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A Comparative Study on Body Composition Analysis against the BMI Analysis and Possibility of Normal Weight Obesity Syndrome among the Young Male Candidates Residing in the UAE Region

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ABSTRACT

Although intellectually engaged and demonstrate complex mental activities, a significant portion of the contemporary youth do not engage in an adequate level of physical activities. The ultimate compensation between this trade-off is day by day deteriorating health. This situation will lead to stressful life, normal weight obesity syndrome, imbalance in autonomous nervous system, intermittent fatigue at younger age etc.

Consultations with physicians do not happen until the human body shows severe symptoms of ill-health. Now a days, the principal part of the body analysis in the field of preventive healthcare is based on BMI. We argue that body composition analysis (BCA) be introduced to the mainstream as part of preventive healthcare.

This paper compares the BMI and BCA based body analysis and proves that BCA will give the accurate body analysis report in terms of age, height, weight, gender, body fat, and excess fat.

The true fact is many individuals coming under BMI healthy region are unfit as per the BCA report. The paper also introduces a new zonal based study by comparing both BMI and BCA reports which gives information about safe and unsafe regions in terms of body fat percentage and BMI. Health practitioners, corporates, and fitness clubs should make it easy for their clientele to access it because periodical body composition analysis will help create a healthier lifestyle in individuals and thereby make them contribute better to the society.

In this paper, we demonstrate the results of a BCA study conducted using a painless near- infrared spectroscopy (NIR) device among young males residing in the United Arab Emirates (UAE).

Keywords: Body composition analysis, body mass index, preventive health care, NIR, UAE, non-invasive healthcare technology.

Introduction

A well-balanced fat percentage in body fat (adipose tissue) is key to health [1]. Having a stable healthy body fat percentage provides many advantages, such as: temperature regulation; balanced hormone levels; better reproductive health; adequate vitamin storage; good neurological function; healthy metabolism; and, balanced blood sugar.

Imbalance in body fat will sooner than later result in some or the other of the following: heart disease and stroke; coronary artery disease; atherosclerosis; pregnancy complications; type 2 diabetes; hormone disturbances; and some type of cancers [2].

There is a common misconception that all body fat is bad [3]. In truth, some quantity of body fat is needed to protect the person's health as well as supplying a reservoir of energy for performing various body functions.

The primary purpose of adipose tissue is to store lipids, which helps the body to create energy. Moreover, it secretes multiple essential hormones and gives the body with some cushioning as well as insulation. To better understand this, the total weight of body fat can be subdivided into three separate categories:

- Weight of Essential Body Fat - This will protect the body from infectious diseases and protect the internal organs from bruising damage.
- Weight of Reserve Body Fat - The amount of additional body fat that does not cause any medical risks, and provides a reservoir of fuel for use by the body.
- Weight of Excess Body Fat - The amount of body fat above the combination of Essential Body Fat and Reserve Body Fat. Excess Body Fat causes the risk of severe health problems such as strokes, heart attacks, diabetes and certain forms of cancer.

Essential body fat is present in the most body parts and it helps to sustain life and reproductive functions. The amount of essential body fat varies between men and women. The average levels are 2-5% in men, and 10-13% in women. (Table 1) shows the body fat ranges needed for young male candidates under various categories.

For young male candidates, the healthy range of body fat is generally defined as 8-19% by various health councils. Both excess body fat and insufficient body fat can have adverse effects on a person's health [4]. The main point of discussion with a health practitioner should be the BF level and its retention in the defined range globally. Storage fat mainly accumulates in adipose tissue. It can be subcutaneous fat (fat that is wrapping around vital organs) or visceral fat (fat located inside the abdominal cavity).

Table 1: Body fat ranges for young male candidates.

Description	BF range
Recommended amount	8-14%
Adults in United States, average	15-19%
Athletes	6-13%
Fitness	14-17%
Average	18-25%
Obese	25+%

Excess amounts of storage fat can lead the health of the person to severe adverse implications. Proper measures taken at the right time can stop increasing body fat [5]. Sometimes overweight or obese can be due to other reasons like increased fat-free mass, significant hydration rate, dense bone mass rather than increased BF level. Sometimes highly muscular people can be classified as overweight. In such scenarios, body composition analysis is the best method to classify a person under the overweight or obese or underweight category.

The accumulation of BF levels varies from person to person, and it depends on various factors like genetic factors, behavioral factors like lack of exercise, excessive food intake, alcohol consumption, and smoking. If the problem is associated with the genetic disorder, it can be more difficult to reduce body fat levels [6].

After the age of 40, due to the reduction in various hormones can lead to excess body fat around the stomach in men. If this happens in young male candidates at a more youthful period, it should be analyzed very carefully and make them aware of the upcoming adverse health implications.

Body fat can produce a number of essential hormones that have positive effects on the human body [7]. However, an excess or insufficient level of these hormones can have negative impacts that preclude proper body function. Excess body fat can disrupt the healthy balance and service of some of these hormones. As noted previously, excess body fat can create obesity.

