Mini-Review

Obesity and its Classification: A Basic Review

Mousumi Hazorika[1]*, Abhijit Deka[1], Pallabi Devi[1], Sushanta Goswami[1], Manjyoti Bhuyan[1], Suparna Sen[2], Mridusmrita Buragohain[3], Utpal Barman[1] and Dhrubajyoti Borpujari[4]

[1]Department of Veterinary Clinical Complex, College of Veterinary Sciences, Assam Agricultural University, Khanapara, Guwahati, Assam, India

[2]Department of Biosciences and Bioengineering, Indian Institute of Technology, Guwahati, Assam, India

[3]Department of Veterinary Pathology, College of Veterinary Sciences, Assam Agricultural University, Khanapara, Guwahati, Assam, India

[4]Department of Animal Reproduction, Ganaecology and Obstetrics, College of Veterinary Sciences, Assam Agricultural University, Khanapara, Guwahati, Assam, India

*Corresponding Author: Mousumi Hazorika, Department of Veterinary Clinical Complex, College of Veterinary Sciences, Assam Agricultural University, Khanapara, Guwahati, Assam, India.

DOI: 10.31080/ASVS.2023.05.0743

Abstract

Obesity is considered as an important preventable disease of public health concern and ranked as the fifth foremost cause for death globally. Obesity is defined as an "abnormal or excessive fat accumulation that may impair health," further clarifying that "the fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended" (World Health Organization). Obesity can leads to numerous chronic diseases, including cancers, diabetes, metabolic syndrome, asthma, hypercholesterolemia and cardiovascular diseases. Early diagnosis of obesity is crucial for preventing the diseases associated with obesity. Thorough knowledge on the methods available for measuring Obesity is required for proper Obesity diagnosis. This review gives an idea regarding obesity and its classification which helps in early predictions of obesity and the risk of overweight thereby the associated disorders or diseases can be prevented.

Keywords: Obesity; Classification; Body Mass Index; Children; Pets

Introduction

Obesity is a medical condition of increased adipose tissue mass, sometimes considered as a disease [1]. Obesity can also be defined as an increase in body weight beyond the limits of physical requirement, as the result of an excessive accumulation of fat, to such a level that it undesirably affects health. Accumulation of fat or triacylglycerol is essentially the only way that body weight can become excessive, as other energy storage (*e.g.,* carbohydrate glycogen or protein in liver and muscle) does not have the potential of adipose tissue to exceed the limits of requirement.

Adipose tissue is a tissue entity that can, through hyperplasia and hypertrophy, vary enormously between individuals, more so than any other tissue. However, it is misleading to think of it as a single entity, as there are sub-types of adipose tissue (*e.g.,* visceral and subcutaneous) which appear to have different implications for health. Adipose tissue is not purely a storage tissue for triacylglycerols, it acts as an endocrine organ also, releasing numerous chemical messengers (adipokines) that communicate and affect other tissues.

Obesity has individual, socioeconomic, and environmental causes. Some of the known causes are diet, physical activity, automation, urbanization, genetic susceptibility, mental disorders, medications, economic policies, endocrine disorders, and exposure to endocrine-disrupting chemicals [2,3].

Obesity is undoubtedly a condition; it also aggravates pre-existing conditions and instigates new ones. Bischoff., et al. [4] reported that obesity can affect nearly every organ of the body, starting from the cardiovascular (CV) system to the endocrine system, central nervous system, and the gastrointestinal (GI) system. In addition, obesity is associated with the growing prevalence of several CV conditions, from hypertension and coronary heart disease (CHD) to atrial fibrillation (AF) and even total heart failure [5].

