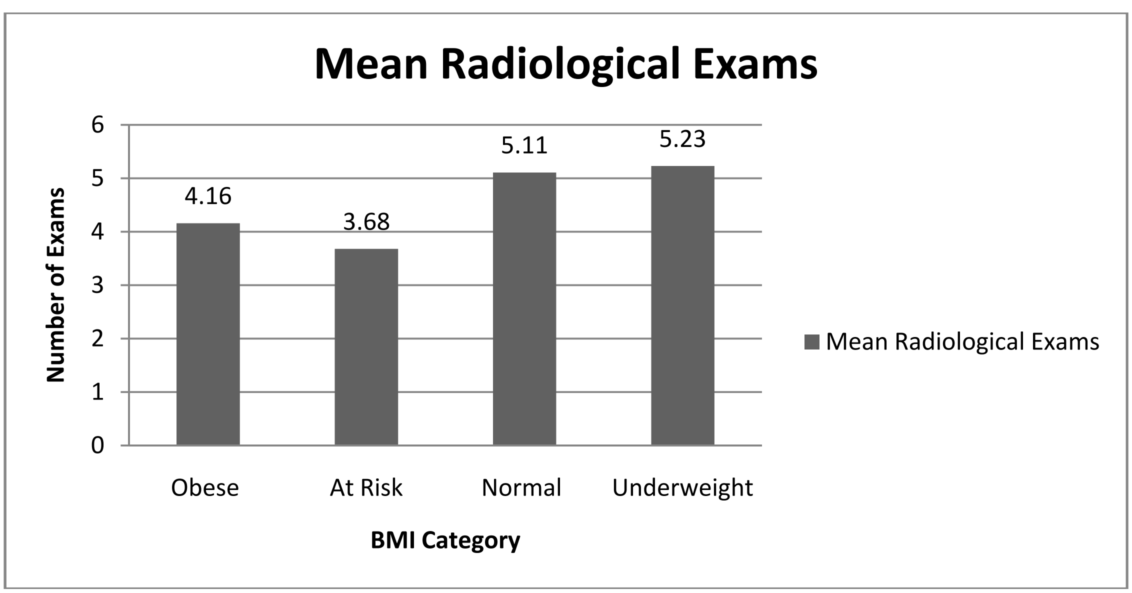


Figure 7.

TOTALPROC vs. BMI category

BMIcategory	Mean	N	Std. Deviation
Obese	1.82	49	2.270
At RIsk	1.24	34	2.001
Normal	1.30	79	1.883
Underweight	1.38	13	1.502
Total	1.44	175	1.996

Table 8.

The overall number of procedures was not significantly different, on average an individual in an of the four BMI-for-age categories experienced slightly greater than 1 procedure. Table 8, Table 9, Figure 8, and Figure 9 illustrate this. The p-value for BMI-for-age category and the number of procedures is 0.48.

BMI-for-age Category vs. Mean total of Procedures (ANOVA)

TOTALPROC

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.870	3	3.290	.823	.483
Within Groups	683.250	171	3.996		
Total	693.120	174			

Table 9.

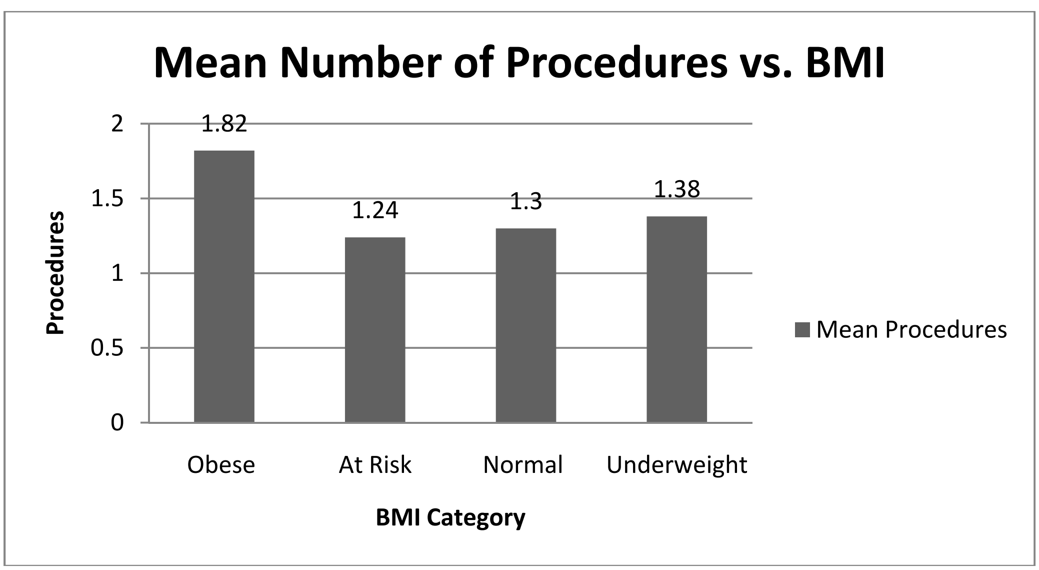


Figure 8.

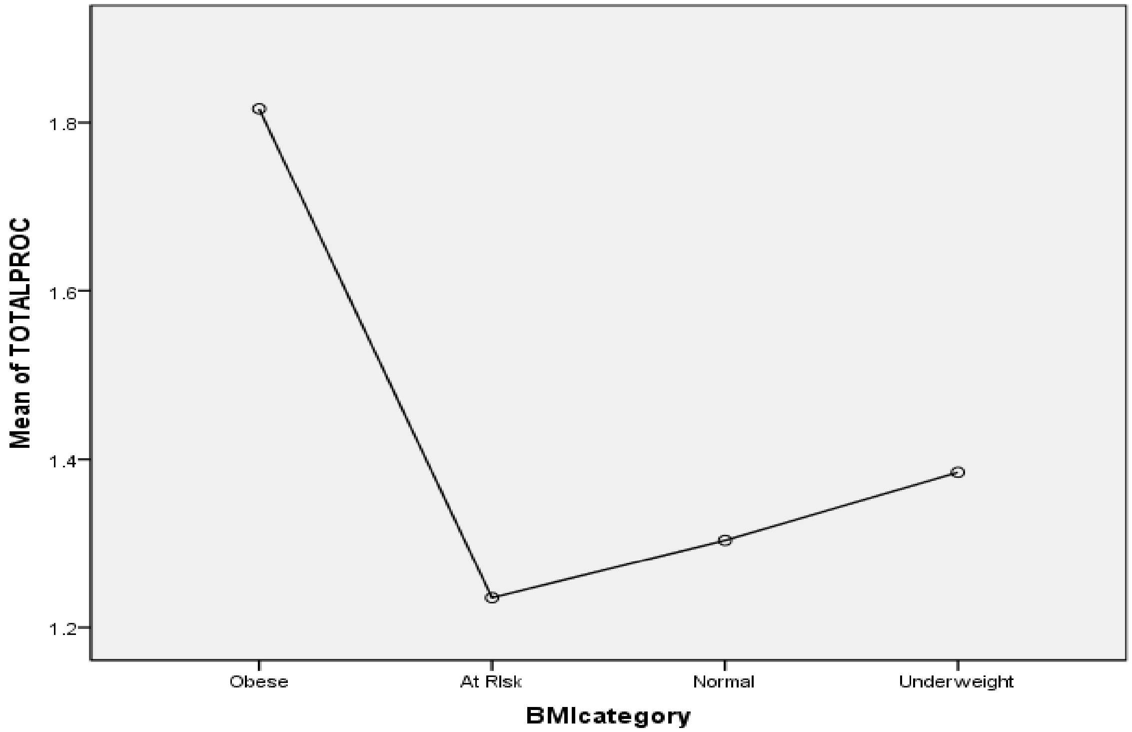


Figure 9.

The total number of complications within each group averages less than 1. This means that certain individuals suffered either 1 or more than 1 complication and other patients experienced multiple complications. Table 10 illustrates the p-value for the comparison among groups on the parameter of the number of complications is 0.34. Figure 11, illustrates the mean of the number of complications among BMI categories. The t-test p-value came out to be 0.12 when comparing the obese and the normal categories along the mean number of complications.

BMI category vs. Mean total Complications(ANOVA)

TOTALCOMP

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.285	3	.428	1.117	.344
Within Groups	65.549	171	.383		
Total	66.834	174			

Table 10.

Figure 10 illustrates that 38% of obese and underweight patients suffer from at least one in hospital complication, 17% of at risk for obesity patients suffer at least one complication and 22 percent of normal weight patients suffer at least one in hospital complication. .

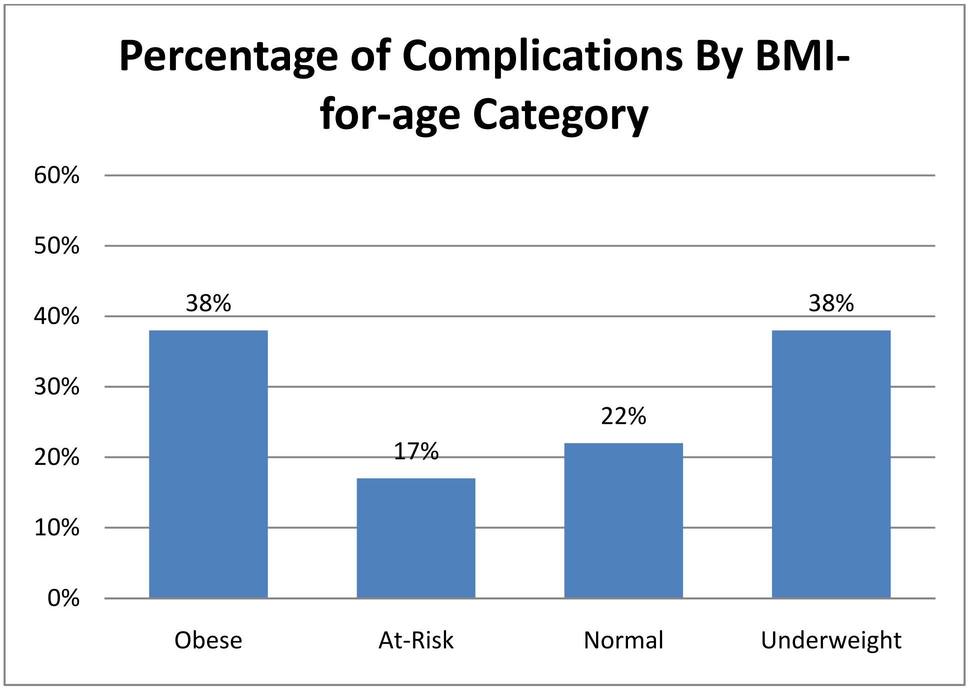


Figure 10.

When an anova comparison was done comparing the extremes vs. the at risk and underweight individuals the p-value was 0.07. Figure 11 shows the same trend just on the terms of the average number of complications. It is difficult to indicate what exactly a fraction of a complication is as is shown in figure 11, however it utility is in illustrating the trend of complications.