Obesity will lead to a reduction in quality of life, reduced person's life expectancy, poorer mental health outcomes, improper sleep as well as significant villains causing death worldwide such as cardiovascular disease, stroke, certain cancers, and diabetes [8]. Furthermore, body fat, especially visceral fat, has a role in the release of specific cytokines, which can potentially increase the risk of cardiovascular disease.

Visceral fat can increase the levels of low-density lipoprotein (LDL) cholesterol, lower the high-density lipoprotein (HDL) cholesterol, and insulin resistance. LDL cholesterol or "bad cholesterol" can clog arteries and lead to complications, including heart attacks. It also leads to high blood sugar levels, eventually to type 2 diabetes. Studies prove that diet management, intermittent fasting, and regular exercise can reduce stored fat.

Body composition analysis mainly focuses on calculating the amount of fat-free mass and proteins, bone mass, fat mass, and hydration part [9]. The above components contribute to the bodyweight of a person. However, the mainstream research is mainly focusing on the fat mass and its distribution because the amount of fat mass directly relates with the health of a person.

The social media has changed the lifestyle of people around the world, a lot, dramatically [10]. Due to the modern lifestyle and work culture, alcohol consumption and smoking are shared among the youth. The improved socioeconomic conditions created a hassle-free world full of automation. The current situation has reduced the physical activity of individuals and this will explain why weight and body mass index (BMI) are increasing globally [11].

As per the BMI standard, a person falls under a healthy category

if the BMI is in range of 18.5 to 25. However, unfortunately, the BMI is measured based on visible height and weight parameters. The BMI calculation does not consider bone mass, water mass, fat-free mass, fat mass, or protein. It takes the overall weight of the person. The disadvantage is a person with higher bone mass may come under the obese or overweight category.

Normal weight obesity (NWO) syndrome is prevalent among the global youth generation, despite decent looking BMI [12]. For such persons, the BMI is still in the healthy range [13, 14].

In this scenario, body composition analysis has gained very much importance because body fat and its distribution can predict the health risks and imbalance in energy metabolism [15]. The above condition is evident from several clinical studies [16]. Several studies based on body composition analysis are available on internet repositories [17-19].

The fat deposits and its distribution have a connection with age [20]. The systematic studies on body composition are rare and most of the researches are based on either the two-compartment model or three-compartment model [21]. In the two-compartment model, the study focuses on body fat (BF) and fat-free mass or lean body mass (FFM or LBM).

In the three-compartment model, we can take the third component total body water (TBW) in addition to the BF and LBM. Near infrared-light interactance (NIR) principle is an excellent technique to carry out the body composition analysis in the two-compartment model or three-compartment model. Several researchers in the past have used NIR principle and have published their results [22-25].

Early finding of excess reserves of fat and its distribution will help the individual, especially the youth, to re-adjust their weights to lower levels. In this study, body composition and distribution of body fat in young males are assessed using an NIR device; also, body composition is correlated with other relevant parameters of healthy living.

BCA - Technology Overview

The scientific community has developed numerous body composition techniques [26]. Some are straightforward techniques that include indirect measurements from waist-to-hip ratio and calipers. Other complex assessments are also available, like volumetric measurements based on three-dimensional imaging techniques. Several non- invasive methods like NIR are also popular among health practitioners [27]. Some of the well-known methods are discussed here briefly.

Hydrostatic weighing

Archimedes' principle is the fundamental principle behind the Hydrostatic weighing (underwater weighing). The body density is computed based on the difference in body weight in air and water [28]. The BF can be calculated for a two-compartment model, but the body fat distribution cannot be found out using this technique [29].

Bioelectrical impedance analysis (BIA)

Based on the electrical properties of the human body, BIA calculates the total body water content (TBW), and from the TBW, the body fat mass calculation is done [30]. Here the body is modeled as five compartments, and they are the trunk and the four limbs. In BIA, the impedance of the human body is taken to be proportional to the height and inversely proportional to the cross-sectional area of each compartment.

Here the human body is assumed as combinations of capacitor and resistors. BIA needs different parameters like age, gender, level of physical activity, amount of body fat, etc. to compute the BF (National Institutes of Health (US), Office of Medical Applications of Research) [31]. In BIA, a small electrical current is passed through the human body. The fat-free mass is watery (less resistance), while fat mass contains a very little quantity of water (more resistance).

The hydration rate of the body will affect the accuracy of the results. The result of the entire body will not get into the calculations since the current will always pass through the least resistance path. Moreover, the candidate has to follow specific rules regarding the consumption of Alcohol, exercise, consumption of food items, application of lotions, persons wearing pacemaker etc. before testing.

Dual-energy X-ray absorptiometry

DXA is a two-dimensional imaging technique based on the X-rays with two different energies [32-35]. The fundamental principle is the attenuation of the X-ray based on the thickness of the tissue. The tissue's attenuation coefficient depends on X-ray energy.

The two different X-ray levels help to take two different images of the human body. We can think of these two images as two components. Based on the attenuation, pixel intensity will also vary. Based on the pixel information, the location of soft tissues, bones, etc. can be plotted using a computer program. The image will help to calculate the BF.