There is no such effective, well-defined, evidence-based intervention for preventing obesity. However, a majority of obese individuals at any given time attempt to lose weight and are often successful, maintaining weight loss long-term is rare [6]. Obesity prevention requires a complex approach, including interventions at societal, community, family, and individual levels [7]. Diet change and regular exercise are the main treatments recommended by health professionals [8]. Inclusion of good quality diet that are easily available, affordable, and accessible, which are rich sources of dietary fibre but low in fat and sugars. Medications can be used, along with a proper diet, to reduce appetite or decrease fat absorption [9]. If diet, exercise, and medication are not effective then a gastric balloon or surgery may be performed to reduce stomach volume or length of the intestines which leads to feeling full earlier, or less nutrients absorption from food [10].

Obesity is an important preventable cause of death worldwide, with increasing rates in adults and children [11]. Obesity is more common in women than in men. Today, obesity is stigmatized in most of the world. On the contrary in some cultures, past and present, obesity is considered as a symbol of wealth and fertility [12]. Nevertheless, in 2013, several medical societies, including the American Medical Association and the American Heart Association, classified obesity as a disease [13].

Classification of obesity

The World Health Organization (WHO) categorizes obesity by body mass index (BMI). BMI is further evaluated in terms of fat distribution *via* the waist–hip ratio and total cardiovascular risk factors [14].

Relative weight and body mass index (BMI) are nearly identical and are reasonable estimates of body fatness as measured by percentage body fat [15]. However, BMI does not account for the wide variation in body fat distribution and may not correspond to the same degree of fatness or associated health risk in different individuals and populations [16].

Other methods for measuring fat distribution includes the waist–hip ratio, Body Volume Index and body fat percentage. Normal weight obesity is a condition of having normal body weight, but high body fat percentages with the same health risks of obesity [17].

Body mass index (BMI)

Body mass index is a simple and extensively used technique for estimating body fat mass [18] and was developed in the 19th century by the Belgian statistician and anthropometrist Adolphe Quetelet [19]. BMI is considered as an accurate reflection of body fat percentage in the majority of the adult population except body builders and pregnant women [20].

According to World Health Organization (WHO, 2000) [21], body weight classification in terms of BMI is listed below

Category [16]	BMI (kg/m^2)
Underweight	< 18.5
Normal weight	18.5-24.9
Overweight	25.0-29.9
Obese (Class I)	30.0-34.9
Obese (Class II)	35.0-39.9
Obese (Class III)	40.0-49.9

Table a

Some modifications to the WHO definitions have been made by particular bodies. Surgical literature breaks down "class III" obesity into further categories whose exact values are still disputed.

Obesity Class-III	BMI (kg/m^2)
Severe obesity	≥ 35 or 40
Morbid obesity	≥ 35 and experiencing obesity-related health conditions
Super obesity	of ≥ 45 or 50

Table b

Asian populations develop negative health consequences at a lower BMI than Western populations, some nations have redefined obesity. The Japanese have defined obesity as any BMI greater than 25 [22]. while China defines it as any BMI of greater than 28 [23].

Body fat percentage

The preferred obesity metric in scholarly circles is the body fat percentage (BF%) Body fat percentage is total body fat expressed as a percentage of total body weight. There is no generally accepted definition of obesity based on total body fat. Many researchers have considered body fat percentage of more than 25% in men, and more than 30% in women, as cut-points to define obesity [24], however the use of these values have been doubtful [21]. Generally, levels in excess of 32% for women and 25% for men indicate obesity. Sumo wrestlers may be categorized as "severely obese" or "very severely obese" by BMI however, many Sumo wrestlers are not categorized as obese when body fat percentage is used instead (having <25% body fat) [25]. Some Sumo wrestlers were found to have similar body fat than a non-Sumo comparison group, with high BMI values resulting from their high amounts of lean body mass [25]. However, exact measurement of body fat percentage is much more difficult than BMI measurement. Several methods of body fat percentage measurement of fluctuating accuracy and complexity exist.

Body fat percentage can be estimated from a person's BMI by the following formula [26].