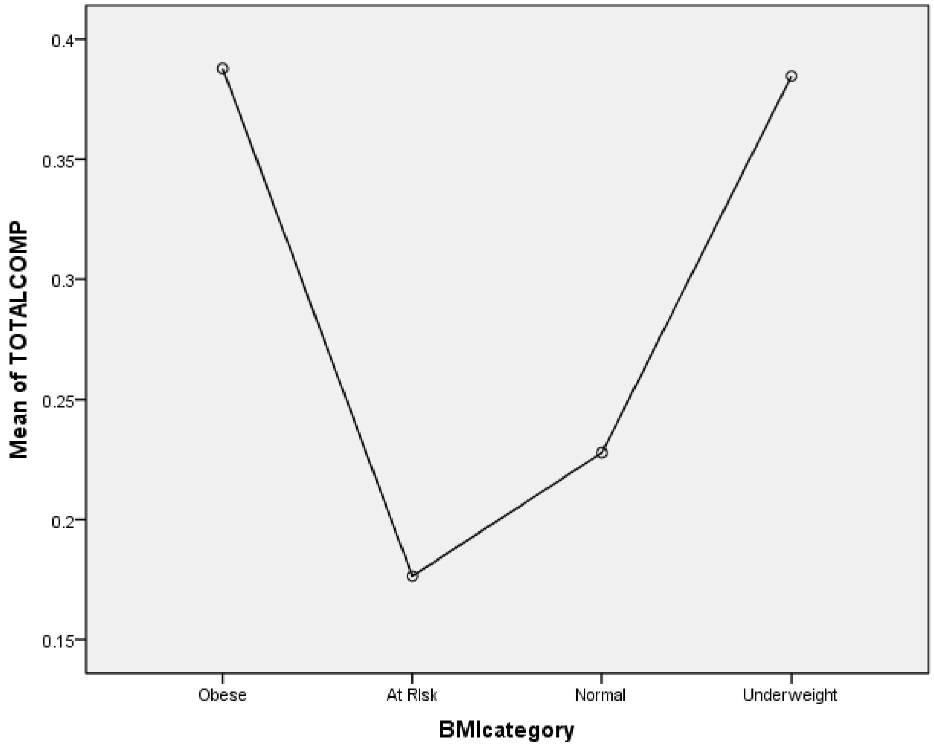


Figure 11. Illustrates the trend noted in figure 10 however on the y-axis is simply the average number of complications.

Discussion:

The p-values that were noted above are not statistically significant at an alpha of 0.05. However there were many limitations to the study and potential drawbacks that may have played a role in the lack of statistical significance. As with many studies, negative results or no statistical significance can be just as beneficial of a conclusion as any. During preliminary discussions of the study, the investigators had decided that approximately 175 patient records would suffice to allow for identification of statistical significance (if present), however after acquiring data and finding a difference in means the Vanderbilt Sample Size calculator indicates that the maximum number of records that would be need for detecting small significant differences in means would be approximately 1400. The small sample size here is one of the largest draw backs.

Secondarily, going through medical records can be quite tedious and requires dedication, commitment and thorough knowledge of the medical and laboratory aspects of medicine. Oftentimes, illegible records as well as incomplete data make it even more challenging to report complications, thus complications could have easily been overlooked if not noted clearly in the medical record. The estimates of the overall number of complications and overall resources are most likely underestimates due to the lack of information or clarity of information within the records themselves. Other aspects of the study numbers such as LOS, ICU-LOS, and the numbers of labs and radiologic exams were clearly noted in the records and those numbers are accurate representations of the actual resources needed during a patient's hospitalization.

Considerations for further investigation into the hypotheses in the study would need to include fixed criteria for defining adverse medical events and complications. With this study, some data came to be marginally significant with p-values less than 0.10 and if an alpha was set at this point instead of 0.05 would indicate significance, however still marginally. The lowest p-value with this study was 0.07 with an extreme comparison of the overall number of hospital complications indicated that obese and underweight individuals suffer more complications than their more normal weight counterparts. Also, with a p-value of 0.08, the number of x-rays that patients receive during hospitalization is greater in the underweight and normal weight patients than at-risk and obese pediatric trauma patients. This may indicate an area requiring further inquiry. Are more obese patients not getting the same efficient and thorough treatment with regards to x-rays as the normal and underweight patients, or are there strict medical reasons for the lack of radiologic examination of more obese patients?

The lack of evidence indicates that routine trauma care can ensue without the necessity for further re-classification and design of trauma protocols in the treatment of obese pediatric trauma patients. This is a very positive end result because due to the fast paced high stress world of trauma and emergency medicine, having to revisit and recreate criteria for treatment in this population may create more problems than it would solve. It would be quite a large challenge for emergency and trauma physicians if they needed to treat obese trauma patients differently than non-obese patients.

Due to the physiologic differences in the pediatric patient population vs. the adult population, and the fact that the adult literature points to significant differences in the outcomes and care received in obese adult patient populations this study further indicates that adult trauma care and pediatric trauma care are quite different worlds. Lastly, the results indicate a necessity to look more intuitively at the pediatric patient once the patient leaves the emergency room or the operating theater towards the complications that occur on the hospital floor and the reasons why the extreme ends (obese and underweight) are sustaining more in hospital complications than their normal weight peers. All of the complications that were mentioned in this study were results of something that occurred on the hospital floor, with a few exceptions in the OR, whether it was an infection of some kind or a complication of a different nature.

Also, figure 1 shows the pediatric trauma distribution on the terms of BMI-for-age percentiles. The Ogden et. al study, published in 2008, showed that the general population has 31.9% of patients in the at-risk category and 16.3% in the overweight/obese category. The population in this study has a far greater percentage of the population in both categories, 29% of the patients seen in the trauma service at St.

Christopher's Hospital for Children are considered obese, and 19.2% are considered at-risk. This may indicate a change in the population statistics or may also indicate a trend within the north Philadelphia region. Nonetheless, it indicates that a large portion of the trauma patients at this hospital are overweight and presents a potential public health problem with socio-environmental factors that influence obesity such as poor diet and/or inadequate physical activity.

Conclusions and Recommendations:

The overall results of this study were inconclusive and indicate no statistical significance along any study variable on the basis of a pediatric trauma patient's BMI. The results with marginal significance are on both on a comparison of the extremes (obese and underweight) vs. the more normal weight patients (normal and at-risk for overweight). These indicate a potentially risk for the extremes to suffer more complications and for normal and underweight patients to experience more radiation exposure through x-rays and radiologic examinations. Furthermore, recommendations for future studies in this area will be to include a larger number of patient records as well as utilize set criteria for complications.

Also, this study looks specifically at all patients between the ages of 2 and 18 and doesn't account for the physiologic changes that occur during puberty where the patients become more physiologically similar to adult patients. Potential trends may exist along the lines of age as children reach physical maturity that may be coherent with the trauma literature that analyses the differences in adult obese and non-obese patients.

This study also has a very wide variability in injury severities, from an injury severity score of 9, representing a moderate to minor trauma, all the way to 75, which is considered unsurvivable. In future studies it may be necessary to create a smaller margin of injury severity, potentially including only pediatric trauma patients with injury severity scores from 15 to 30, or an even small window of injury severity scores. The wide variability of severity of injury may be one of the contributing factors that created the lack of statistical significance or any real difference in length of stay, our primary outcome measure. As with any physical trauma, the mechanism is the most important predictor of physical morbidity and possibly the amount of resources it will take to bring the patient back to appropriate functional status. For example, a patient hit by a car at low speed versus a patient hit by a car at high speed will have a very large difference in injury severity, and likewise the patient hit by the high speed vehicle will likely require much more care than the low speed patient. These types of physical or mechanical energy differences can be accounted for by using a smaller margin of injury severity scores.

There is a real potential that this study shows the real or true results that there is no differences among BMI percentiles in the pediatric trauma population. This is just as significant for clinicians as elucidating a result. However, the only way to verify the results of this study would be to create a secondary study that analyzes a larger sample of patient records, potentially a multi-hospital study.

References:

1. Ogden CL, Flegal KM, Carroll MD, et al. **High Body Mass Index for Age Among US Children and Adolescents, 2003-2006.** JAMA 2008;299(20):2401-2405
2. Nafiu OO; Ndao-Brumlay KS, Bamgbade OA, Morris M, Zasu-Vubu JZ; **Prevalence of Overweight and obesity in a U.S. Pediatric Surgical Population.** Journal of the National Medical Association. 2007; 99(1):46-51
3. Brown C, Neville AL, Salim A, et al. **The impact of obesity on severely injured children and adolescents.** J of Pediatr Surg. 2006;41: 88-91
4. Smith-Choban P.S.; Weireter Jr. L.J.; Maynes C. **Obesity and increased mortality in blunt trauma.** J Trauma 1991; 31:1253-1257.
5. Christmas AB, Reynolds J, Wilson AK, Franklin GA, Miller FB, Richardson JD, Rodriguez JL; **Morbid Obesity Impacts Mortality in Blunt Trauma.** The American Surgeon, 73(11):1122-1125
6. Bercault N, Boulain T, Kuteifan K, et al. **Obesity-related excess mortality rate in an adult intensive care unit: A risk-adjusted matched cohort study** Crit Care Med 2004;32:998-1003
7. Byrnes MC. McDaniel MD. Moore MB. Helmer SD. Smith RS. **The effect of obesity on outcomes among injured patients.** *Journal of Trauma-Injury Infection & Critical Care.Feb 2005;58(2):232-7.*
8. Brown C. Neville AL. **The Impact of Obesity on Trauma**. *J of Trauma*. Nov 2005; 59: 1048-1051.
9. Neville AL. Brown CV. Weng J. Demetriades D. Velmahos GC. **Obesity is an independent risk factor of mortality in severely injured blunt trauma patients.** *Archives of Surgery.* Sept 2004;*139(9):983-7.*
10. National Institutes of Health. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and obesity in Adults: the Evidence Report: Washington, DC. National Institutes of Health 1998. Publication 98-4083.
11. http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm
12. http://www.cdc.gov/nccdphp/dnpa/growthcharts/bmi_tools.htm
13. *http://www.cdc.gov/growthcharts/*

14. Furnival RA, Schunk JE. **ABC's of scoring systems in pediatric trauma**. Peds Emerg Care 1999;15:215-220
15. Pollack MM, Patel KM, Ruttimann UE. **PRISM III: an Updated Pediatric Risk of Mortality Score.** Crit care Med. 1996;24:743
16. Castello FV, Cassano A, Gregory P, Hammond J: **The Pediatric Risk of Mortality (PRISM) Score and Injury Severity Score (ISS) for Predicting Resource Utilization and Outcome of Intensive Care in Pediatric Trauma.** Critical Care Medicine. 1999; 27(5):985-988.
17. Flynn JM. Lou JE. Ganley TJ. Prevention of sports injuries in children. Current Opinion in Pediatrics 2002;14(6):719-22 Dec. Abstract
18. Kannus P. Jarvinen M. **Age, overweight, sex, and knee instability: their relationship to the post-traumatic osteoarthrosis of the knee joint. Injury.** 19(2):105-8, 1988 Mar.Abstract
19. Kaplan TA. Digel SL. Scavo VA. Arellana SB. **Effect of obesity on injury risk in high school football players.** Clinical Journal of Sport Medicine. 5(1):43-7, 1995. Abstract
20. Boulanger B.R.; Milzman D.; Mitchell K.; Rodriguez A. **Body habitus as a predictor of injury pattern after blunt trauma**.J of Trauma 1992; 33(2):228-232.
21. Morris JA, MacKenzie EJ, Edelstein SL. **The effect of preexisting conditions on mortality in trauma patients.** JAMA. 1990;263:1942-1946.
22. Miltman DP, Boulanger BR, Rodriquez A, Soderstrom CA, Mitchell KA, Magnant CM. **Pre-existing Disease in trauma patients: a predictor of fate independent of age and injury severity score.** J of Trauma. 1992; 32-236-244.
23. Brown CV. Martin MJ. Shoemaker WC. Wo CC. Chan L. Azarow K. Demetriades D. **The effect of obesity on bioimpedance cardiac index.** *American Journal of Surgery.* May 2005; 189(5):547-50; discussion 550-1.
24. Bazelmans C. Coppieters Y. Godin I. Parent F. Berghmans L. Dramaix M. Leveque A. **Is obesity associated with injuries among young people?.** *European Journal of Epidemiology. 2004; 19(11):1037-42.*

25. Grant P. Newcombe M. **Emergency management of the morbidly obese.** *Emergency Medicine Australasia. Aug 2004;16(4):309-17.*
26. Larkin H. **Capital & candor. To meet the needs of obese patients, hospitals change processes, equipment and attitudes.** *Hospitals & Health Networks. Feb 2004;78(2):58-62, 2.*
27. Arbabi S. Wahl WL. Hemmila MR. Kohoyda-Inglis C. Taheri PA. Wang SC. **The cushion effect.** J of *Trauma*. *Injury Infection & Critical Care. Jun 2003;54(6):1090-3.*
28. Mathison CJ. **Skin and wound care challenges in the hospitalized morbidly obese patient.** *Journal of Wound, Ostomy, & Continence Nursing. Mar 2004;30(2):78-8.*

Appendix A.