Near-infrared Interactance (NIR)

In this technique, a beam of infra-red light is allowed to fall into biceps or triceps [36, 37]. The light is reflected from the underlying muscle and absorbed by the fat. The advantage of this method is safe, rapid, non-invasive, and easy to use. The fundamental principle of NIR depends on both the reflectance and transmittance law of infrared light.

A specific sensor detects interactive light waves and using some algorithms, and it provides body composition readings directly. The typical wavelength used in NIR analysis are wavelengths ranging from 940-950 nm. The advantage of this technique is it will give the TBF, BF, TBW, and LBM. Lean body mass calculation depends on body weight and body fat, age, sex, height, body frame, physical activity rating.

Ultrasound

Ultrasound is another technique used to find the tissue structure, and it can measure the thickness of the subcutaneous fat layer [38]. The fat thickness can be calculated based on the tissue sound speed and automated signal analysis. The overall BF calculated by taking thickness measurements at multiple sites on the body. Ultrasound equipment is costly, and it is not cost-effective for body fat measurement alone.

Skinfold methods

This test is also known as the pinch test. Here a pinch of the skin at specific standardized test points are measure using a skinfold caliper known as picometer [39]. The test will help to determine the

subcutaneous fat layer thickness. The BF can be estimated using some critical equations from the fat layer thickness information [40].

The test will not give an accurate reading since the BF distribution is different for various people. The technique will provide the body composition change over some time, provided the test is carried out by the same person with the same technology.

The Study

This study was conducted in the United Arab Emirates (UAE). The reason behind the selection of this particular region is gulf countries are not considered in most of the health-related studies. The subjects for the study were either UAE citizens or those who are currently residing in the UAE. For the report, male candidates having the age ranging from 25 to 35 are selected.

A normal BMI based analysis can be done for any individual irrespective of the gender. However, in BCA based studies, gender is an influential parameter because body fat definitions for male and female candidates are different for the same classification given in the Table 1. In order to carry out an effective progressive analysis, the age range has to be selected in small sections like 25 to 35, 35 to 45 and so on. For the analysis, a total of 1013 candidates were screened.

The screening was done using the heath kiosk, K-350 series manufactured by Spotcheck Health & Wellness Private Limited. The health kiosk uses NIR technology-based body composition analysis developed by Futrex Inc, which is well known among global health practitioners for doing body composition analysis.

The (Figure 1) shows K-350 series kiosk. The kiosk uses NIR technology to read body composition analysis, HRV (Heart rate variability-Frequency domain) to analyze the Autonomic Nervous System and stress analysis, and PPG (Photo Plethysmography) & APG (Accelerated Plethysmography) to analyze the vascular health analysis.

The kiosk consists of four parts, and they are weighing scale, height sensor, body composition analyzer, and the ANS analyzer. The health kiosk has a CPU that runs a screening software designed by Spotcheck.

Figure 1: Kiosk K-350 series.

The analysis will take around eight minutes to complete. After the screening, the device will generate a report containing a detailed explanation of each parameter along with a traffic light graph. The device will provide around thirty parameters under the Body composition analysis, Autonomic

Nervous system, Stress analysis, and vascular health analysis. The graphs will help the user and the health practitioner to analyze the report quickly. The user will also get the electronic copy to his registered email ID.

The study can be broadly classified into two sections. The first section deals with BMI based analysis in which the candidates are classified based on the standard BMI range. The next segment of the study deals with the BCA based analysis in which the comparison of the healthy and unhealthy percentage of candidates based on BMI as well as BCA is shown. Finally, the excess fat-based investigation coming under BCA analysis will give you the true hidden unhealthy percentage of the candidates which is not available under BMI based analysis.

BMI Analysis of Young Male Candidates

The analysis starts with height and weight histogram to get a better grip on the primary details of the cluster under study. (Figure 2) shows the histogram of weight distribution. From the chart, it is clear that most of the candidates are having a weight ranging from 60 to 70 kilograms. A total of 296 candidates or 29% of the total candidates falls under this category.

In the second category, that is candidates having a weight ranging from 70 to 80 kilograms, a sum of 245 candidates, or 24% of the total subjects are there. The third group consists of candidates whose weight comes under the range of 80 to 90 kilograms. In the third category, 20% of the total candidates fall.

In the fourth group, which is weight lying in the range of 90 to 100 kilograms, a total of 154 candidates or 15% are there. Interestingly we found two groups who have a weight greater than 100 kilograms and less than sixty kilograms. Six percentage of the candidates have bodyweight more than 100 kilograms, and 5% of the candidates have bodyweight less than 60 kilograms. This information will be one of the inputs of BMI based analysis. The main disadvantage of this information, none of the candidates, cannot be classified as underweight or normal or overweight since important details like LBM, BF, TBW, bone mass are not taken into account.

From (Figure 3), 39% of the candidates are having a height ranging from 160 to 170 cms. Forty- eight percentage of candidates have a body height in the range of 170 to 180 cms. A total of 115 candidates or 12% of the subjects have height lies in the field of 180 to 190 cms. However, a small number of the candidates are having the elevation higher than 190 cms and less than 160 cms.