Adult (body fat percentage) = (1.39 × BMI) + (0.16 × Age) - (10.34 × Gender)- 9

where gender (sex) is 0 if female and 1 if male to account for the lower body fat percentage of men.

There are various other methods which determine body fat percentage. One of the most accurate methods for estimating body fat is hydrostatic weighing, includes weighing a person underwater. Some other Simpler and less accurate methods are there which have been used historically but are nowadays not recommended [27]. The first is the skinfold test, in which a pinch of skin is precisely measured to determine the thickness of the subcutaneous fat layer [28]. The other is bioelectrical impedance analysis which uses electrical resistance but shown to have no advantage over BMI [27].

Body fat percentage measurement techniques that are used for research include computed tomography (CT scan), magnetic resonance imaging (MRI), and dual energy X-ray absorptiometry (DEXA) [29]. These techniques provide very accurate measurements, but it can be difficult to obtain in the severely obese due to weight limits of most equipment and insufficient diameter of many CT or MRI scanners [30].

Body Volume Index (BVI)

Body volume index is a novel method for estimating body fat distribution. Human body volumes and body volume ratios and their links to body compositions have been researched for several years [31]. Later the term Body Volume Index (BVI) instead of ratio was introduced by Select Research and Mayo Clinic, BVI has been developed as an alternative to BMI [32]. BMI is not considered as an accurate method to measure obesity in many individuals because BMI doesn't account for muscle and fat distribution, or gender, or ethnicity.

Body volume index uses 3D technology to estimate overall body shape, identifying the places on the body where fat is deposited [33]. Body Volume means the conformation of a person and their body parts and each part of a person's body (arms, legs, chest, etc.) has its own shape (3D), weight and measurement. An increase in the fat and muscle volume normally corresponds with an increase or decrease of volume in that particular area of the body. BVI calculates a person's body fat composition from two images taken front and side on. A silhouette is drawn from these images and a 3D model created, from which a complete linear and volume measurements can be calculated. By comparing the 3D models to MRI data, BVI software is able to calculate out the fat distribution in general and visceral fat accumulated near the individual's organs in particular.

The BVI number has been considered by Mayo Clinic as an alternative to the BMI number which provides an indication of health risk on the basis of fat distribution with a particular emphasis on visceral fat; which is. Visceral fat is located around organs which is metabolically active, with high levels a known risk factor for metabolic disease which includes cardiovascular disease [34]. and diabetes type II [35].

Waist circumference and waist–hip ratio

In the United States, Central obesity is defined by two parameters *viz.* a waist circumference of >102 cm (≈40") in men and >88 cm (≈34.5") in women [36]. Or the waist-hip ratio (the circumference of the waist divided by that of the hips) of > 0.9 for men and > 0.85 for women [37]. In the European Union, waist circumference of ≥ 94 cm (≈37") in men and ≥ 80 cm (≈31.5") in non-pregnant women are considered as cut offs for central obesity. A lower cut off of 90 cm waist circumference has been recommended

for South Asian and Chinese men, while a cut off of 85 cm has been recommended for Japanese men [38].

In those with a BMI < 35, intra-abdominal body fat is related to negative health outcomes independent of total body fat [29]. Intra-abdominal or visceral fat has a strong correlation with cardiovascular disease [37]. In a study of 15,000 people, it was found that waist circumference more strongly correlated with metabolic syndrome than with BMI [39]. In both Women and man abdominal obesity is correlated with cardiovascular risk [40]. While in people with a BMI > 35, measurement of waist circumference however has little effect in the predicting Obesity along with BMI as majority of population with this BMI have abnormal waist circumferences [41].