DATA COLLECTION TOOL/COLLECTION VARIABLES AND CRITERIA
Retrospective study "Comparison of Clinical Outcomes, Resource Utilization and Injury Patterns Between Hospitalized Obese and Non-obese Pediatric Patients with Traumatic Injury."

General Patient Information

Subject number		COMMENTS
Age- in months		
Gender		1-male, 2- female
Height		In inches
Weight		In kilos to nearest 0.1
BMI		%ile
Race		1-Black, 2-Hispanic, 3-White, 4-Asian, 5-others
ICU length of stay		To the nearest 0.5 day
Hospital length of stay		To nearest 0.5 day
GCS		On admission
ISS		
# of laboratory studies completed.		
# of imaging studies completed.		
Time of arrival in ED		Use military time
Date of discharge		Use military time
Discharge status (Alive or dead)		1- Home, 2- rehab or 3-morgue

Description/location of injuries.

Primary Mechanism of injury (circle all that apply) Of most-life threatening injury	Blunt	Penetrating	Burn
Secondary Mechanism of Injury			
Anatomical region of principal injury	Head/Neck	Trunk	Extremity

(circle all that apply).	Check if primary And encircle the second most common body part		
Type of injury in each area (describe) e.g. R LE fracture, chest and abdominal bruising.	Head	Trunk	Extremity

Past Medical History/ Comorbidities

A: Asthma B: Diabetes C. Hypertension D. Sleep Apnea E: UTI F : others__________

Medications given:

1. Antibiotics
2. Paralysis meds
3. Pain meds

Complications during hospitalization e.g. pneumonia, infection

A. Pneumonia
B. Decubitis ulcer
C. Osteomyelitis
D. Line infection
E. Mechanical failure
F. Reintubation
G. Arrythmias
H. Cerebral edema
I. Others:

# of Procedures done
Types of procedures done:

1. Intubation
2. Craniotomy
3. Skin Grafting
4. Evacuation of subdural, etc
5. Fracture reduction/pinning
6. others

Appendix B.

T-Test Results (ANOVA RESULTS SPECIFICALLY IN RESULTS SECTION)

T-tests Obese vs. At Risk

Group Statistics

	BMIcategory	N	Mean	Std. Deviation	Std. Error Mean
SystolicBP	Obese	49	126.53	17.794	2.542
	At RIsk	126	125.76	23.264	2.073
Glucose	Obese	39	137.56	39.231	6.282
	At RIsk	85	134.78	52.077	5.649
LOS	Obese	49	6.12	5.270	.753
	At RIsk	126	5.17	5.522	.492
ICULOS	Obese	49	2.06	3.913	.559
	At RIsk	126	1.68	4.512	.402
TOTALLAB	Obese	49	11.43	15.578	2.225
	At RIsk	126	13.39	32.021	2.853
TOTALRAD	Obese	49	4.16	2.911	.416
	At RIsk	126	4.74	5.359	.477
TOTALX	Obese	49	2.57	2.533	.362
	At RIsk	126	3.25	4.456	.397
TOTALCT	Obese	49	1.22	1.212	.173
	At RIsk	126	1.02	1.290	.115
TOTALFLUORO	Obese	49	.37	.528	.075
	At RIsk	126	.45	.627	.056
TOTALPROC	Obese	49	1.82	2.270	.324
	At RIsk	126	1.29	1.868	.166
TOTALCOMP	Obese	49	.39	.671	.096
	At RIsk	126	.23	.595	.053
COMORBITIIES	Obese	49	.22	.511	.073
	At RIsk	126	.36	.600	.053

Independent Samples Test

	Levene's Test for Equality of Variances	t-test for Equality of Means

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
SystolicBP	Equal variances assumed	.303	.583	.210	173	.834	.772	3.684	-6.500	8.044
	Equal variances not assumed			.235	113.729	.814	.772	3.280	-5.726	7.269
Glucose	Equal variances assumed	.114	.736	.298	122	.767	2.788	9.369	-15.759	21.335
	Equal variances not assumed			.330	95.922	.742	2.788	8.448	-13.982	19.557
LOS	Equal variances assumed	.075	.785	1.032	173	.303	.948	.918	-.864	2.760
	Equal variances not assumed			1.054	91.346	.295	.948	.899	-.839	2.734
ICULOS	Equal variances assumed	.051	.821	.517	173	.606	.379	.733	-1.068	1.826
	Equal variances not assumed			.550	100.205	.584	.379	.688	-.987	1.745
TOTALLAB	Equal variances assumed	2.215	.138	-.410	173	.683	-1.960	4.786	-11.407	7.487
	Equal variances not assumed			-.542	164.643	.589	-1.960	3.618	-9.104	5.183
TOTALRAD	Equal variances assumed	3.251	.073	-.710	173	.478	-.575	.809	-2.172	1.022
	Equal variances not assumed			-.908	154.723	.365	-.575	.633	-1.826	.676
TOTALX	Equal variances assumed	2.832	.094	-1.010	173	.314	-.683	.676	-2.017	.652
	Equal variances not assumed			-1.271	149.755	.206	-.683	.537	-1.744	.379
TOTALCT	Equal variances assumed	.207	.650	.977	173	.330	.209	.214	-.213	.630
	Equal variances not assumed			1.004	92.678	.318	.209	.208	-.204	.621
TOTALFLUORO	Equal variances assumed	1.923	.167	-.840	173	.402	-.085	.101	-.285	.115

	Equal variances not assumed			-.906	103.220	.367	-.085	.094	-.271	.101
TOTALPROC	Equal variances assumed	3.384	.068	1.562	173	.120	.523	.335	-.138	1.183
	Equal variances not assumed			1.434	74.619	.156	.523	.364	-.203	1.249
TOTALCOMP	Equal variances assumed	5.295	.023	1.516	173	.131	.158	.104	-.048	.363
	Equal variances not assumed			1.438	79.027	.154	.158	.110	-.061	.376
COMORBITIIES	Equal variances assumed	5.477	.020	-1.367	173	.173	-.133	.097	-.324	.059
	Equal variances not assumed			-1.467	101.940	.146	-.133	.090	-.312	.047

T-Tests Obese vs. Normal

Group Statistics

	BMIcategory	N	Mean	Std. Deviation	Std. Error Mean
TOTALLAB	Obese	49	11.43	15.578	2.225
	Normal	79	14.10	32.272	3.631
SystolicBP	Obese	49	126.53	17.794	2.542
	Normal	79	125.18	17.305	1.947
Glucose	Obese	39	137.56	39.231	6.282
	Normal	55	140.22	61.106	8.240
LOS	Obese	49	6.12	5.270	.753
	Normal	79	5.48	5.944	.669
ICULOS	Obese	49	2.06	3.913	.559
	Normal	79	1.94	4.839	.544
TOTALRAD	Obese	49	4.16	2.911	.416
	Normal	79	5.11	5.897	.663
TOTALX	Obese	49	2.57	2.533	.362
	Normal	79	3.54	4.927	.554
TOTALCT	Obese	49	1.22	1.212	.173
	Normal	79	1.15	1.397	.157
TOTALFLUORO	Obese	49	.37	.528	.075
	Normal	79	.39	.608	.068

TOTALPROC	Obese	49	1.82	2.270	.324
	Normal	79	1.30	1.883	.212
TOTALCOMP	Obese	49	.39	.671	.096
	Normal	79	.23	.554	.062
COMORBITIIES	Obese	49	.22	.511	.073
	Normal	79	.41	.610	.069

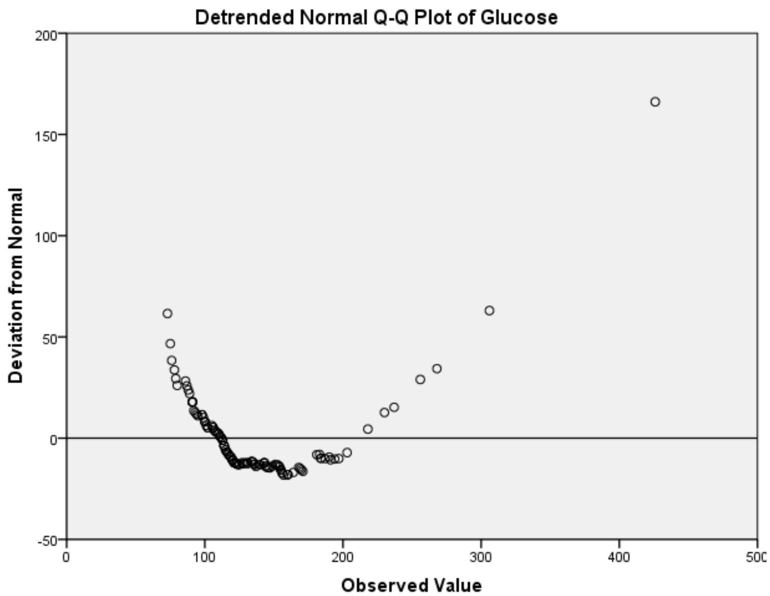
Independent Samples Test

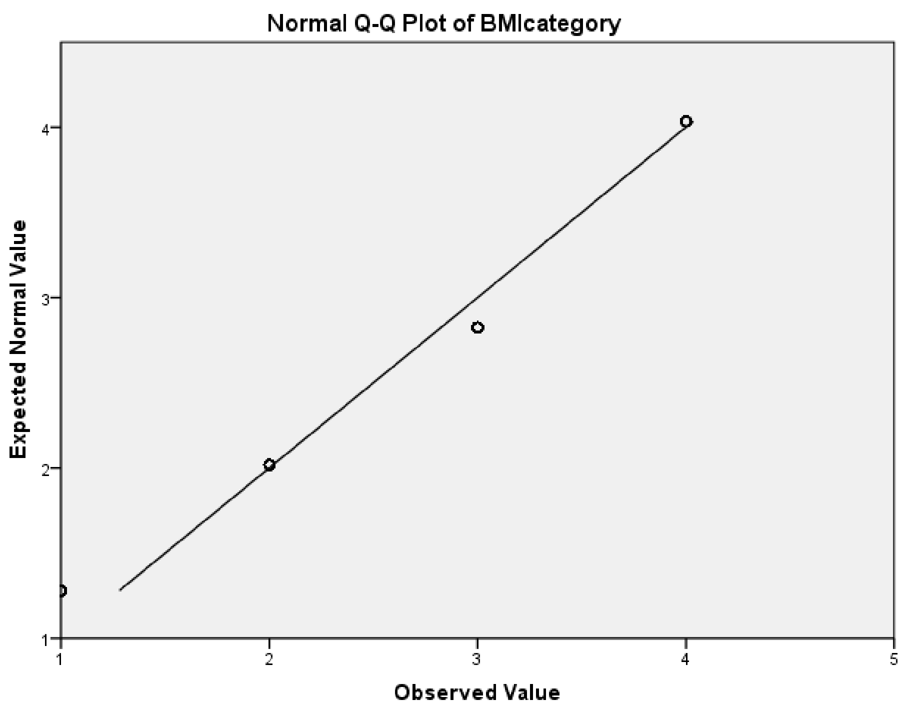
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TOTALLAB	Equal variances assumed	3.280	.072	-.541	126	.589	-2.673	4.937	-12.443	7.098
	Equal variances not assumed			-.628	120.075	.531	-2.673	4.259	-11.104	5.759
SystolicBP	Equal variances assumed	.500	.481	.425	126	.671	1.353	3.181	-4.942	7.648
	Equal variances not assumed			.423	99.716	.673	1.353	3.202	-4.999	7.706
Glucose	Equal variances assumed	1.457	.231	-.238	92	.812	-2.654	11.131	-24.762	19.453
	Equal variances not assumed			-.256	91.223	.798	-2.654	10.361	-23.234	17.926
LOS	Equal variances assumed	.069	.794	.619	126	.537	.641	1.036	-1.409	2.691
	Equal variances not assumed			.637	111.070	.525	.641	1.007	-1.354	2.637
ICULOS	Equal variances assumed	.109	.742	.152	126	.880	.125	.820	-1.498	1.747
	Equal variances not assumed			.160	117.310	.873	.125	.780	-1.421	1.670
TOTALRAD	Equal variances assumed	4.535	.035	-1.051	126	.295	-.951	.905	-2.741	.840
	Equal variances not assumed			-1.214	120.983	.227	-.951	.783	-2.501	.599

