IMPROVING BODY MEASUREMENTS USING Shae

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PRECISION INTELLIGENCE

Improving Body Measurements with Shae

With estimates of around 2.1 billion people worldwide being overweight or obese[1], obesity has become a global epidemic[2]. It causes a broad range of debilitating issues, including stroke[3], heart disease[4], hypertension[5], osteoarthritis[6], gallbladder disease[7], kidney disease[8], non-alcoholic fatty liver disease[9], gout[10,11], and sleep apnea[12].

Obesity can be defined in several ways. Most often obesity is classified by the ratio between body weight and height (called the Body Mass Index, or BMI); when the BMI is calculated and values equal 30 or above the individual is considered to be in the obese range[13,14]. Other researchers prefer to look at the percent of body fat (BFI)[15-17] as a way to distinguish weight from fat-free mass like muscle gains and define obesity differently based on gender and age. These calculations can be complex. Another easy and efficient means of assessing obesity is comparing the waist circumference[18-21], to the height (this is the waist-to-height-ratio - WHtR)[22-24], the healthy range is below 0.5. Each of these approaches has benefits and drawbacks, so the use of multiple measures often works best in research[25,26] and will be used in this study.

Keeping body measurements within these recommended healthy limits is crucial to physical and mental wellbeing[27-29], as it affects outside of these healthy ranges impact important aspects in daily life, including mobility[30], putting individuals at risk for loss of independence[31], leading to muscle loss[32], and compromised quality of life[33]. Many individuals struggle to stay within the healthy ranges for various reasons. Researchers are finding that those who carry more fat have a more challenging time losing weight for multiple reasons that include;

- The production of proteins that reduce lipid thermogenesis[33]
- Genetic factors[33-39]
- Issues during fetal development[40-42]
- Pathogenic[43-45] conditions like leptin[46-49] or insulin[50-52] resistance
- Gut microbiome imbalances[53,54]

The result is that obesity becomes a self-perpetuating state[55,56] that becomes difficult to stop or reverse. Aside from the physical challenges to this condition, there are psychological[57-59] ones that must also be overcome. Studies have found several mental health conditions related to obesity to be common, including depression[60-63] or low self-efficacy[64] both preventing successful weight loss efforts.

Through the years, many programs and interventions have been introduced that are primarily focused on weight and fat loss[65]. However, these have often been found ineffective, being effective for shorter periods of time only and inevitably leading participants to the well-known yo-yo effect[66]. Because of this complex, intertwined and multifactorial nature of obesity, focusing on diet alone is not sufficient[67], therefore holistic approaches are needed. Programs need to address the lack of education[68] and resources on food and nutrition[69], provide regular motivators and feedback[70], plus tracking systems[71] and social support[72] that can help with the common feelings of shame[73] and unrealistic expectations[74,75]. The support network that comes along with recommended lifestyle changes is paramount to the long-term success of any intervention.

The Shae precision health and wellness program provides a holistic approach to health and wellness with virtual social networks and personalized resources to support individuals to achieve long-term goals using online and mobile device technology. The program is designed to support people in achieving and maintaining a healthy lifestyle and weight through progressive results that last an individual's lifetime by encouraging the formation of achievable lifestyle changes. The delivery of the program is designed in order to reach a global population in an affordable manner.

Method

This study meets the need for a statistical assessment of the program's efficacy as a mobile device with limited in-person coaching. Participants used the program as they wanted, with limited coaching or staff intervention, providing their anthropometric measurements (height, weight, neck circumference, waist circumference, hip circumference) and updates to their health assessment questionnaire on a regular basis. Feedback and testimonials from participants about the program were very promising, demonstrating the programs effectiveness without human intervention.

For the purpose of statistical analysis, the database was examined and cleaned based on those who were in the program for at least three months, who regularly provided updated measurement information, and who were not pregnant, hospitalised or seriously ill or injured during the study period. Results from 1,334 participants across a four-year span remained, with participants ranging from 18 to 89 years of age, close to 90% being female.