As a general rule, it is clear that bone density increases with the increase in body height. The (Figure 4) utilizes the information obtained from the height and weight histogram values to classify the candidates under various BMI zones. It shows the height weight distribution chart of the total candidates.

Based on the frequency of the candidates, the figure is divided

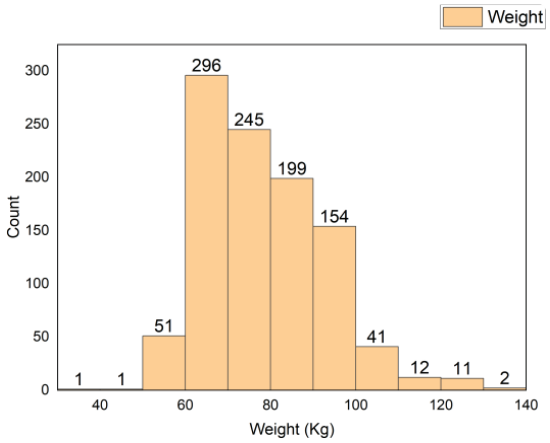

Figure 2: Histogram of weight distribution.

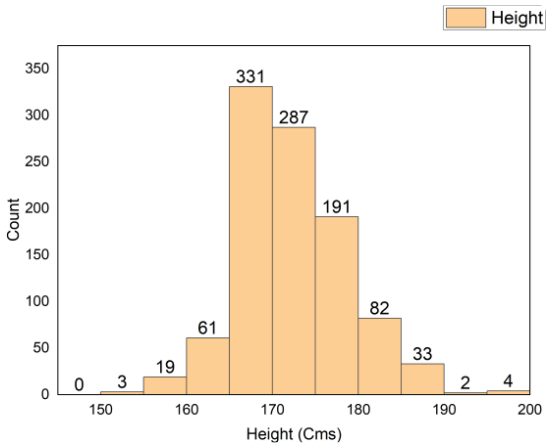

Figure 3: Histogram of height distribution.

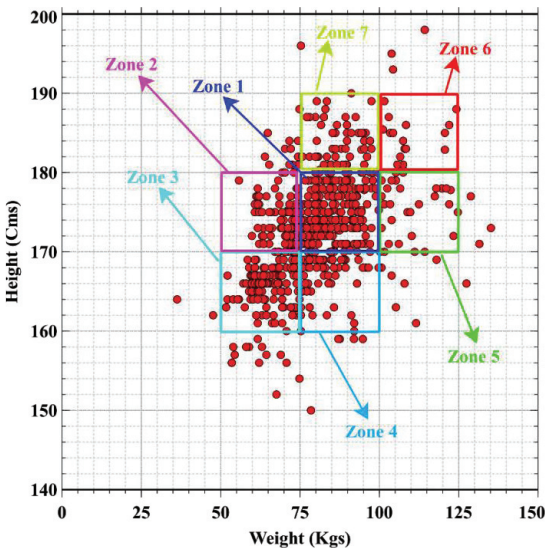

Figure 4: Height-weight distribution chart.

into seven zones. The height, weight, and average BMI information of each zone is provided in (Table 2). The majority of the candidates fall under the zone 1 category, and the average BMI is 28.6 and it indicates overweight. The average BMI of zone 2 class is 20.4. If we compare areas 1 and 2, the height range is the same, and the only differentiating factor is the bodyweight parameter.

It is clear that based on the body weight, the overweight category under area 1 changes to normal weight in zone 2. Zones 4, 5, and 6 come under the obese category. From (Figure 4), we can conclude that bodyweight is the most influential parameter in BMI based analysis. If we assume the zone 4 candidates as a fitness class, then they are falsely classified as an obese category rather than the normal category.

(Figure 5) shows the age and BMI relationship of all subjects based on the K-350 data. By observing the graph, it is clear that the number of persons irrespective of the age falling under the healthy weight category is less than the total number of persons falling under the overweight and obese category.

Interestingly, a few candidates come in the underweight category too. Based on the BMI report, the increased number of candidates in the overweight and obese region is highly alarming to society. As discussed earlier, this may be due to the genetic problem or improper diet plan or work pressure or other behavioral problem. Humans are addicted to the internet and social networking platforms at a rapid rate, and this may lead to irregular exercise levels.

Table 2: Zonal classification based on height-weight distribution chart.

Zone Number	Height Range (Cms)	Weight Range (Kg)	Average BMI	Category
1	170-180	75-100	28.6	Overweight
2	170-180	50-75	20.4	Normal
3	160-170	50-75	23	Normal
4	160-170	75-100	32.1	Obese Class 1
5	170-180	100-125	36.7	Obese Class 2
6	180-190	100-125	32.9	Obese
7	180-190	75-100	25.6	Overweight