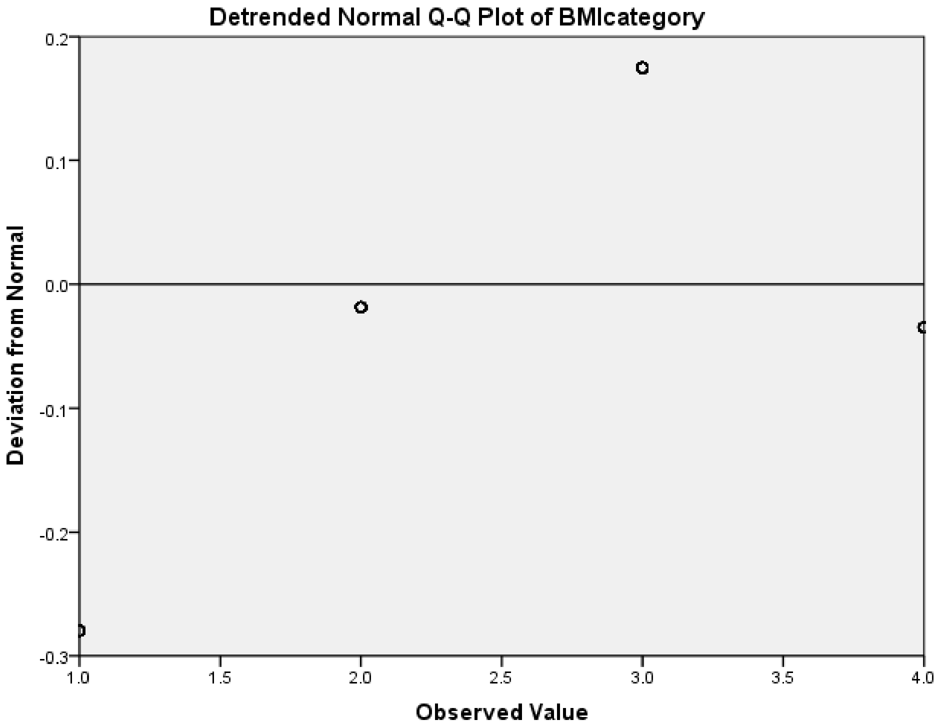
TOTALX	Equal variances assumed	4.122	.044	-1.280	126	.203	-.973	.760	-2.477	.531
	Equal variances not assumed			-1.470	122.495	.144	-.973	.662	-2.283	.338
TOTALCT	Equal variances assumed	.019	.889	.300	126	.764	.073	.242	-.406	.551
	Equal variances not assumed			.310	112.614	.757	.073	.234	-.391	.536
TOTALFLUORO	Equal variances assumed	.523	.471	-.238	126	.812	-.025	.105	-.233	.183
	Equal variances not assumed			-.246	112.552	.806	-.025	.102	-.227	.177
TOTALPROC	Equal variances assumed	2.634	.107	1.382	126	.169	.513	.371	-.221	1.246
	Equal variances not assumed			1.323	87.883	.189	.513	.387	-.257	1.282
TOTALCOMP	Equal variances assumed	6.004	.016	1.463	126	.146	.160	.109	-.056	.376
	Equal variances not assumed			1.398	87.447	.166	.160	.114	-.067	.387
COMORBITIIES	Equal variances assumed	8.459	.004	-1.729	126	.086	-.181	.104	-.387	.026
	Equal variances not assumed			-1.802	115.068	.074	-.181	.100	-.379	.018

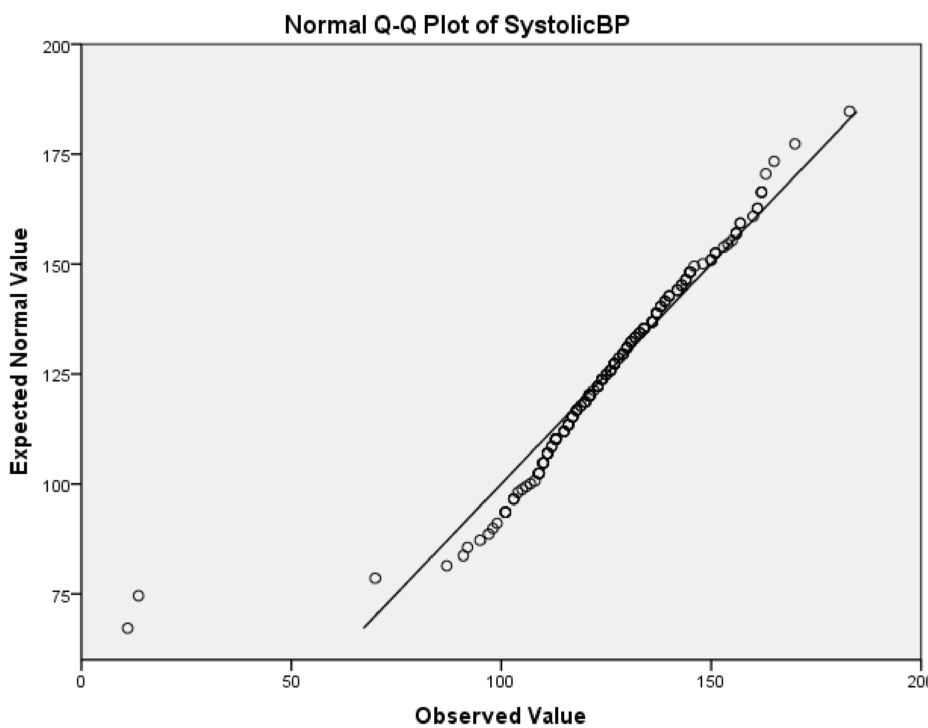
Appendix C.

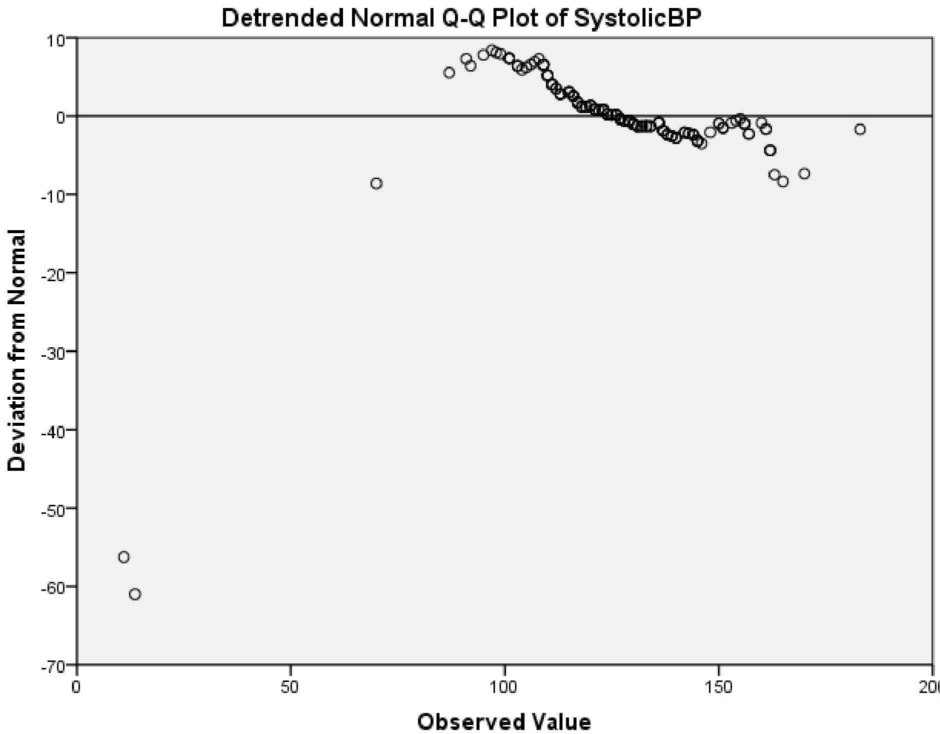
Q-Q Plots (Check for Normality of Data)