A second data-cleaning process was conducted on the included data set to select the user-provided information at intervals of one, three, six, and nine months, and every half year thereafter, allowing for a more appropriate and valid comparison of results. A total of 4133 data-points remained for the 1,334 participants.

From these user-provided anthropometric measurements, three key indices were calculated (WHtR, BMI, and BFI) and used in the statistical analysis and evaluation of the program's efficacy.

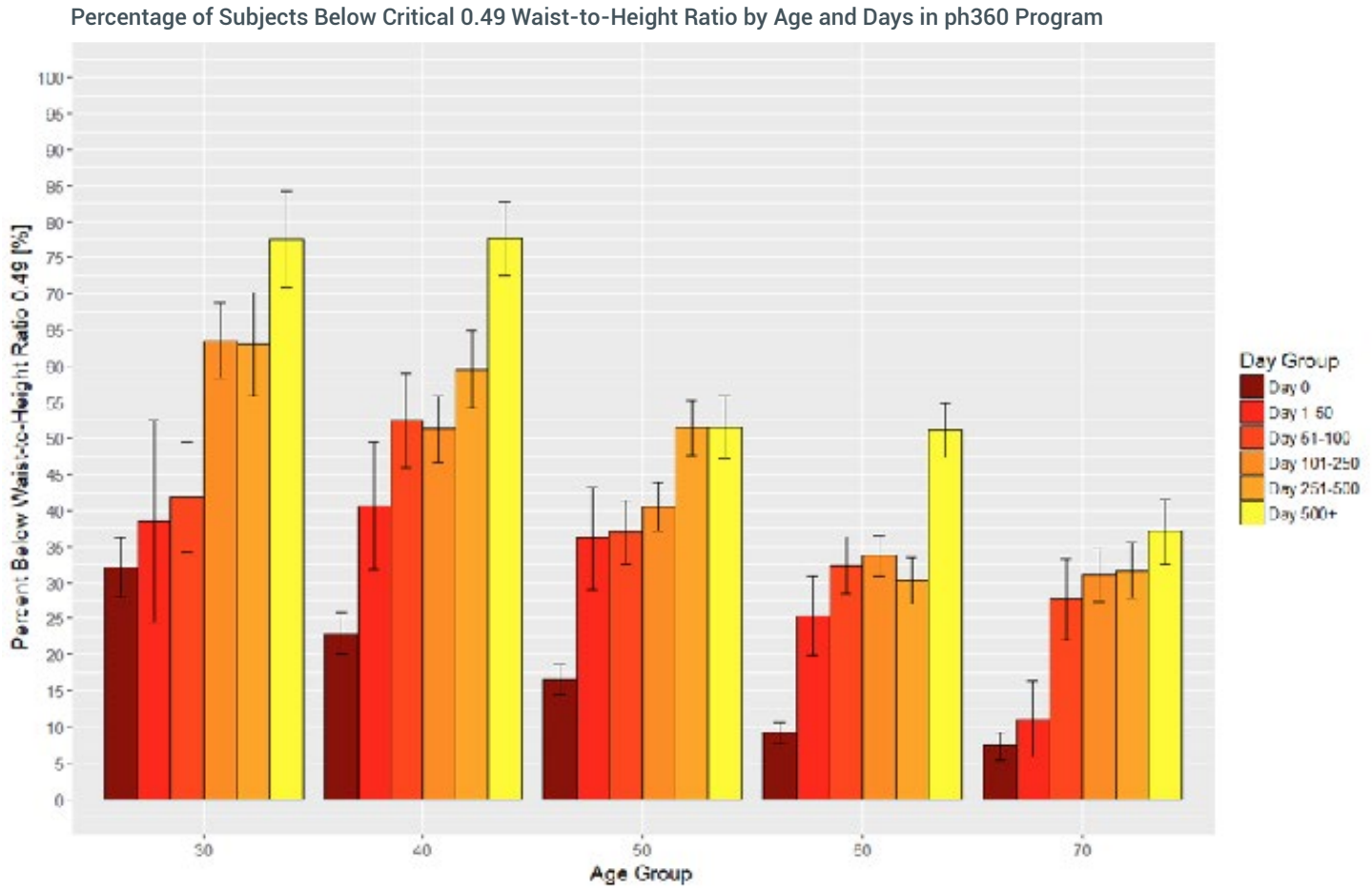
Results

Improvements in waist circumference

Abdominal fat has been associated with reduced health and increased risk of developing diseases such as diabetes and cardiovascular disease[76-79]. An elevated WHtR is associated with increased visceral fat and fat around important organs which can restrict their function[76], and may indicate excess fat inside the organs, like in fatty liver disease[80]. Therefore, WHtR is a very appropriate indicator of one's physical health. It is calculated by dividing waist circumference by height. A WHtR greater than 0.5 is considered a health concern, and an increased risk for developing cardiovascular disease and diabetes[81,82]. A healthy WHtR is defined a value below 0.524.

