Influence of Body Parts Measurements with Low and High Risk of Obesity Using Male Human Body Fat Percentage

Mir Ghulam Hyder Talpur
Department of Mathematics and Statistics, Institute of Business Management, Karachi
hyder.talpur@iobm.edu.pk
0301-3409885
Muhammad Shahbaz Khan
Department of Mathematics and Statistics, Karachi Institute of Economics & Technology, Karachi
shahbazk@kiet.edu.pk
03222515941

Abstract
There are many indicators of the body that inform about the health of a person. In these indicators, Body-Fat-Percentage (BFP) is an important factor that classifies the low and high risk of obesity. Obesity is one of the silent killer illnesses that make people lazy and unable to perform their daily routine work smoothly. BFP factor distinguishes the status of normal and obese persons. In this study, we identified that all body measurements including density and age have significant differences between Low and High risk of obesity. Human body measurement factors are density (den), age, weight (w), height (h), neck (n), chest (c), abdomen (abd), hip, thigh (t), knee (K), ankle (A), biceps (b), forearm (f), and wrist (w) body measures. Screening of data was performed by removing outliers using Box-Whisker plots from all factors. Box-Whisker plot constructed through R software using package ggplot2. Comparison of body parts measurements based on Low-Risk and High-Risk using two-sample t-tests done through SPSS software.
Keywords: Body fat percentage, density, two-sample t-test, heatmap, obesity

Introduction

In medical science, obesity term is considered an increasingly chronic disease that leads to life-threatening problems such as heart attack or diabetes problems. A peculiar or high body fat buildup impairs health issues (Ellulu, et.al, 2017).

Obesity is the unhealthy status of a person whose body is at high risk of different diseases. It upsets the normal function of the heart, liver, kidneys, joints, and reproductive system (Fatima, et.al, 2023). It starts with a range of noncontagious diseases (NCDs), for example, Type-2 diabetes, heart and blood vessel disorders, and hypersensitivity. and increased chances of stroke, different types of cancer, as well as psychological disorders issues (Lin. C. L. et.al, 2021).

A person with obesity is three times more chance to be hospitalized for COVID-19 [WHO]. The global incidence of obesity has increased from 7% in 1980 to 13% in 2015, an increase of almost 85%, reaching epidemic levels (Petrakis, D., et.al, 2020). In medical science, BFP is a measurement that defines the status of a person as either obese or normal. BFP calculates how much of a person's body consists of fat (Chiplonkar et al., 2017). It helps doctors to recognize healthy and obese people more

effectively. Physical fitness and aerophilic exercises have significantly correlated with BFP (Shoebuddin & Daimi, 2019).

Non-alcoholic fatty liver disease (NAFLD) is rising internationally as the number of obesity cases increases. Among those cases who have NAFLD, a strong relationship between Low Muscle Mass (LMM) (e.g. sarcopenia) and high risk of NAFLD and fibrosis were observed with also some studies of child obesity (Y.M. Choi et.al, 2023). Obesity is the growth of peculiar or unnecessary body fat (BF) that may cause an unhealthy status. Controlling obesity decreases the chance of cardiovascular and stroke diseases (Akil, L., 2011).

A high correlation is observed between Type 2 diabetes mellitus (T2DM) with obesity, which can also be determined through Body Mass Index (BMI). It is also a fact that BMI cannot differentiate muscle mass and fat mass. Research shows that BMI is not a fat distribution in the body, which is a basic limitation. Studies showed that T2DM has a higher correlation between BFP and skeletal muscle than BMI (Bays, H. E., 2007). This study also mitigates the risks of global obese people (Safaei et al., 2021).

This study described the high-risk obesity in Karachi due to overweight and obesity dominance. A high rate of obesity is found in males as compared to females in Karachi. Some factors identified in this study such an unmoving lifestyle, unhealthy diet, and lack of physical workout. Preemptive actions regarding overweight and obesity may be suggested for people (Ibrahim et al., 2021).

A researcher found differences in body composition between playing standard and age in males who played rugby games. Spotlight training and nutritionary schemes that minimize fat mass growth (Geeson-Brown et al., 2020). In America, a team distinguished adults according to cardiovascular fitness (CVf), BFP, and BMI in the National Health and Nutrition Examination Survey (NHANES) data (Bunn et al., 2019). Short-term and long-term diseases like hypertension, some types of cancer, cardiovascular, Alzheimer's, asthma, osteoarthritis, metabolic syndrome, musculoskeletal disorders, gallbladder disease, obstructive sleep apnea, hypercholesterolemia, metabolic syndrome, and type 2diabetes caused by obesity (Mohajan & Mohajan, 2023)

Thant Zin and his team members have determined the mean BMI and average BFP with body fat assessments for obesity awareness among people. They suggested that including BMI, BFP other factors will be examined to monitor obesity such as age, sex, race, nutrition, and body parts measurements which change over time (Zin et al., 2014).

According to Sema Can examine the impacts of physical activity which control BMI, and body fat. In this research, shared workouts in both genders presented a positive impact on BMI and BFP (Can et al., 2019). Kathryn E. Bradbury and her team identified that those people who are continuously involved in physical activities have a low BFP after observing BMI importance (Bradbury et al., 2017).