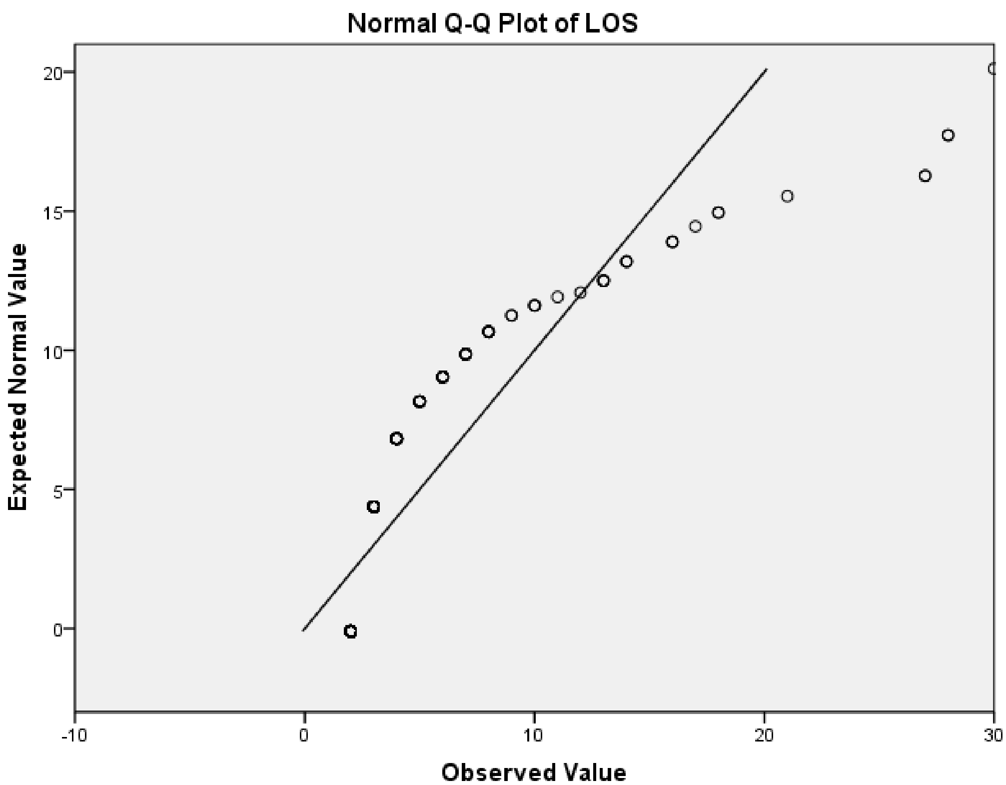


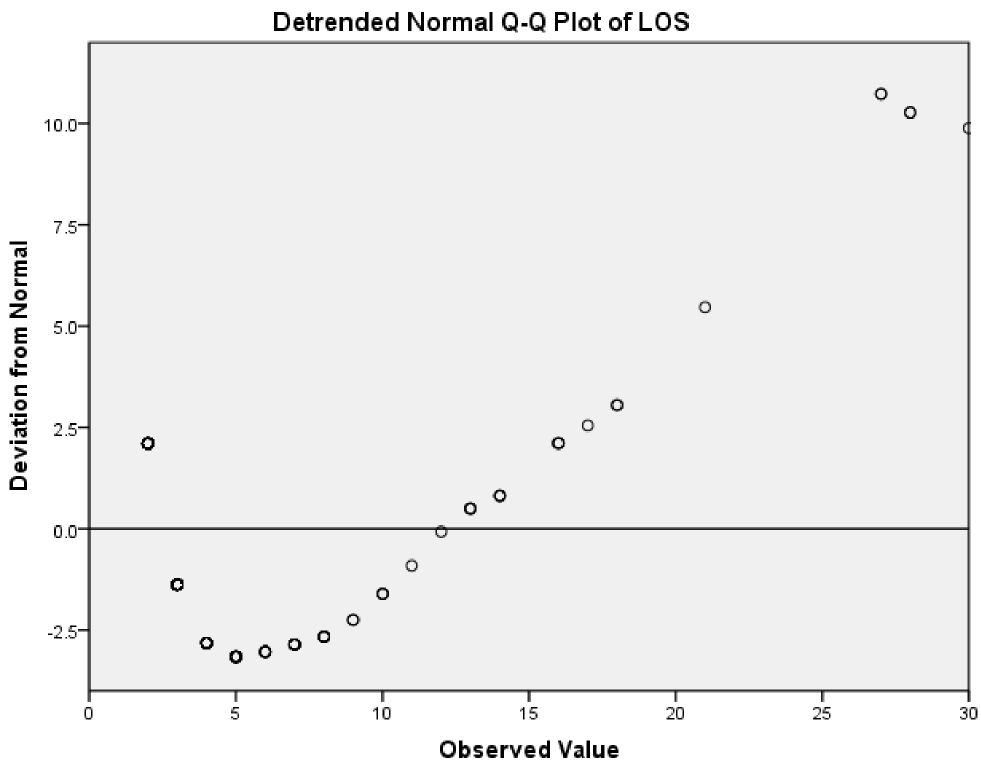


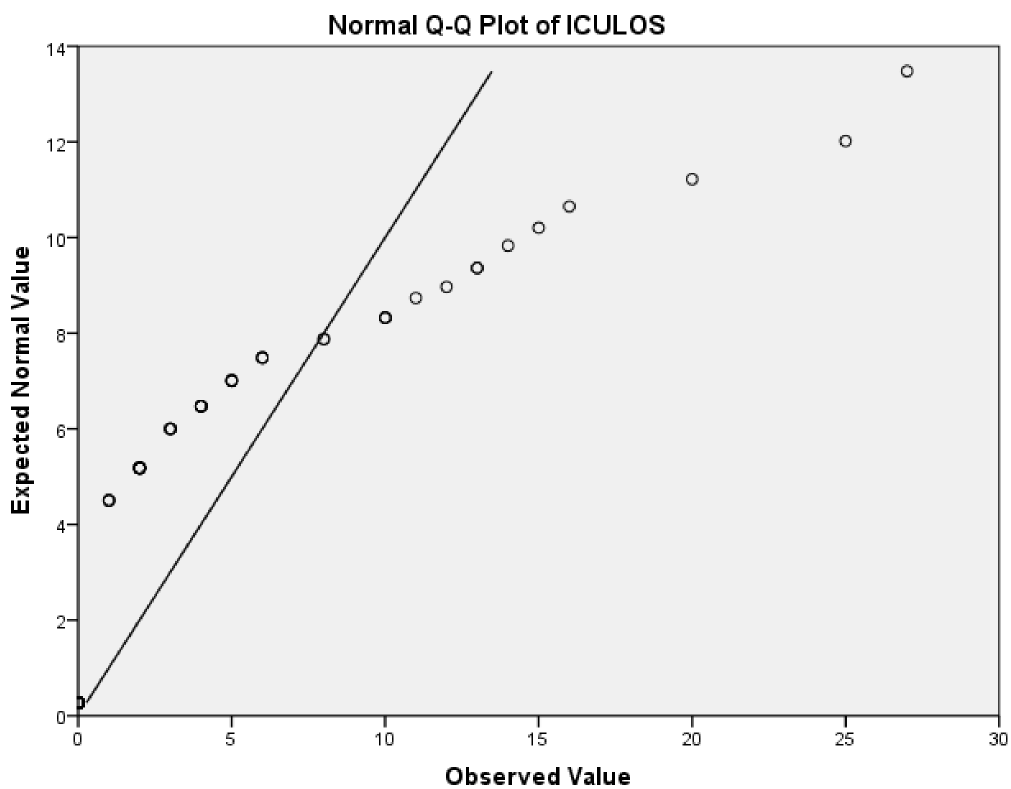

Detrended Normal Q-Q Plot of BMIcategory
Deviation from Normal
0.2
0.1
0.0
-0.1
-0.2
-0.3
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Observed Value

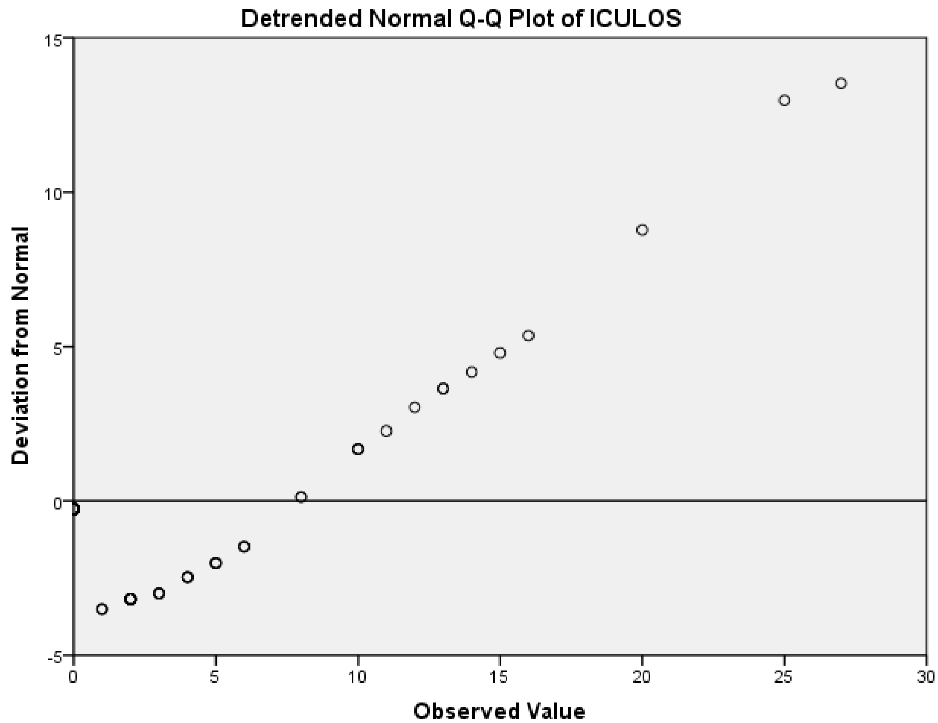

Normal Q-Q Plot of SystolicBP
Expected Normal Value
200
175
150
125
100
75
0
50
100
150
200
Observed Value


Detrended Normal Q-Q Plot of SystolicBP
Deviation from Normal
10
0
-10
-20
-30
-40
-50
-60
-70
0
50
100
150
200
Observed Value

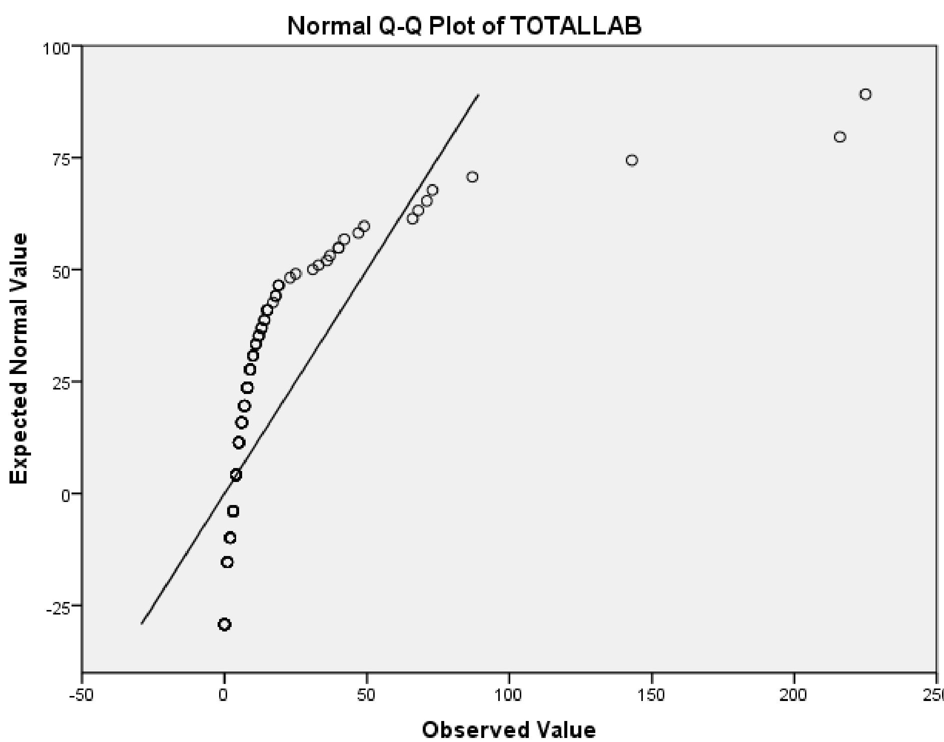

Normal Q-Q Plot of LOS
Expected Normal Value
20
15
10
5
0
-10
0
10
20
30
Observed Value


Detrended Normal Q-Q Plot of LOS
Deviation from Normal
10.0
7.5
5.0
2.5
0.0
-2.5
0
5
10
15
20
25
30
Observed Value

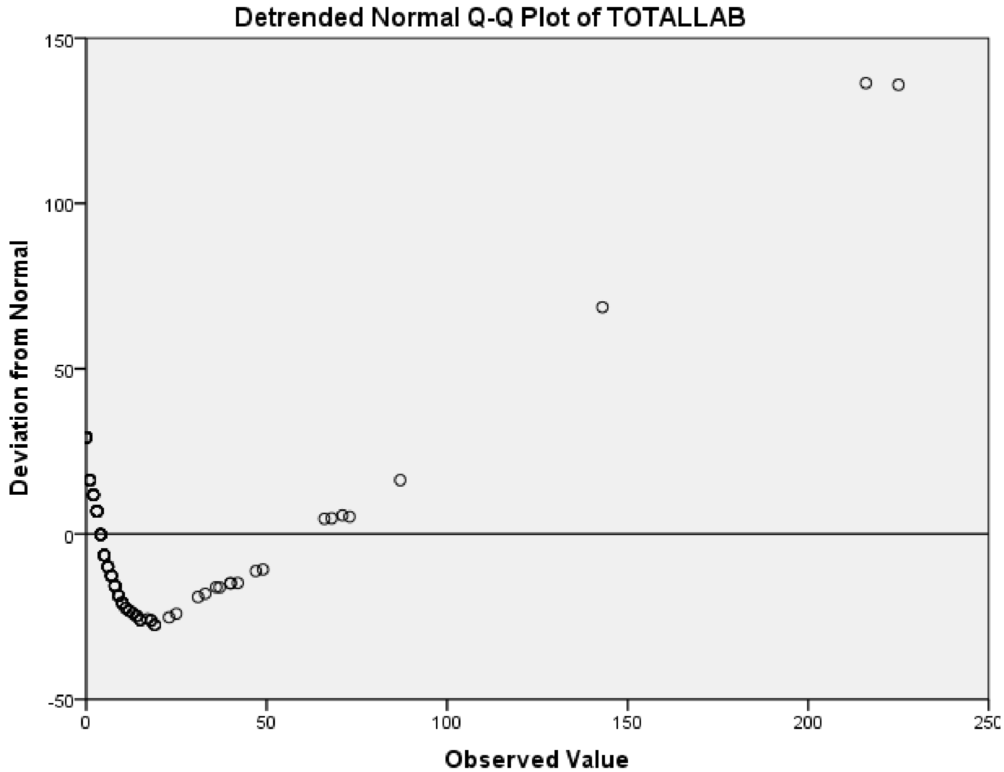

Normal Q-Q Plot of ICULOS
Expected Normal Value
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Observed Value