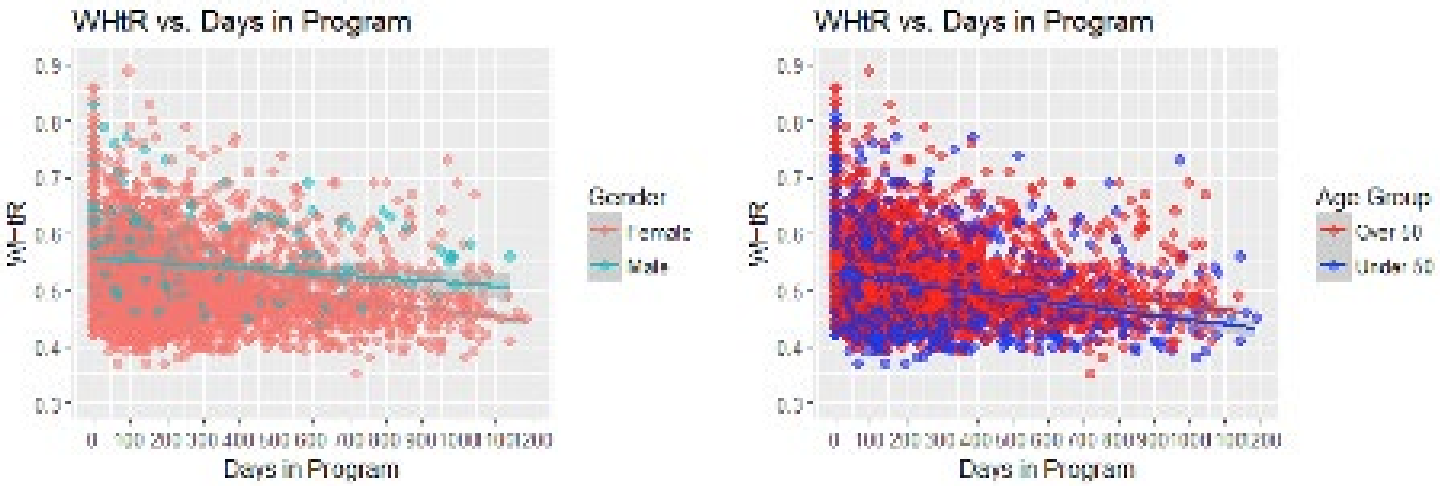
Figure 1 demonstrates a clear decrease in the percentage of most participants below the health limit ($p < 0.05$), reflecting a significant improvement in waist circumference and an important step towards a healthier body. The fact that waist circumference increases with age[83,84] likely explains the lower number of older participants under the critical limit, and underlines the importance of early lifestyle intervention. However, more than double the number of participants achieved a healthy value in under a year of participation, which is very encouraging since it is an often difficult process to implement new lifestyle behaviors to form new habits[85]. Furthermore, the number of participants achieving a healthy WHtR increased with time of participation, indicating that the program remains effective in the long term, which is crucial for some to reach and maintain a healthy weight[85,86].

Figure 1. Participants below the critical WHtR limit by age and days of participation.