Childhood obesity

Childhood obesity is a condition where excessive accumulation of body fat negatively affects the health or well-being of child. Due to the growing prevalence of obesity in children and its adverse health effects, it is being known as a serious public health concern. The term 'overweight' is often used when discussing childhood obesity rather than 'obese' as it is less stigmatizing, although the term 'overweight' can also refer to a different BMI category [42]. The prevalence of childhood obesity varies within sex and gender [43]. As like in adults, the diagnosis of childhood obesity is often based on BMI (Body mass index). BMI is usually used for determining obesity in children of ≥ 2 years of age by calculating the ratio of weight to height [44]. The healthy BMI range varies with the age and sex of the child. Childhood obesity has reached epidemic proportions in the 21st century with rising rates in both the developed and developing world. Similar to the obesity in adults, many different factors contribute to the rising rates of childhood obesity. Changing diet and decreasing physical activity are believed to be the two most important factors that causes the recent increase in the rate of obesity. Activities from self-propelled transport, to school physical education, and organized sports has been declining in many countries [45].

Because childhood obesity often persists into adulthood, and is associated with various chronic illnesses, it is important that children who are obese be tested for hypertension, diabetes, hyperlipidemia, and fatty liver [46].

Treatments used in children are primarily lifestyle interventions and behavioral techniques. Usually, medications are not preferred for use in this age group. Short-term weight management interventions in primary care (taken by a physician or nurse practitioner) have only a borderline positive effect in reducing childhood obesity. Multi-component behavior change interventions which include changes in dietary intake and physical activity may reduce short term BMI in children's however, the advantages are meagre and quality of evidence is also not up-to mark [47].

Obesity in pets

Obesity has become a common problem among pets nowadays. Obesity occurs when there is excessive dietary intake but inadequate utilization of energy. It can affect all kinds of pets and the most common causes are over-feeding and lack of exercise, although certain diseases like hypothyroidism and insulinoma can also cause obesity in pets. Overweight pets may exhibit symptoms like lethargy, intolerance for exercise, respiratory problems, and loss of mobility. It can also shorten the life span of pet animals, other than impacting their overall health. Obese pets may develop serious health problems like heart diseases, diabetes, osteoarthritis, respiratory problems, high blood pressure, and cardiovascular disease.

The most important reason for obesity in pets is the lifestyle of the pet owner, excessive consumption of commercial food along with an unbalanced feeding schedule. Pet should be always provided with natural food by their owner. Dr Gustavo Pinto, a veterinary doctor from Panjim, Goa, said "Other than that, old pets and the pets who are not doing well emotionally also tend to suffer from obesity,".

However, obesity in dogs is more often compared with cats or other pets. The risk of obesity in dogs is reported to be related to whether or not their owners are obese; however, there is no similar correlation between cats and their owners [48]. Restricting the treats and regular frequent exercise is found helpful in monitoring the weight of animals. Obesity is not just a rising problem in pets like dogs and cats, obesity has been affecting wild animals too. Recently, an obese monkey has been treated whose weight was five to six times more than the normal weight as reported by Dr Narendra Pardeshi, veterinarian, Small Animal Clinic, Pune.

Morbid obesity cannot be treated with exercise, needed laparoscopic surgery. In India, the very first laparoscopic surgery of a dog named Dipika of 50 Kg body weight suffering from hypothyroidism was performed by Dr Pardeshi along with Dr Shashank Shah, Laparoscopic bariatric surgeon of Laparo Obeso Centre, Pune [49]. Dogs body weight has been reducing week by week. In just a week after her surgery, her weight has reduced to 45 Kg, in next few weeks it reduced by 10-15 kg which help her in walking, which was not possible before the surgery.

Conclusion

The present article helps to understand the impact of obesity on the health of general population as well as in Childrens and in Pets. Identifying obesity at an early stage by using the appropriate method of obesity classification will helps to recognize upshots that supports to guide health authorities and public health in order to alleviate threats and effectively guide obese people globally.

As a preventive measure, every individual themselves and every pet owner also should take proper care of their lifestyle in order prevent obesity. A proper diet and a proper feeding schedule should be maintained and at the same time, regular exercise and happy environment is also considered necessary.

Conflict of Interest

The authors declare no conflict of interest.