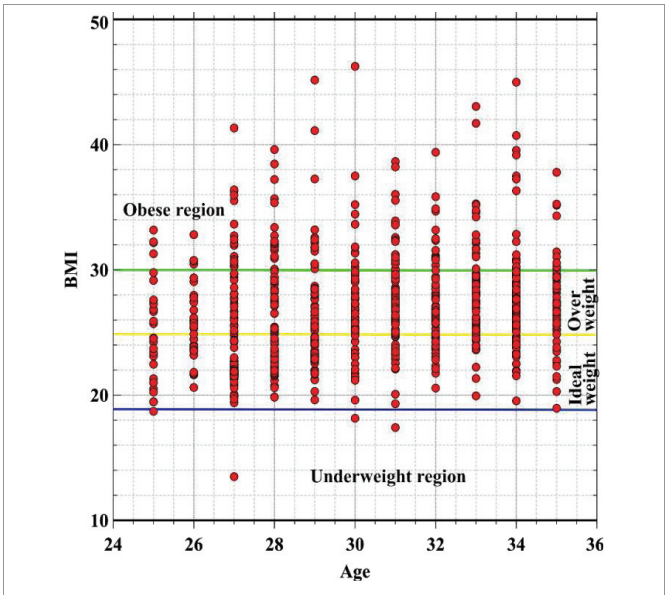

Figure 5: Age-BMI distribution chart.

As the person goes from an ideal weight region to overweight and above regions, they will lose interest in working, and naturally, this will again make them more obese. The blood pressure and sugar level will also increase. Currently, the world is facing severe pandemics like covid-19. In such a scenario, the society should pass the awareness to the younger generation about the importance of being healthy. The main target of viruses causing severe pandemics are the persons having unhealthy conditions like high blood pressure, diabetes, heart disease, etc. If this situation prevails, the contemporary youth cannot sustain such pandemics.

Based on the information obtained from (Figure 4, 5), (Table 3) indicates that around 43% of candidates have a healthy weight. However, 38% of the subjects under study have overweight, and 19% of the candidates have obesity. This is a distressing situation indicating that major portion of our younger candidates comes under the unhealthy region based on the BMI analysis. In the next section, we will do the analysis based on body fat and excess fat data obtained through the NIR device. The intention of the analysis is to classify the healthy and unhealthy candidates based on BCA.

Table 3: BMI analysis report of the candidates.

Sl. No.	BMI Range	Category	Percentage
1	<18.5	Underweight	0.29%
2	18.5 to 25	Normal	42.89%
3	25 to 30	Overweight	37.96%
4	>30	Obese	18.83%

BF Analysis of Young Male Candidates

(Figure 6) shows the contribution of the fat mass percentage to the overall weight of the body. From table 1, it is clear that the recommended amount of BF is 15 to 19%. In some countries, the upper limit can come up to 25%. However, the current report takes 20% as the upper limit for body fat percentage, and the BF percentage higher than 20% is taking as overweight or obese category. Moreover, 8% is taken as the lower level of the BF percentage. From the picture, we can see that several candidates are approaching the upper limit, and they can fall into the obese category if they are not thinking about the recommended diet plan and regular workouts or exercise.

The candidates having lower BF percentage (15%) or nearer value are also advised to follow a proper diet plan along with consistent exercise patterns. From the chart, it is clear that a certain number of candidates have an insufficient amount of BF percentage, and such candidates are also advised to gain BF percentage by proper diet plan. A fat mass percentage higher than 20% is not suitable for younger candidates.

As age increases, it is commonly found that the BF percentage is also increasing, and the cause is the reduction in the several hormone levels. Sleeplessness will also contribute to a higher body fat percentage. A minimum body fat percentage is needed for the human body to execute all body functions, which include killing the cancer cells, insulin production, temperature regulation, etc.

The relationship between age and BF percentage are shown in (Figure 7). The most exciting part is for the same age group; several candidates have elevated BF percentage. The reason is the society is not aware of the importance of body composition analysis.

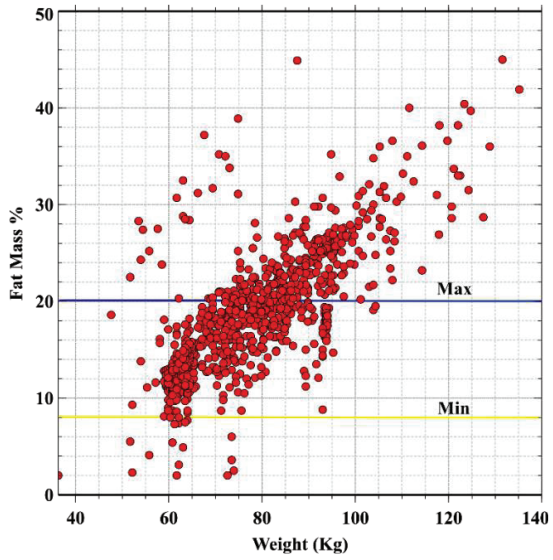

Figure 6: Weight and fat mass distribution chart.