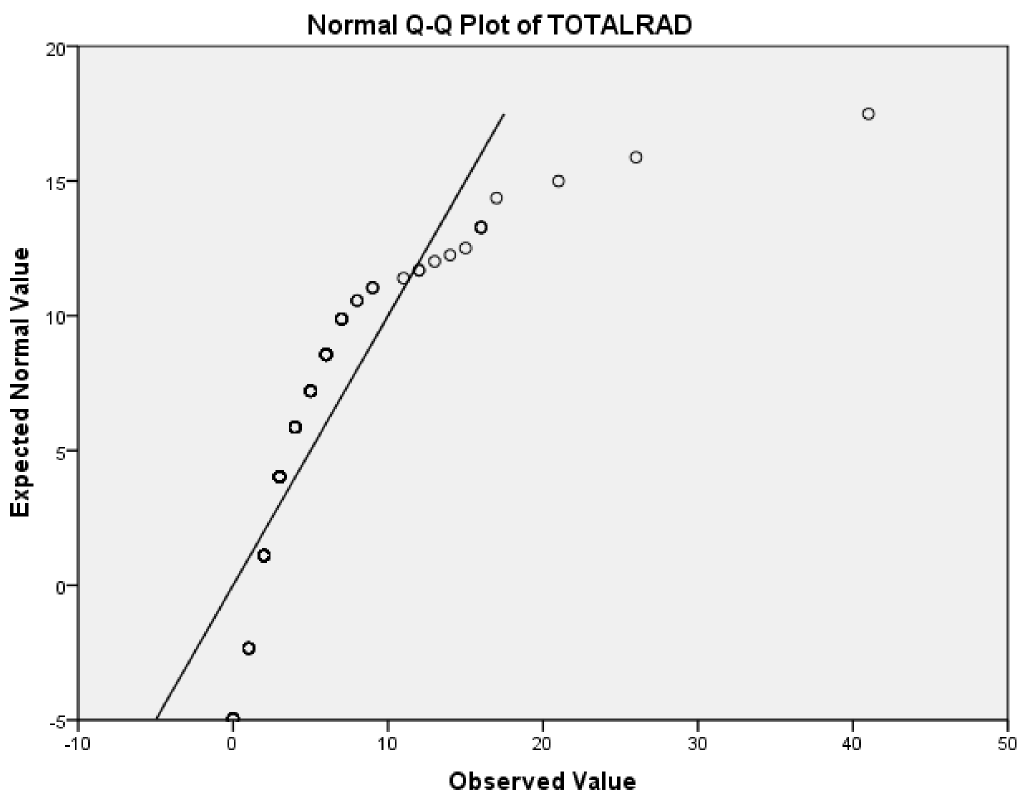


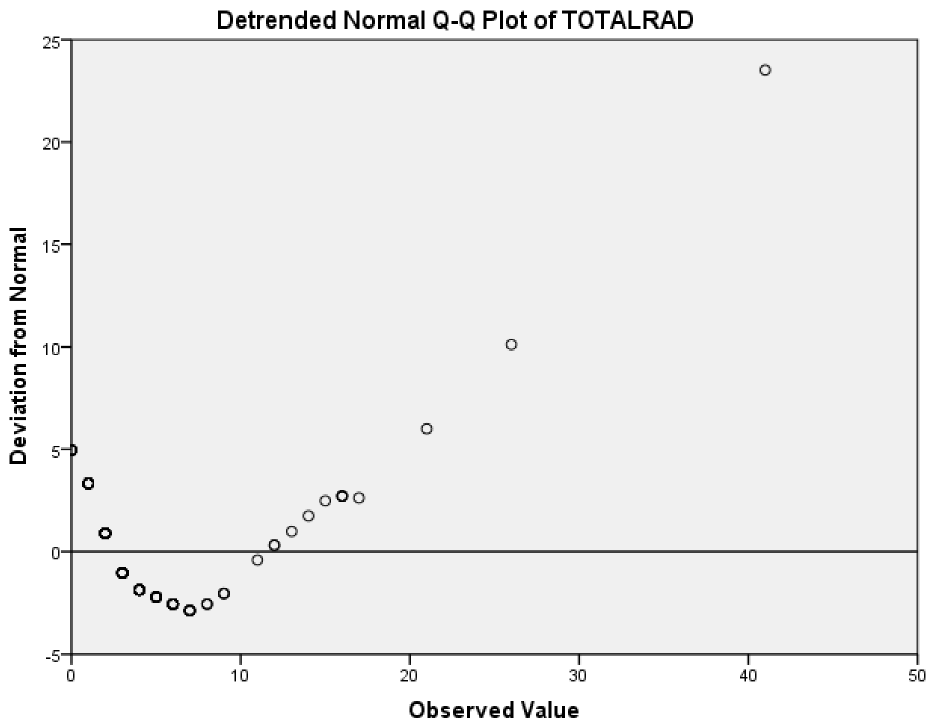
Detrended Normal Q-Q Plot of ICULOS
Deviation from Normal
Observed Value
15
10
5
0
-5
0
5
10
15
20
25
30

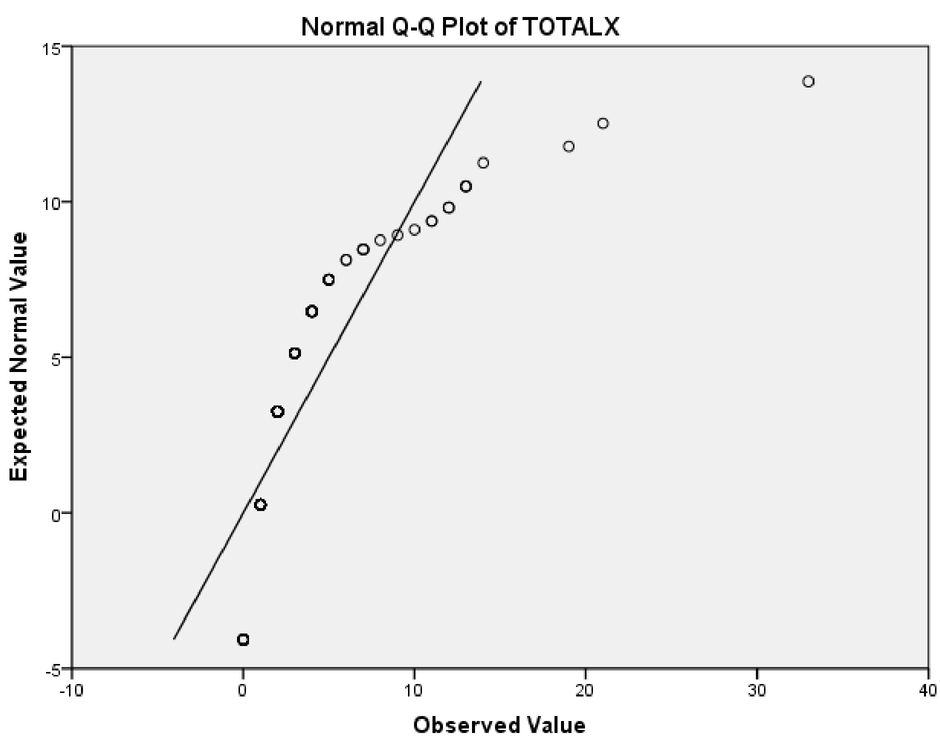


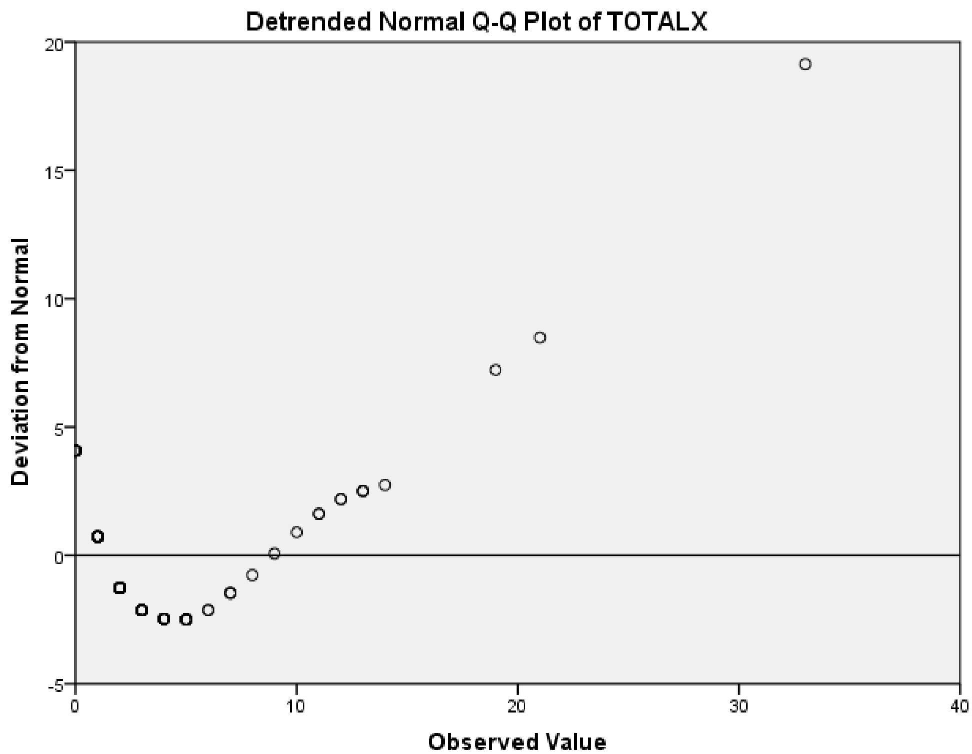
Normal Q-Q Plot of TOTALLAB
Expected Normal Value
Observed Value
100
75
50
25
0
-25
-50
0
50
100
150
200
250

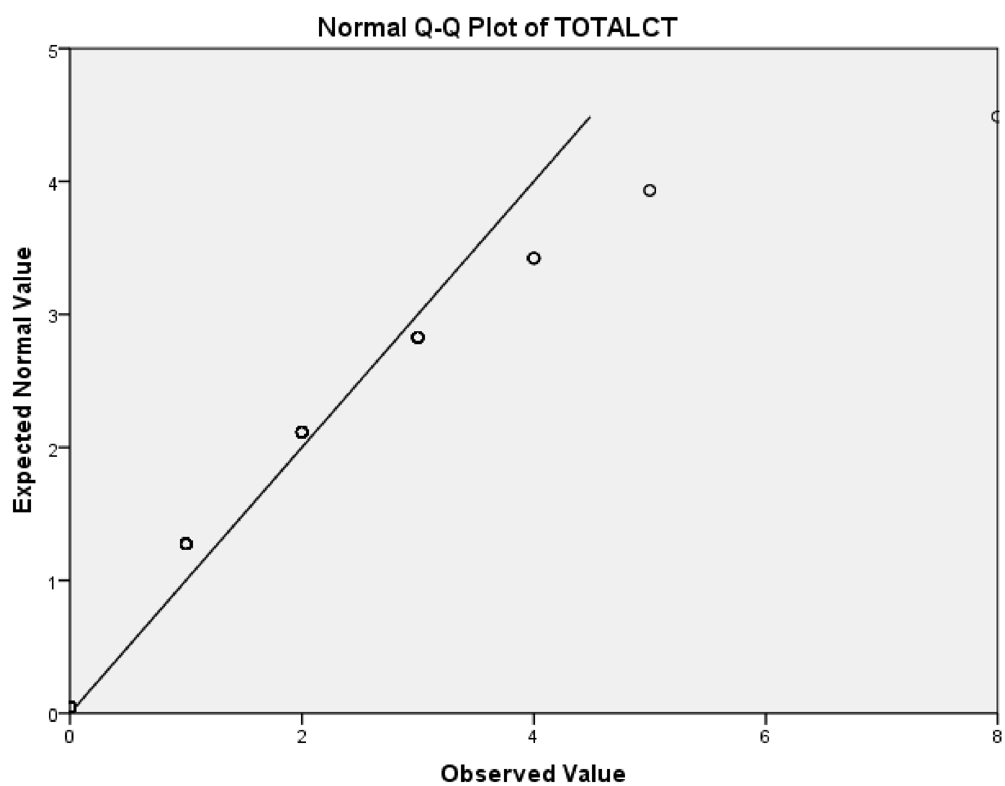

Detrended Normal Q-Q Plot of TOTALLAB
Deviation from Normal
Observed Value
150
100
50
0
-50
0
50
100
150
200
250