With regard to gender, **there was a significant decrease in WHtR of both male and female participants**, although the decrease in female participants' results was even greater. While the improvements were more significant for younger participants, the proportional improvements were actually greater for those over 50 years of age. For example, when starting the program, only 7% of the 70-year-old age group meet the healthy WHtR criteria, but **within 100 days the percentage of people who meet the healthy WHtR criteria had quadrupled to 28%**. These improvements in the different age and gender groups can be observed in Figure 2 as reflected by decreases in WHtR value. These scatterplots highlight a decrease in the great variability in WHtR at the beginning of the program, and more participants get closer to the 0.5 mark[24].

Figure 2. Waist-to-height-ratio over the course of the program stratified by gender and age.

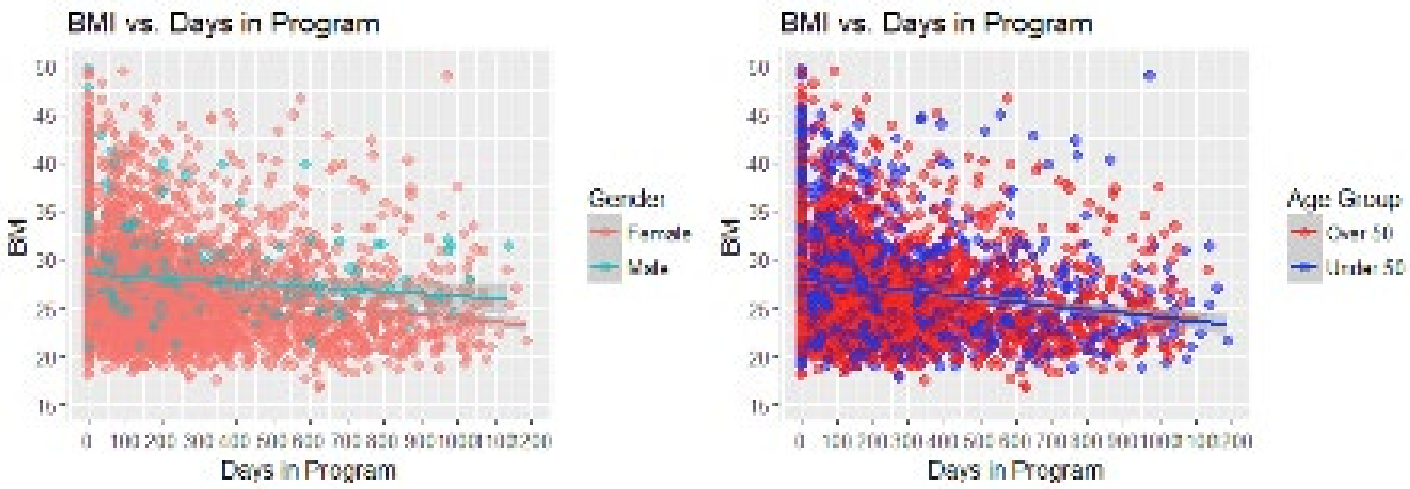


Improvements in body mass

BMI has been used to a very wide extent over the years, and is calculated by dividing one's weight in kilograms by their squared height in meters[87]. A BMI between 18.5 and 25 is suggested to indicate a healthy weight, a value below 18.5 indicates being underweight, above 25 overweight, and above 30 is obese[88,89].

The results from this study with regard to BMI showed that both men and women of most age groups effectively lost body mass while following the program ($p < 0.05$). However, women seemed to have slightly greater decreases in body mass than men, and women who stayed longest in the program were more likely to get below the healthy weight cutoff for BMI (below 25). This trend seemed to be consistent throughout all age groups, although those under 50 years of age appeared to see slightly more body mass decrease than their higher age group counterparts. The scatterplots in Figure 3 show the decreases in body mass over the number of days the average person participated in the program, and slightly less variation with time, which further supports the long term effectiveness of the program.

Figure 3. Body mass index over the course of the program stratified by gender and age.