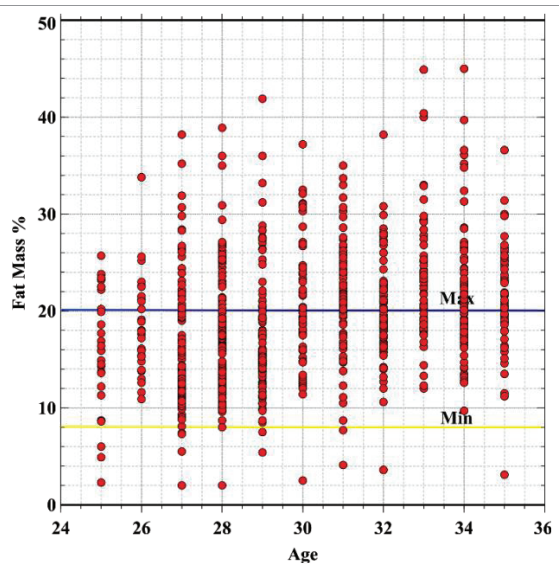

Figure 7: Age and fat mass distribution chart.

The health practitioners should inform the community about performing the body composition analysis twice in a year rather than the usual checking of the BP level or sugar level or cholesterol levels. Society has to think more about the health of younger candidates since they are going through the vibrant time in their age. The community cannot think of a younger person having several illnesses, including metabolic syndrome, diabetes, heart diseases, stroke, hypertension, high cholesterol level, etc. at a colorful stage in his life.

(Table 4) is prepared based on the BF percentage data provided by (Figure 6). The group having a healthy weight is around 53%, but the group coming under overweight and obese will be approximately 45%. From (Figure 6, 7), it is clear that a greater number of candidates are waiting to cross the maximum borderline of BF percentage.

If the candidates are not thoughtful about maintaining a healthy lifestyle, the overweight category figure, 45%, will increase at an

alarming rate. As per BMI, around 43% of the candidates were coming under normal category. Table 4 shows that BMI based analysis will mislead the fitness trainers and health practitioners since BMI calculation is based on height and weight only.

In (Figure 8), we can see the critical chart that specifies the safe and unsafe region for an individual. The map is prepared by plotting BMI data against the BF percentage data. The map also uses the borderlines defined by the BMI scale and body fat percentage scale for a healthy individual. The safe region is the area that falls under the green box.

Table 4: BF analysis report of the candidates.

Sl. No.	Body fat percentage	Category	Percentage
1	< 8%	Underweight	1.77%
2	8% to 20%	Normal	53.01%
3	20% to 25%	Overweight	28.43%
4	>25%	Obese	16.78%

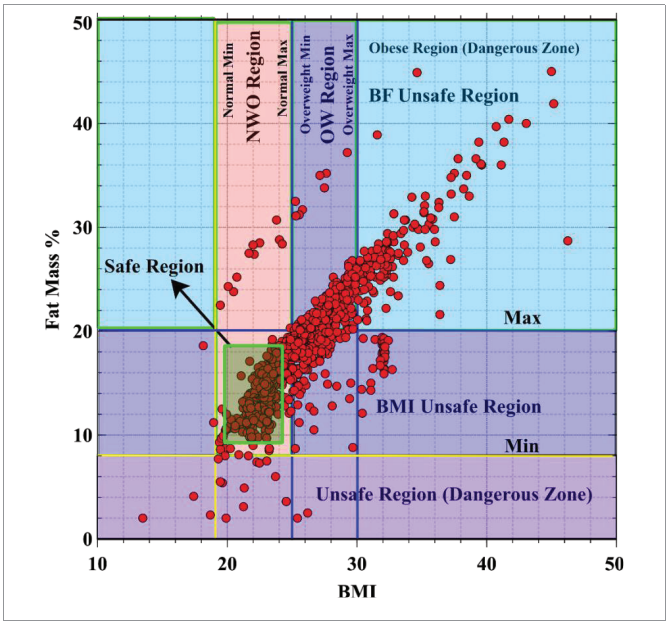

Figure 8: BMI and BF % distribution chart.

The red zone indicates the NWO region. If we observe the NWO region, it is clear that BMI is healthy for such a person, and the BF percentage is elevated on the other side. A total of 10 candidates fall under the NWO category. NOW candidates may exhibit several illness patterns, higher stress rate, high fatigue etc. (Figure 8) clearly states that body composition analysis has significant impact on health analysis rather than BMI based analysis. Body fat can provide significant meaning to the health practitioners for performing detailed health analysis.

The other unsafe regions, including the overweight or obese region, are risky due to either improper BMI or irregular BF percentage. The hazardous part contains the underweight category also since a few numbers of candidates have insufficient body weight or body fat percentage. For thoroughly analyzing the map, additional information like excess fat levels was also considered.

Importance of Excess Fat Based Analysis

As discussed earlier, the human body will convert all the unused calories to excess fat. However, during the data analysis, we found excess body fat in specific candidates, even though the subjects under study have a healthy body fat percentage, as recommended in (Table 1).

In such a case, proper care should be taken while classifying a candidate under a particular category based on BMI or BF percentage. The excess fat will give more meaningful insight during the candidate's classification along with the BF percentage. The recommended excess fat levels by the Futrex researchers is 2 kilograms. Ideally, it should be zero, but every ordinary human being will have some excess fat in lower levels. If it increases to a higher quantity, severe health implications will occur. In the current studies also, the borderline of excess fat is set as 2 kilograms as per the recommendations put forward by Futrex.