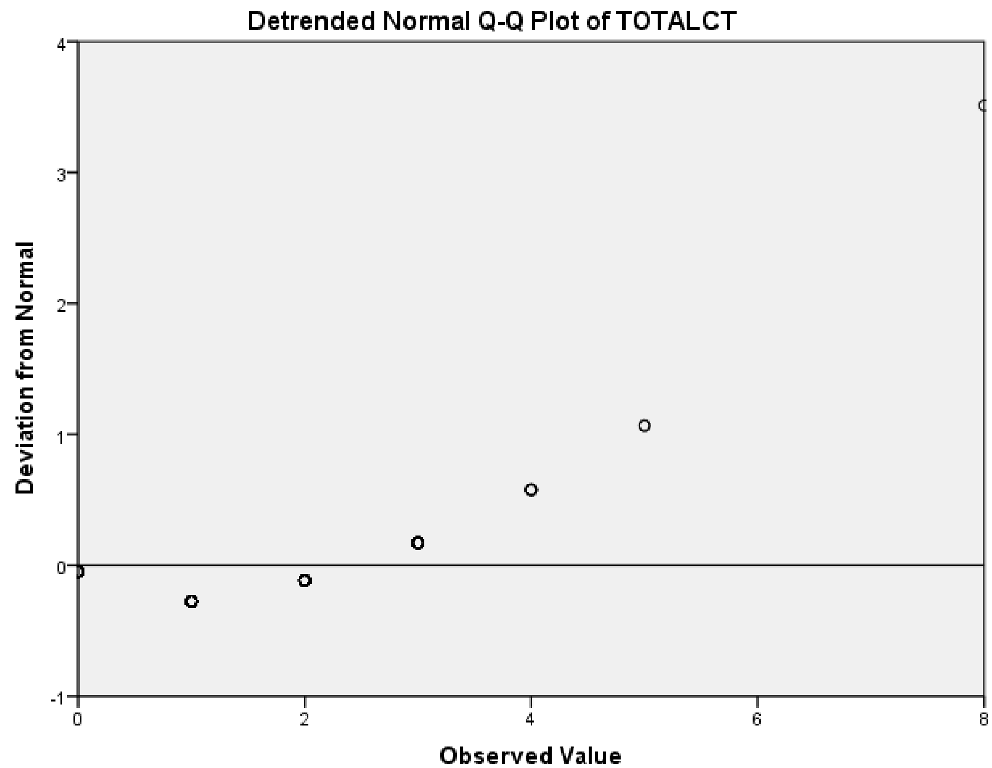

Normal Q-Q Plot of TOTALRAD
Expected Normal Value
Observed Value
20
15
10
5
0
-5
-10
0
10
20
30
40
50

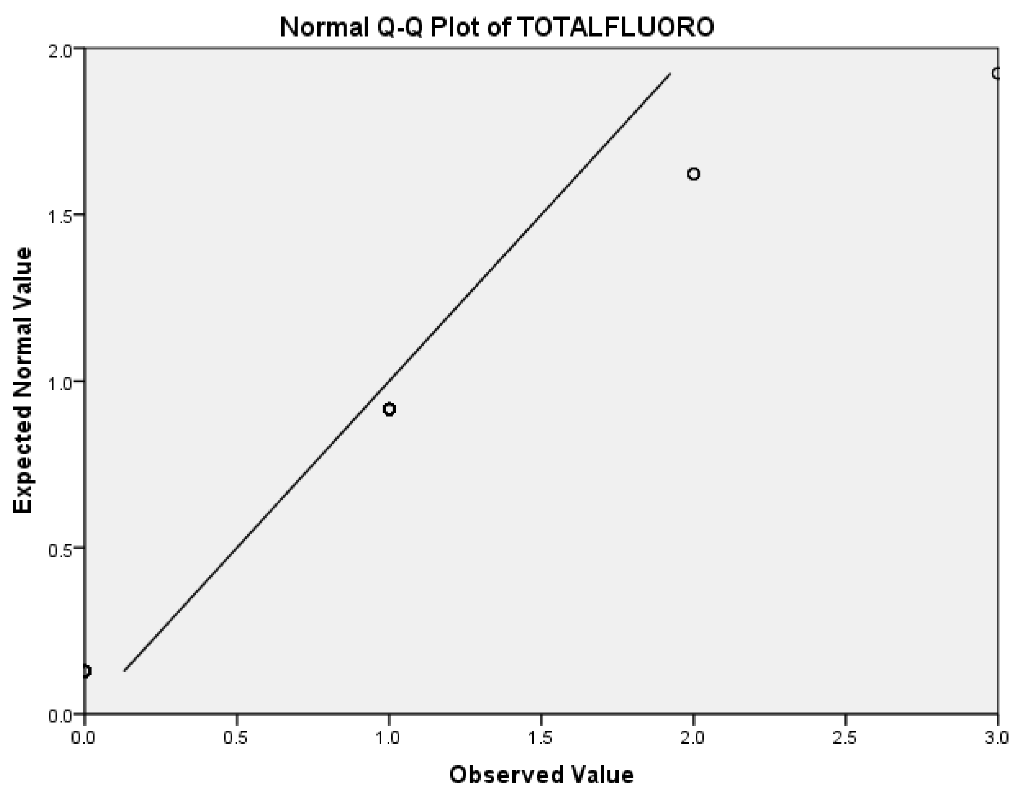

Detrended Normal Q-Q Plot of TOTALRAD
Deviation from Normal
Observed Value
25
20
15
10
5
0
-5
0
10
20
30
40
50

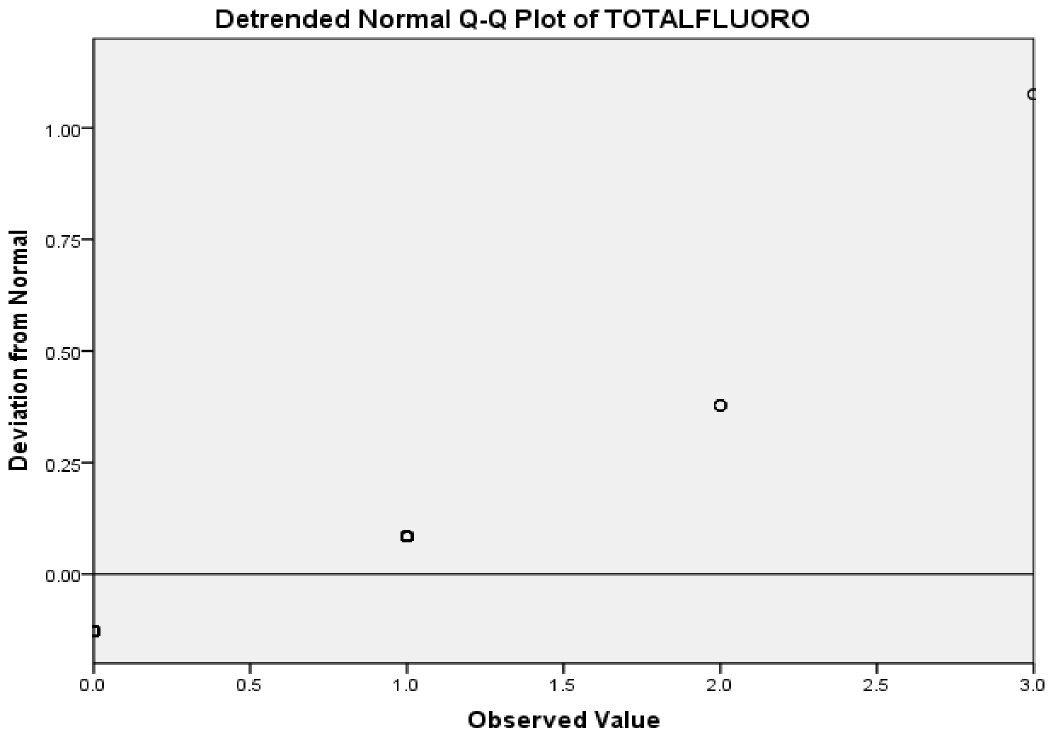

Normal Q-Q Plot of TOTALX
Expected Normal Value
Observed Value
15
10
5
0
-5
-10
0
10
20
30
40

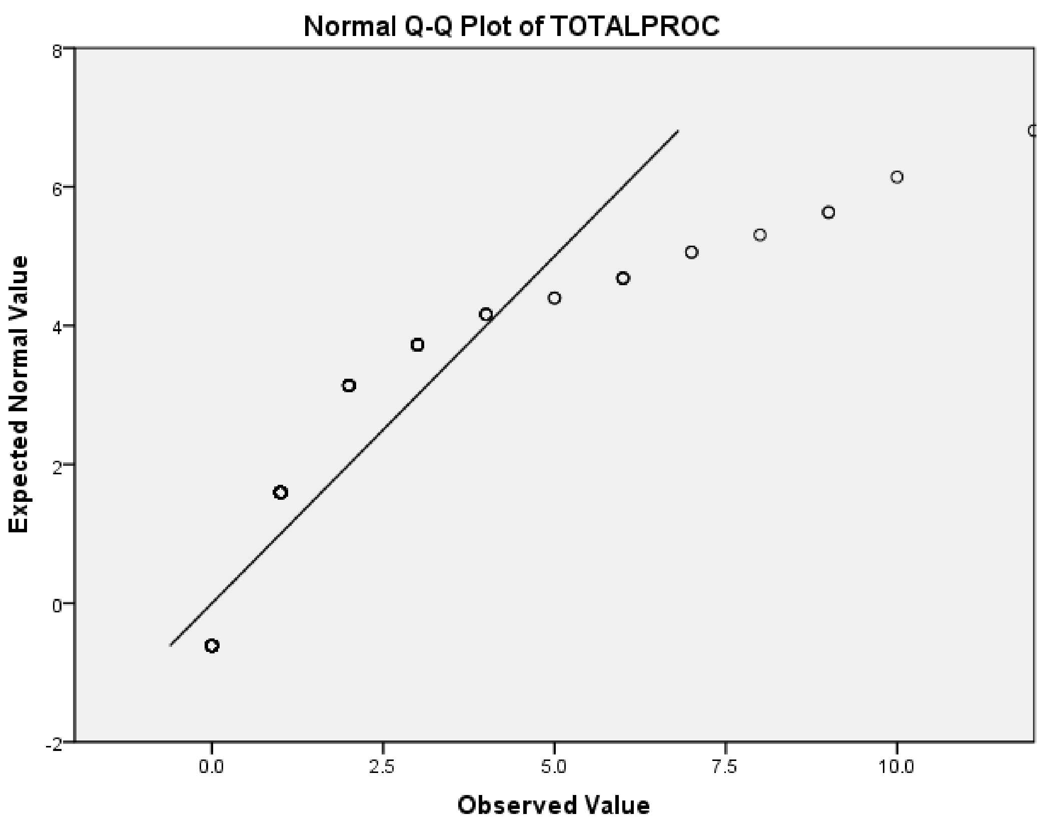

Detrended Normal Q-Q Plot of TOTALX
Deviation from Normal
Observed Value
20
15
10
5
0
-5
0
10
20
30
40