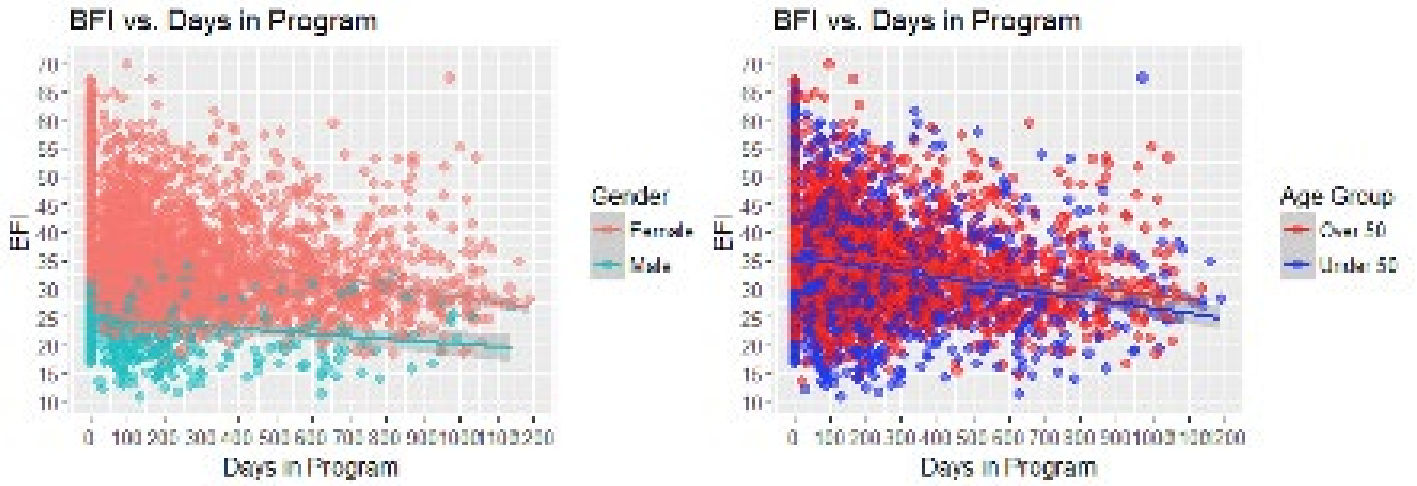


Improvements in body fat

Although BMI is a well-known measure for obesity, BFI is increasingly being used since it has been found to be a better indicator of physical health, as some individuals are overweight but not overfat[90]. Body fat has been increasingly associated with reduced physical health and, similar to WHtR, indicates a possible risk of developing a number of life-altering diseases[91-94]. BFI is calculated (see Appendix 1 for details) as an estimate of one's body fat content using the waist, hip and neck circumferences rather than using complex methods like calipers or expensive methods like bioelectric impedance. Depending on age group, a healthy BFI value is outlined in Appendix 2.

In this study, participants substantially decreased their body fat index over the course of the program. Although most men and women of most age groups saw significant improvements ($p < 0.05$), women seemed to lose fat more quickly over the course of the program than men did, and the average woman who stayed in the program for a prolonged time reached to below the healthy limits by the end of the program. This finding is similar to the results found for WHtR, suggesting that women may even benefit more from this program in terms of losing body fat, especially around their waist line, which is indicative of better physical health[76,78]. In turn, younger participants saw a slightly greater decrease in body fat than those over 50 years of age. These trends can be well observed in the scatterplots of Figure 4 that show a clear trend towards lower BFI values as time progresses.

Figure 4. Body fat index over the course of the program stratified by gender and age.