(Figure 9) shows the distribution chart between BMI and excess fat. By observing the picture, it is clear that by BMI statistics, approximately 43% of the candidates are coming under a healthy category. If we consider the borderline of excess fat, the BMI safe candidates' statistics will go down from 43% to 41%. It indicates that excess fat levels have a significant impact on health analysis. Moreover, from the distribution chart, it is clear that a lot of candidates have a low excess fat level, and at the same time majority come under the dangerous zone.

The information regarding the age and excess fat distribution is

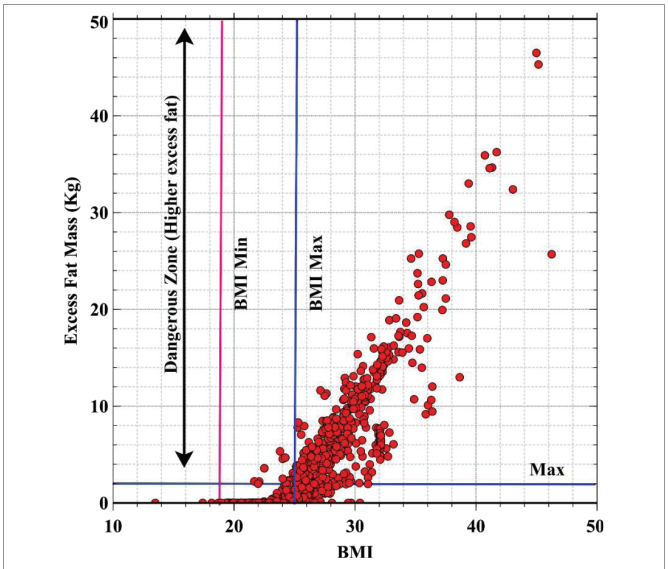

Figure 9: BMI and Excess fat distribution chart.

given in (Figure 10). For a comparative study, the chart is divided into four zones. Zone 1 contains the frequency of candidates having excess fat up to 2 kilograms.

The next region shows the candidates who are having excess fat lying in the range of 2 to 6 kilograms, and in the third category, the frequency of candidates whose excess fat is coming in the field of 6 to 10 kilograms, and in the last zone, those are having excess fat

higher than 10 kilograms. Remember, the age of the candidates is the x-axis parameter, and it will tell some most important severe health complications happening to our younger generation to society.

There are only 51.43% of the candidates coming under zone 1, defined by Futrex irrespective of the age. The second region has around 20% of candidates, and definitely, it is an alarming rate. Approximately 13% and 16% of the subjects under the study are coming under zone 3 and 4, respectively, and it is creating a highly distressing situation among the global community. Interestingly, every age group has its existence in each zone at a vital rate.

Theoretically, zones 2, 3, and 4 should contain zero candidates. The health practitioners should provide careful counselling to their younger candidates regarding the importance of body composition analysis and its impact on building a healthy community.

(Figure 11) shows the distribution chart between excess fat and BF percentage. From the graph, it is clear that only a lesser number of candidates are coming under the safe zone. The stable area is created by considering the borderline of excess fat levels, and minimum and maximum values defined for the body fat as given in table 1. As per the criteria of BF percentage alone, several candidates can exist in the safe region if we are hiding the excess fat information. ByShielding the excess fat information, the secure part will contain 53.01% of candidates. When the excess fat is considered, the safe category has only 46.79% of the candidates. It distinctly states that every candidate should perform a thorough body composition analysis rather than mere BMI based analysis. BMI based analysis will never give you the outline or detailed report of your precious health. The NIR device can provide 4 to 5 compartment model of your body that includes bone density, water content, LBM, fat mass, storage fat and excess fat information. When such a painless technology is available, the global community should make use of it to create a healthy society.

From (Table 5), by considering excess fat information, normal weight region contains only 46.79%, and overweight/obese category has 48.66%. Table 6 compares the health statistics obtained through BMI analysis and body composition analysis (BCA). From the table, it is evident that BMI based analysis can misclassify the candidates between different categories. It can place a healthy individual under the overweight or obese category.

While taking BCA, it is advised to consider the excess fat information to classify the subject correctly. If possible, the health practitioner can include other parameters like bone mass, water content, fat-free mass in the BCA analysis to get an accurate analysis of the subject under study.

Conclusion

Most people think that a high-fat diet is the leading cause behind too much body fat, and this is only partially true [41]. People need a certain amount of dietary fat to maintain good health. Refined or processed foods having high carbohydrates and low fiber can increase body weight. Consumption of diets high in refined sugars can elevate the visceral fat, and which is more dangerous as a predictor of disease. The human body will convert excess calories as fat reserves.