Materials and Methods

In this research study, the body fat percentage variable was converted into two groups. These two groups are designed to define the high and the low risk of obesity. A body fat percentage when more than 25 percent then it is considered to be a person at high risk of obesity. Similarly, less than 25 percent of the Body fat percentage is considered to be a person who is at a low risk of obesity. After making two groups, we now compare low-risk and high-risk obese person body measurements using two sample "t" tests. Data screening is necessary for removing the outliers therefore R package "ggplot2" (Wickham H., (2016) was used to construct the Box-Whisker plot. Two sample t-tests will be performed through SPSS (IBM Corp. 2011) to compare the body parts measurements among low and high risk of obesity.

A. Data set:
Secondary data is used to analyze the low-risk and high-risk obesity (Body Fat Percentage Dataset, 2023). This sample data consists of 252 men's information about body parts measurements including density, BFP, and age.

B. Definitions:
Some important definitions related to the study are as follows:
   (i)   Obesity: Excess food and non-physical activity develop a chronic disease called Obesity. A series of extra food consumption forms excess calories which lead to cause of obesity (Mohajan & Mohajan, 2023).
   (ii)   Body Fat Percentage: The quantity of fat mass observed on the body conveyed as the total mass of fat (TMoF) divided by total body mass (TBM), and multiplied by 100, i.e.,

$$BFP = \frac{Total\ mass\ of\ fat}{Total\ body\ mas}x100$$

   Body fat percentage calculators can be used to measure the individual person's body fat percentage (Body Fat Calculator, 2023).
   (iii)   Density: Density is also known as Hydrostatic weighing. According to it, the body's density is calculated by getting the change in body weight in air and underwater based on Archimedes Rule.
   (iv)   Body Measurements: Body measurements such as neck, chest, abdomen, hip, and thigh. Knee and others are very important to compare between low-risk and high-risk obese persons.

Table 1 shows the body measurements with their units.
Table 1: *Body measurements with their units:*

| Measurements	Units	Measurements	Units
Weight	lbs.	Thigh circumference	cm
Height	cm	Knee circumference	cm
Neck circumference	cm	Ankle circumference	cm
Chest circumference	cm	Biceps (extended) circumference	cm
Abdomen 2 circumference	cm	Forearm circumference	cm
Hip circumference	cm	Wrist circumference	cm

Results& Discussion
Statistical results help us to analyze the low and high risk of obesity in men. First, remove the outlier's values from the data. Out of 252, 232 values are left for analysis. Box and Whisker plots were used to find outliers from each factor. Secondly, determine basic statistics for checking the basic assumptions about the normality of the variables to apply the statistical method "Two sample t-test" presented in Table 2. Thirdly, a "two sample t-test" was applied to determine the difference between the two groups' low and high risk of obesity persons using different factors. Results are presented in Table 3. The following flow diagram shows the steps:

(i)   Applied Box-Whisker plot to remove outlier's values from the sample data.

(ii)   Compute the basic statistics to check the normality assumption for the two-sample t-test method.

(iii)   Applied two-sample t-test, over every factor with respect to groups with low and high risk of obesity.

Step 1: The Box-Whisker Plot after removing the extreme outliers from the data presented in Fig.1.

Figure 1: Box-Whisker Plot
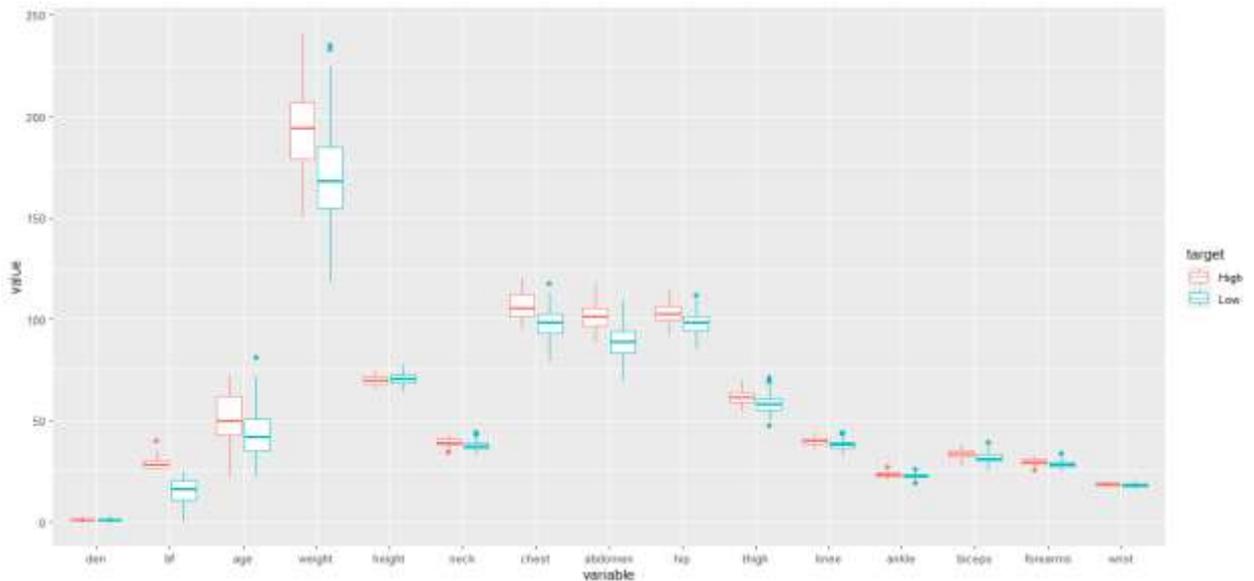
Step 2: Compute the basic statistics of all variables to check the normality assumption for the two-sample t-test method presented in Table 2.