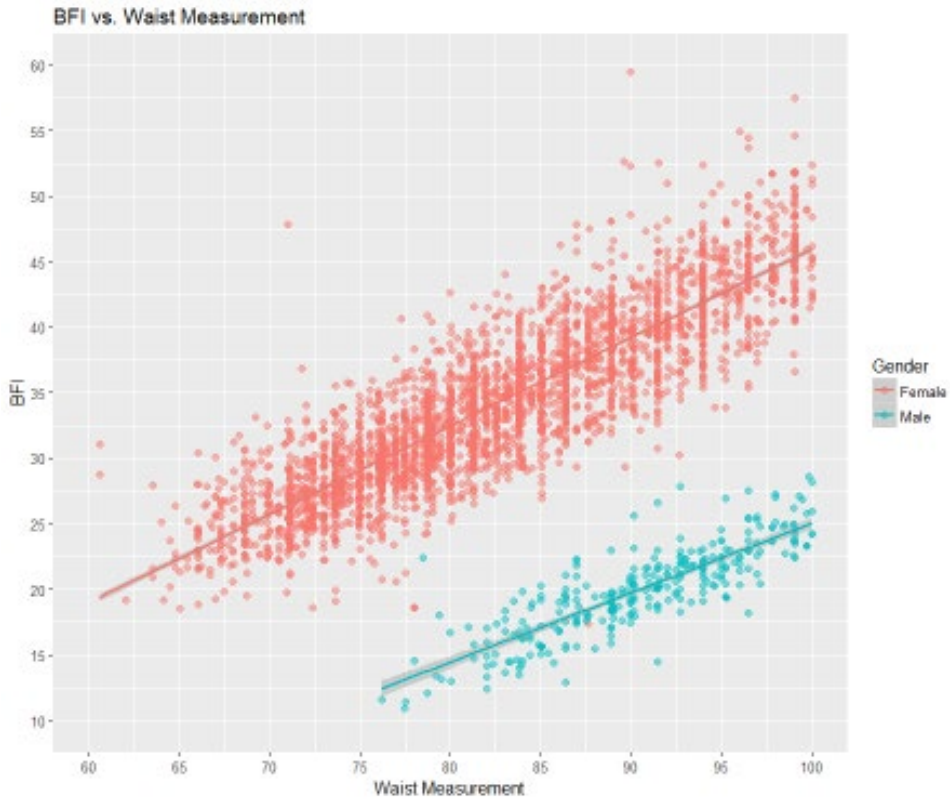


Correlations of variables included in the study

Correlations between variables used in the study help provide a clearer idea of how the changes over time relate to each other and what may provide more or less influence towards desired results. Two types of correlational analyses were performed. First, between the measurable outcomes and then with non-variable factors like age, gender and the length of time in the study.

Pearson's r correlation coefficients between the measurable outcomes strong significant ($p < 0.01$) correlations between BFI and WHtR ($r=0.78$), BFI and BMI ($r=0.77$) as well as WHtR to BMI ($r =0.83$). This triangulated correlation is a good sign of statistical reliability of the findings. A further examination into this relationship found that the relationship between BFI and WHtR based on gender was clear yet distinct (Figure 5). Since women naturally have more fat that men, it is of no surprise to see the higher BFI values, but what is noticeable is that there seems to be a greater proportion of men with seemingly low BFI but high WHtR, justifying the inclusion of multiple anthropometric measures in the assessment of obesity-related health risks.

Figure 5. Body fat index versus waistline measurement in men and women.



Conclusion

This study evidences that the online and mobile application of the Shae precision health and wellness program is effective in improving body composition, specifically with measure of WHtR, BMI and BFI. For most participants the effects were nearly immediate, with a significant proportion of the improvement realized within the first hundred days of the program, with the desired progress continuing the longer participants remained in the program.

The percentage of participants that successfully reduced their waistline to below health cut-off value more than doubled in under a year, which again underlines the immediate positive effects of the program in improving body measurements and decreasing the risk of developing highly prevalent related diseases, such as diabetes and cardiovascular disease[77-79,95].

BFI showed significant improvements in both males and females across the age group. Improvements in BMI were less pronounced than in WHtR and BFI, though the triangulation of correlations shows they're all highly interconnected. Since weight alone is a poor indicator of physical health (i.e. muscle mass weighs more than fat mass), and studies have demonstrated that WHtR and BFI are better indicators of obesity comorbidities, and that the smaller changes in BMI are of less concern, it benefits to use multiple measures. Hence the Shae precision health and wellness program tracking each of these measures within the program itself, shown in the 'Track' section.