Bibliography

1. Powell-Wiley TM., *et al*. "Obesity and Cardiovascular Disease: A Scientific Statement from the American Heart Association". *Circulation* 143.21 (2021):984-1010.

2. Kassotis CD., *et al*. "Endocrine-disrupting chemicals: economic, regulatory, and policy implications". *The Lancet. Diabetes and Endocrinology* 8.8 (2020): 719-730.

3. Bleich S., *et al*. "Why is the developed world obese?" *Annual Review of Public Health (Research Support)* 29 (2008): 273 295.

4. Stephan C., *et al*. "Towards a multidisciplinary approach to understand and manage obesity and related diseases". *Clinical Nutrition* 36.4 (2017): 917-938.

5. Carl J., *et al*. "Obesity and cardiovascular diseases: implications regarding fitness, fatness, and severity in the obesity paradox". *Journal of the American College of Cardiology* 63.14 (2014): 1345-1354.

6. Strohacker K., *et al*. "Consequences of Weight Cycling: An Increase in Disease Risk?" *International Journal of Exercise Science* 2.3 (2009):191-201.

7. Chiolero A. "Why causality, and not prediction, should guide obesity prevention policy". *The Lancet Public Health* 3.10 (2018): 461-462.

8. Yazdi FT., *et al*. "Obesity genetics in mouse and human: back and forth, and back again". *Peer Journal* 3 (2015): 856.

9. Yanovski SZ and Yanovski JA. "Long-term drug treatment for obesity: a systematic and clinical review". *Journal of the American Medical Association* 311 (2014): 74-86.

10. Colquitt JL., *et al*. "Surgery for weight loss in adults". *The Cochrane Database of Systematic Reviews (Meta-analysis, Review)* 8 (2014): CD003641.

11. Encyclopedia of Mental Health (2 Edition.). Academic Press (2015): 158.

12. Woodhouse R. "Obesity in art: a brief overview". *Frontiers of Hormone Research* 36(2008): 271-286.

13. Jensen MD., *et al*. "2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society". *Circulation* 129.25.2 (2014): 102-138.

14. Sweeting HN. "Measurement and definitions of obesity in childhood and adolescence: a field guide for the uninitiated". *Nutrition Journal* 6.1 (2007): 32.

15. Gray DS and Fujioka K. "Use of relative weight and Body Mass Index for the determination of adiposity". *Journal of Clinical Epidemiology* 44.6 (1991): 545-550.

16. Sweeting HN. "Measurement and Definitions of Obesity In Childhood and Adolescence: A field guide for the uninitiated". *Nutrition Journal* 6.1 (2007): 32.

17. Katherine Zeratsky RD. "Normal weight obesity: A hidden health risk?: Can you be considered obese if you have a normal body weight?" *Mayo Clinic - Obesity Expert Answers* (2009).

18. Mei., *et al*. "Validity of body mass index compared with other body-composition screening indexes for the assessment of body fatness in children and adolescents". *American Journal of Clinical Nutrition* 75.6 (2002): 978-985.

19. Quetelet LAJ. "Antropométrie ou Mesure des Différences Facultés de l'Homme". Brussels: Musquardt (1871).

20. NHLBI 60.

21. WHO (2000): 7.

22. Kanazawa M., *et al*. "Criteria and classification of obesity in Japan and Asia-Oceania". *Asia Pacific Journal of Clinical Nutrition* 11.8 (2002): 732-737.

23. Bei-Fan Z. "Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults: study on optimal cut-off points of body mass index and waist circumference in Chinese adults". *Asia Pacific Journal of Clinical Nutrition* 11.8 (2002): 685-693.

24. Okorodudu., *et al*. "Diagnostic performance of body mass index to identify obesity as defined by body adiposity: a systematic review and meta-analysis". *International Journal of Obesity* 34.5 (2010): 791-799.