The gaining or losing weight depends on the total calorie intake and the calories that you burn every day through different modes. Most health practitioners recommend a diet high in protein, complex carbohydrates, and fiber with moderate portion sizes. A regular

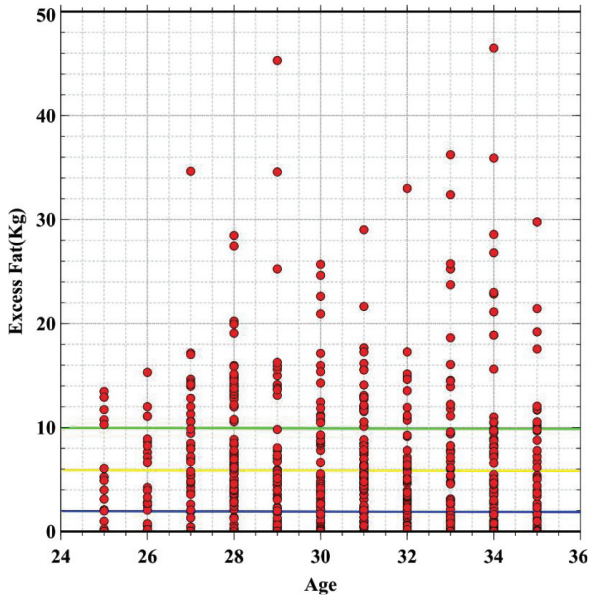

Figure 10: Age and excess fat distribution chart.

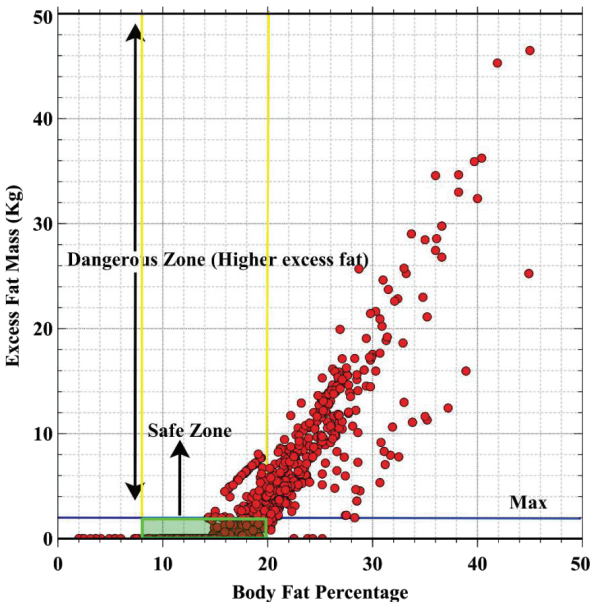

Figure 11: BF percentage and excess fat distribution chart.

Table 5: BF based health analysis review after considering the excess fat.

Sl. No.	Body fat percentage	Excess fat	Category	Percentage
1	< 8%	< 2Kg	Underweight	1.77%
2	8% to 19%		Normal	46.79%
3	19% to 25%	> 2Kg	Overweight/Obese	48.66%

Table 6: Comparison of underweight, normal weight, overweight and obese based on BMI, BCA data.

Analysis type	Underweight	Normal weight	Over weight	Obese
BMI	0.29%	42.89%	37.96%	18.83%
BCA	1.77%	53.01%	28.43%	16.78%
BCA with excess fat	1.77%	46.79%	48.66%	

exercise program will make the healthy diet plan the most effective. Exercise focusing on fitness is effective in elevating metabolism, development of lean muscle mass, and preventing fat gain in the long term. In order to come to any of these decisions, a valid yet easily accomplishable measurement of fat is needed. The procedures detailed in this paper employing the NIR device, thus, is a companion to healthcare practitioners.

Also, understanding normal weight obesity is vital when we deal with the health challenges of the contemporary society [42]. In the earlier days, foods prepared at home were low-calorie foods. The people in the community were more active. There were opportunities for burning excess calories. However, the situation has changed a lot in the present day. Despite having low-calorie intake, and ideal BMI levels, our younger

Generation are facing some fatigue. They are not active in the house, schools, or organizations, and this is a severe issue. Modern research focuses on analyzing the body fat of a person. As said earlier, the body fat is found everywhere on the body. The body fat can be divided as essential fat, reserve fat, and excess fat. For a healthy person, the excess fat should be zero. The excess fat is the real villain behind normal weight obesity syndrome.

NWO candidates have an ideal BMI, but they have higher body fat on the other side. The body fat may exist in the form of higher excess fat, and this may be the reason behind the fatigue in most of the cases. The candidates should follow strict instructions like a proper diet plan, good behavioral habits, regular exercise, etc. if the doctor identifies that a particular person has NWO. The K350 or similar NIR devices could accurately measure fat in the body and practitioners are suggested to examine these solutions in more detail.

At a broader level, the study is intended to create the awareness of body composition analysis and its benefits. In several countries, BMI is the base criteria for identifying whether the person is healthy or not. In a more profound sense, BMI tells whether the person is in the region of underweight, healthy weight, overweight or obese. BMI never considers the body fat percentage or excess fat of the person and this type of classification is misleading. Using BMI based analysis, it is challenging to identify a person with NWO syndrome.

To identify a person, whether he is having healthy weight or abnormal weight, the health practitioner should consider the body fat percentage as well as excess fat information or in short body composition analysis is the correct method to analyze the health of a person. From the tables and comparison charts, the authors prove and encourage the scientific community to do more research in the field of body composition analysis [43].

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