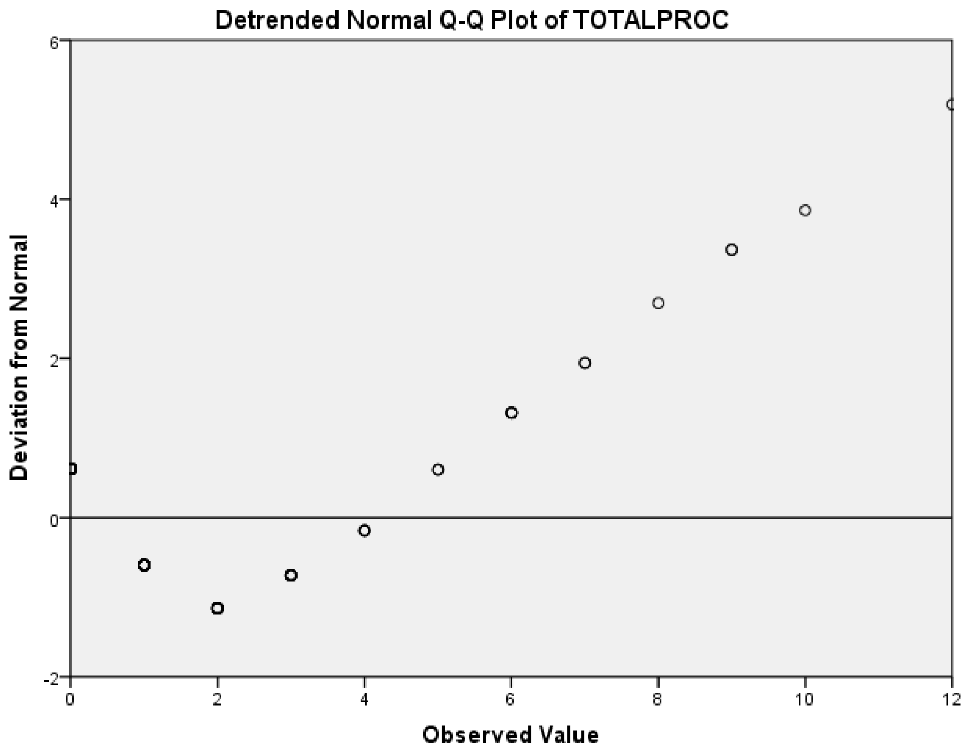

Normal Q-Q Plot of TOTALCT
Expected Normal Value
Observed Value
5
4
3
2
1
0
0
2
4
6
8

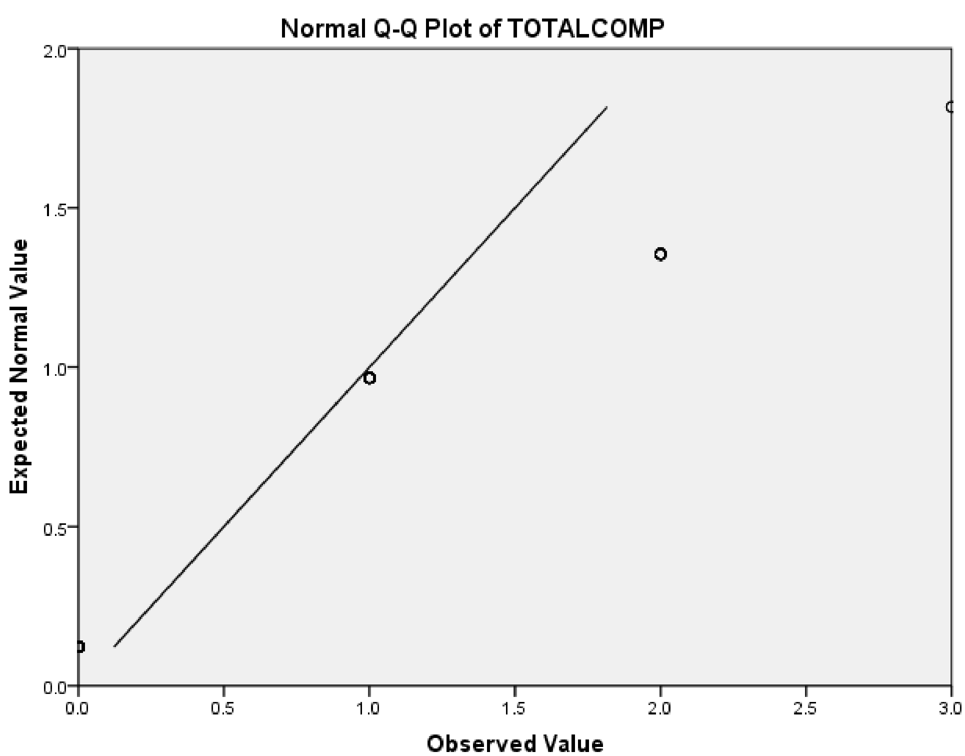

Detrended Normal Q-Q Plot of TOTALCT
Deviation from Normal
Observed Value
4
3
2
1
0
-1
0
2
4
6
8

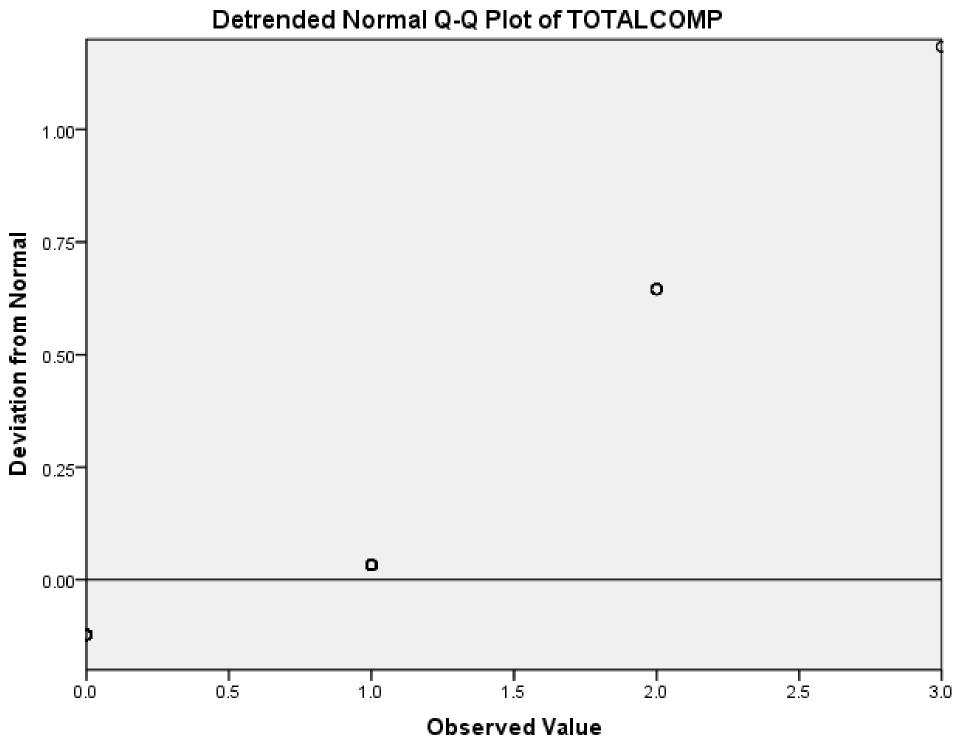

Normal Q-Q Plot of TOTALFLUORO
Expected Normal Value
Observed Value
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0

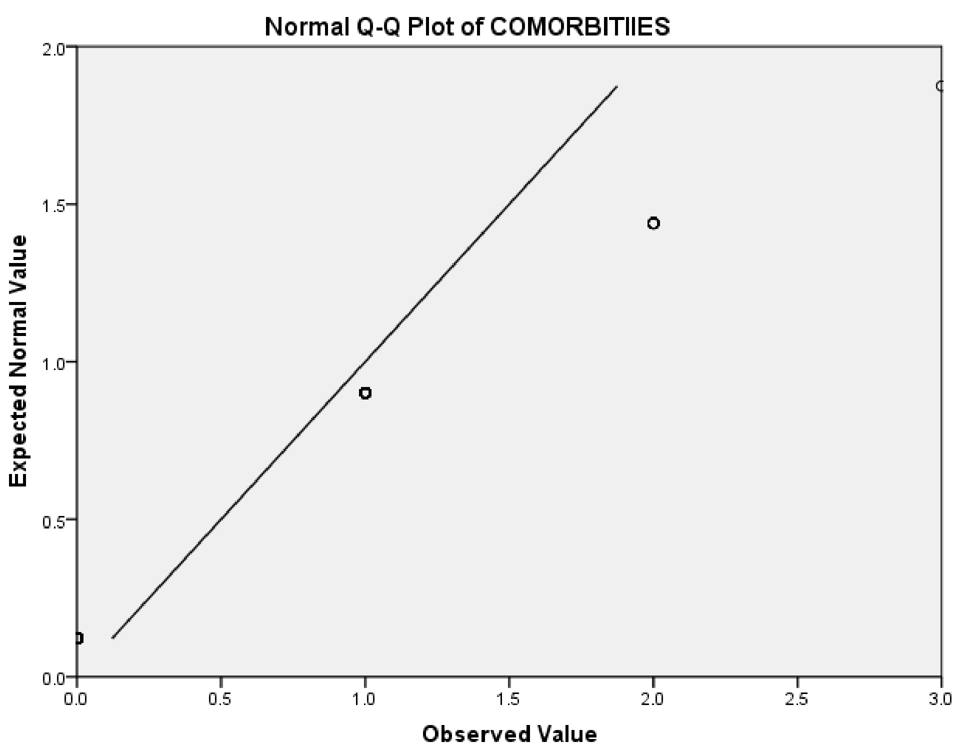

Detrended Normal Q-Q Plot of TOTALFLUORO
Deviation from Normal
1.00
0.75
0.50
0.25
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Observed Value

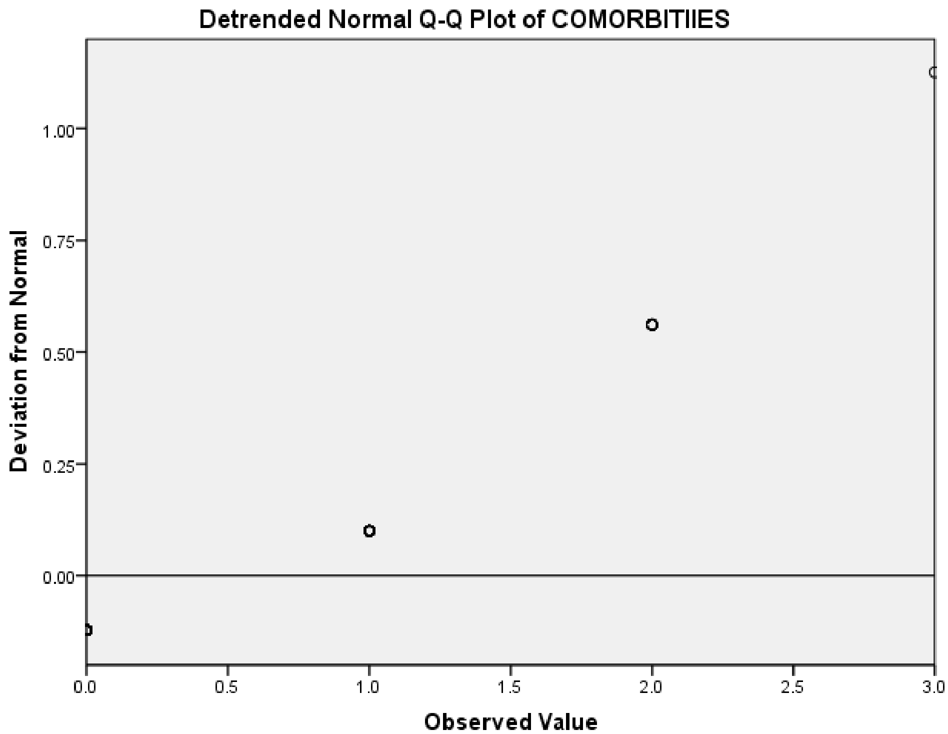

Normal Q-Q Plot of TOTALPROC
Expected Normal Value
8
6
4
2
0
-2
0.0
2.5
5.0
7.5
10.0
Observed Value


Detrended Normal Q-Q Plot of TOTALPROC
Deviation from Normal
Observed Value
6
4
2
0
-2
0
2
4
6
8
10
12


Normal Q-Q Plot of TOTALCOMP
Expected Normal Value
Observed Value
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0


Detrended Normal Q-Q Plot of TOTALCOMP
Deviation from Normal
1.00
0.75
0.50
0.25
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Observed Value


Normal Q-Q Plot of COMORBITIIES
Expected Normal Value
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Observed Value


Detrended Normal Q-Q Plot of COMORBITIIES
Deviation from Normal
1.00
0.75
0.50
0.25
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Observed Value