Table 2:   Basic statistics for all variables:

					Statistics			
Variables	Average	Variance	Std. Deviation	Minimum	Maximum	Interquartile Range	Skewness	Kurtosis
Density	1.0569	0.0003	0.0179	1.0101	1.1089	0.0278	0.1633	-0.5173
BodyFat %	18.5459	61.5714	7.8467	0.0000	40.1000	12.3000	-0.0436	-0.6557
Age	44.8498	159.0937	12.6132	22.0000	81.0000	19.0000	0.2421	-0.4566
Weight	176.3135	605.8511	24.6140	118.5000	241.2500	35.8750	0.2484	-0.3811
Height	178.55	42.90	6.54	162.56	197.48	34.92	0.1200	-0.4010
Neck	37.8635	4.4880	2.1185	32.8000	43.9000	2.8500	0.1068	-0.3780
Chest	100.1554	56.0127	7.4842	79.3000	119.9000	10.6000	0.3764	0.0862
Abdomen	91.5790	85.7634	9.2609	69.4000	118.0000	14.2500	0.1781	-0.3696
Hip	99.2322	33.6927	5.8045	85.0000	114.3000	7.2000	0.2161	-0.0134
Thigh	59.0202	20.2887	4.5043	47.2000	71.2000	5.8500	0.1253	-0.1602
Knee	38.4361	4.6770	2.1626	33.4000	44.2000	2.8500	0.1592	-0.2051
Ankle	22.9296	1.6283	1.2760	19.1000	27.0000	1.8000	0.2937	0.0175
Biceps	32.1176	7.8794	2.8070	24.8000	39.1000	3.8500	0.1278	-0.3745
Forearm	28.6519	3.2018	1.7894	24.6000	33.7000	2.7000	0.1037	-0.4970
Wrist	18.1794	0.7041	0.8391	16.3000	20.4000	1.2000	0.0406	-0.4312

The summary of statistics shows that all variables follow the basic assumption of normality because

skeweness lies within the -3 to +3 range. Now we can apply two sample t-tests for the comparison of variables between low and high risk of obese people.

Step 3: Two sample "t" test results are presented in Table 3:

Table 3: *T-test for Equality of Means*

Variables	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		Results based on P value
Density	15.141	231	0	0.03	0.002	0.026	0.034	Important
BodyFat	-15.684	231	0	-13.326	0.85	-15	-11.652	Important
Age	-4.221	231	0	-7.981	1.891	-11.707	-4.256	Important
Weight	-6.528	231	0	-22.971	3.519	-29.905	-16.038	Important
Height	1.417	231	0.158	1.43	1.01	-0.5620	3.435	Not Important
Neck	-5.522	231	0	-1.711	0.31	-2.321	-1.1	Important
Chest	-8.479	231	0	-8.623	1.017	-10.626	-6.619	Important
Abdomen	-11.17	231	0	-12.969	1.161	-15.257	-10.682	Important
Hip	-6.685	231	0	-5.526	0.827	-7.155	-3.898	Important
Thigh	-5.284	231	0	-3.498	0.662	-4.802	-2.194	Important
Knee	-5.13	231	0	-1.636	0.319	-2.264	-1.007	Important
Ankle	-2.536	231	0.012	-0.497	0.196	-0.882	-0.111	Important
Forearm	-3.745	231	0	-1.012	0.27	-1.545	-0.48	Important
Wrist	-2.8	231	0.006	-0.359	0.128	-0.612	-0.106	Important

The two-sample t-test results show that all the factors are significantly playing role between low-risk obesity and high-risk obesity in men through two information P-value and Confidence interval of the differences except height. Height is the only factor which shows not important for the distinguish of low and high risk of obesity.

Conclusions and Limitation

In this study, we compared different factors based on Low and High risk of obesity in male persons. Two sample t-tests methods compared the average of different factors and found significant differences between Low and High Risk of obesity personals. Researchers claimed in different studies found significant that physical workout is very important for maintaining a healthy life. A very important limitation of this study is only one gender was used for this analysis which is male. Future work would be possible with female gender and children also. Finally, body measurements such as hip, abdomen, weight, knee, and others played a significant role in low and high risk of obese male persons.

Conflict of interest
There is no conflict of interest.

Ethical information
This study is focused on the people who are involved and not involved in physical workouts for the betterment of their lives.
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Author contribution
Author contributions are as follows:
Author 1 conceived the idea and directions and write-up of the whole paper.
Author 2, R program for graph and data analysis.

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