Although both men and women greatly improved their body measurements over the course of the program, women seemed to benefit most; especially in terms of losing body fat and reducing their waistline to below healthy cut offs. Impressively were the positive results in the women above 50 years of age; considering the increased difficulty of shrinking their waistline due to hormonal changes[96-98], this is a very impressive result.

Furthermore, this study found a clear trend that the longer someone participated in the program the more their body measurements decreased toward desirable healthy ranges. **The results of this study show that the virtual Shae precision health and wellness program is a viable tool for long-term weight management and decreasing individuals risk of health related diseases including diabetes and cardiovascular disease, and a broad range of debilitating issues including stroke[3], heart disease[4], hypertension[5], osteoarthritis[6], gallbladder disease[7], kidney disease[8], non-alcoholic fatty liver disease[9], gout[10,11], and sleep apnea[12].**

Appendix 1 - Calculation of Body Fat Index

For Males:

Using US Imperial Units:

BFI = 86.010×log10(abdomen-neck) - 70.041×log10(height) + 36.76

Using Metric Units:

BFI = 495/[1.0324 - 0.19077×log10(waist-neck)) + 0.15456×log10(height)] -450

For Females:

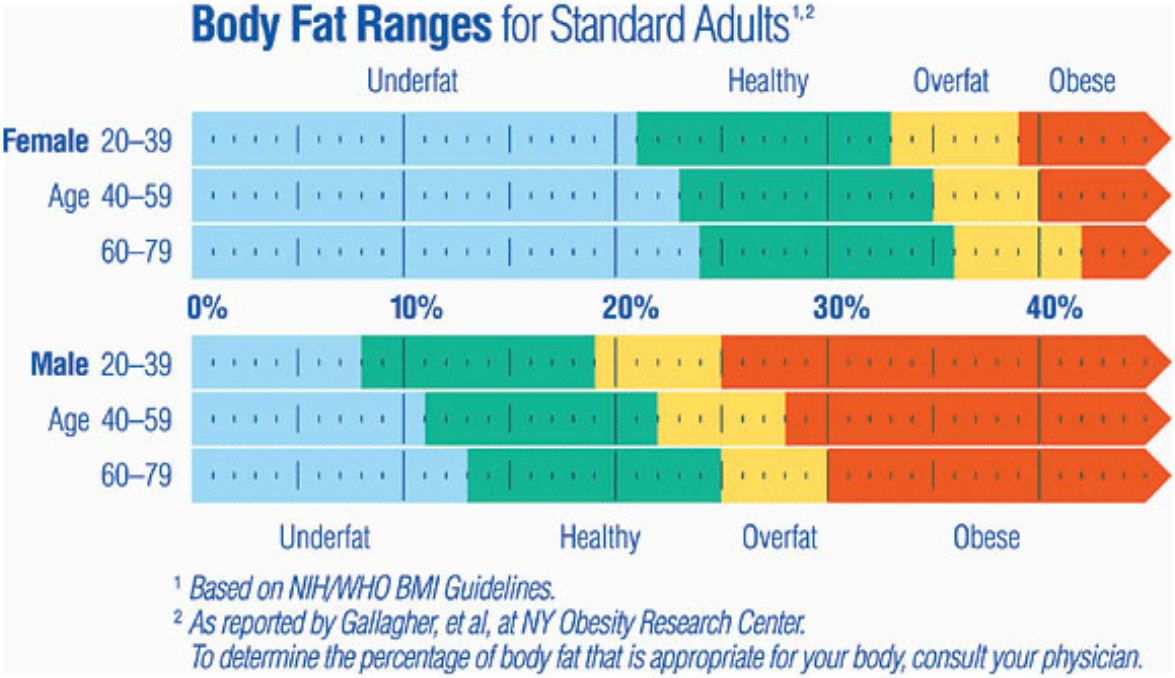
Using US Imperial Units:

BFI = 163.205×log10(waist+hip-neck) - 97.684×(log10(height)) + 36.76

Using Metric Units:

BFI = 495/[1.29579 - 0.35004×log10(waist+hip-neck) + 0.22100×log10(height)]-450

Appendix 2 - Table of Body Fat Ranges



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