25. Yamauchi T., *et al*. "Body composition and resting metabolic rate of Japanese college Sumo wrestlers and non-athlete students: are Sumo wrestlers obese?" *Anthropological Science* 112.2 (2004): 179-185.

26. Jessica B. "How to Convert BMI to Body Fat Percentage". *International Journal of Obesity and Related Metabolic Disorders* (2002) (2017).

27. NICE (2006): 36.

28. Jebb and Wells (2005): 16.

29. U.S. Preventive Services Task Force Evidence Syntheses. "HSTAT: Guide to Clinical Preventive Services". (2000). (3rd Edition). Recommendations and Systematic Evidence Reviews, Guide to Community Preventive Services.

30. Jebb and Wells 2005 p.20

31. Olivares J., *et al*. "Comparisons of body volumes and dimensions using three-dimensional photonic scanning in adult Hispanic-Americans and Caucasian-Americans". *Journal of Diabetes Science and Technology* 1.6 (2007): 921-928.

32. "About BVI". Archived from the original on (2018).

33. Abd T. "Body volume index: time to replace body mass index?" *Endocrine Abstracts* 15 (2008): 104.

34. Van Gaal LF. "Mechanisms linking obesity with cardiovascular disease". *Hypertension and Diabetes Type II* 444.7121 (2006): 875-880.

35. Kahn SE., *et al*. "Mechanisms linking obesity to insulin resistance and type 2 diabetes". *Nature* 444.7121(2006): 840-846.

36. Janssen I., *et al*. "Body mass index, waist circumference, and health risk: evidence in support of current National Institutes of Health guidelines". *Archives of Internal Medicine* 162.18 (2002): 2074-2079.

37. Yusuf S., *et al*. "Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): Case-control study". *Lancet* 364.9438 (2004): 937-952.

38. Tsigosa C., *et al*. "Management of Obesity in Adults: European Clinical Practice Guidelines". *The European Journal of Obesity* 1.2 (2008): 106-116.

39. Janssen I., *et al*. "Waist circumference and not body mass index explains obesity-related health risk". *American Journal of Clinical Nutrition* 79.3 (2004): 379-384.

40. Larsson B., *et al*. "Is abdominal body fat distribution a major explanation for the sex difference in the incidence of myocardial infarction? The study of men born in 1913 and the study of women, Göteborg, Sweden". *American Journal of Epidemiology* 135.3 (1992): 266-273.

41. "Morbidity and Mortality: Chartbook of Cardiovascular, Lung and Blood Diseases". Bethesda, MD: National Institutes of Health. (1998). National Heart, Lung and Blood Institute (1998): 61.

42. Bessesen DH. "Update on obesity". *Journal of Clinical Endocrinology and Metabolism* 93.6 (2006): 2027-2034.

43. Shah B., *et al*. "Sex and gender differences in childhood obesity: contributing to the research agenda". *BMJ Nutrition, Prevention and Health* 3.2 (2020): 387-390.

44. Deurenberg P., *et al*. "Body mass index as a measure of body fatness: age- and sex-specific prediction formulas". *British Journal of Nutrition* 65.2 (1991): 105-114.

45. Dollman J., *et al*. "Evidence for secular trends in children's physical activity behaviour". *British Journal of Sports Medicine* 39.12 (2005): 892-897.

46. Fennoy I. "Childhood Obesity, Part 1: Weight Evaluation and Comorbidity Screening". *Consultant for Pediatricians* (2008).

47. Mead E., *et al*. "Diet, physical activity and behavioural interventions for the treatment of overweight or obese children from the age of 6 to 11 years". *The Cochrane Database of Systematic Reviews* 6 (2017): CD012651.

48. Nijland ML., *et al*. "Overweight in dogs, but not in cats, is related to overweight in their owners". *Public Health Nutrition* 13.1 (2010): 102-106.

49. "Obesity in animals: Symptoms, causes and treatment". The Indian express. *JOURNALISM OF COURAGE* (2023).