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The Crisis of Obesity

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Abstract

The prevalence of overweight and obesity is increasing in nearly every country around the world and that this public health crisis even affects infants and children of pre-school age. In discussing obesity, the prevalence, definition and the health and economic consequences of this global crisis are discussed, with a specific focus on childhood obesity.

Keywords: Obesity; Overweight; Public health; Population

The Prevalence of Obesity

Since 1980, the global prevalence of obesity has risen threefold, and since 1998 the WHO has recognised obesity as a problem of epidemic proportions [1]. In 2008, an estimated 1.46 billion adults worldwide were overweight; of these, 502 million people were obese [2]. The rates of overweight and obesity around the world have been observed to be higher in economically developed regions than in economically developing regions. However, developing regions are predicted to experience a higher proportional increase than developed regions in the number of overweight and obese people in their populations between 2005 and 2030, due to several factors: population growth, population aging, urbanisation and lifestyle changes [3].

The prevalence of overweight and obesity among children and adolescents has been observed to have followed a similar pattern to the prevalence among adults, with dramatic increases reported around the world over the past thirty years [4]. For example, a study by de described the global prevalence and patterns of overweight and obesity among pre-school children. The study analysed 450 nationally representative cross-sectional surveys from 144 countries worldwide between 1990-2010, and found a relative increase of 21% in the first decade and a 31% increase in the second decade in terms of the prevalence of overweight and obesity among countries' populations, while the projection given for the expected relative increase for 2010– 2020 was 36% [5].

It is also important to consider the contrast between rates of prevalence in developed and developing countries. The US can be regarded as a good example of the severity of the obesity problem in the developed world. An analysis of National Health and Nutrition Examination Survey (NHANES) data for the US between 1980 and 2008 revealed that "obesity doubled (5.0% to 10.4%) among children aged 2–5 years, tripled (6.5% to 19.6%) in children aged 6–11 years, and almost quadrupled (5.0% to 18.1%) in adolescents aged 12–19 years" [6]. It is also important to note that although the rates of overweight and obesity among young children living in developed areas of the world are approximately twice the level of those in developing countries (11.7% and 6.1%, respectively), the vast majority of affected children are living in developing countries when measured in absolute terms (35 million of a total of 43 million) [5]. Perhaps surprisingly, a number of recent epidemiological studies have found that the problem of overweight and obesity extends even to children who are under two years of age [6,7]. The most important consequence of being overweight or obese during the early years of the life is the tracking of adiposity through childhood to adulthood [8]. A longitudinal study by Vogels provides a good example of the tracking of very young children's weight status over time, as it examined the patterns of BMI from birth until the age of 12 in a cohort of Dutch children who were born between 1990 and 1993. The results of this study indicated that the children's BMI at 12 years of age significantly tracked their BMI in the first year of life.

The Definition of Obesity

Obesity is defined by the WHO (2013) as "abnormal or excessive fat accumulation that may impair health". It is widely believed that the most useful measure of the level of overweight and obesity in a population is the BMI, which can be calculated using a ratio involving an individual's weight in kilograms and the square of the individual's height in metres (kg/m^2) [9,10]. The BMI has been used extensively in epidemiological research to evaluate the health outcomes associated with different classifications of body [11]. BMI has certain obvious advantages which explain its wide usage: it is derived from measurements of height and weight which are simple and accurate to take, and this means that it is an inexpensive method to use [12]. However, BMI does also have one main limitation which should be borne in mind, which is that it is only a surrogate marker of an individual's body fat and does not provide precise information about their body composition [11].

The two sub-sections which follow outline the use of BMI in defining overweight and obesity in adults, and in children and adolescents, respectively.

Using BMI for adults

Over the past few decades, overweight and obesity have mostly been diagnosed using the BMI calculation (kg/m^2) [13]. This has been widely used because it offers a reasonable measure of general adiposity in adults [14]. A number of epidemiological studies have observed that a higher level of BMI is a major risk indicator for several causes of death, including coronary heart disease, stroke, type 2 diabetes and some cancers [10,14]. Accordingly, the cut-off points of the definition of overweight and obesity for individuals over the age of 20 are related to functional outcomes of mortality and morbidity [15]. The WHO [16] defines overweight as a BMI of between 25 and 29.9 kg/m^2, while obesity is defined as a BMI of 30 kg/m^2 or greater. It is important to note that these BMI cut-offs are the same for both male and female adults and do not vary with age [17].

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Using BMI for children and adolescents

The use of BMI to define overweight and obesity among children and adolescents is much more complex than it is for adults, as BMI varies with age and sex for children and adolescents. Because of this, BMI must be compared to a reference standard that accounts for subjects' age and sex for it to be meaningfully used in relation to children and adolescents [1]. A number of national and international reference standards have been constructed [15] and examples now follow.

In the UK, the 1990 BMI reference is the most commonly used adjustment tool to define overweight and obesity in children and adolescents at a population level. The UK 1990 reference was developed from height and weight data collected in 1990 on a nationally representative sample of approximately 30,000 individuals, from birth to 23 years of age [18]. A similar national reference standard exists for the US, and this US BMI reference is based on nationally representative data gathered from all US children aged between two and 20 years, and collected between 1963 and 1980 [19,20]. Further, there are also presently two international BMI references which can be used to define overweight and obesity for children and adolescents: the International Obesity Task Force (IOTF) reference and the WHO standard [9,21].

The BMI references mentioned above, whether national or international, can all be used to convert the BMI values for individual children and adolescents into BMI z-scores or BMI percentiles. This process allows comparisons of the BMI across different ages and by gender [18]. Both BMI z-scores (also known as BMI standard deviation scores (SDS)) and BMI percentiles represent a subject's relative weight which has been adjusted according to their age and sex, and cannot therefore simply be taken as a measure of a child or adolescent's weight and height [6]. It is important to mention here that BMI z-scores and BMI percentiles can be regarded as equivalent to one another, and that each can be transformed into the other via a straightforward mathematical process. Generally, in research applications, either BMI z-scores or BMI percentiles are used to determine cut-off values and to provide a classification of the different weight statuses of children and adolescents [6].

Given the above, children and adolescents can be defined as overweight or obese using a variety of BMI reference cut-offs [6,18]. It should be pointed out that the cut-offs which are used to define overweight and obesity in children and adolescents are based purely on statistical information, and do not make reference to health risk, whereas, as has been mentioned above, the cut-offs defining obesity and overweight among adults are linked to health risk [22-24]. As a result, the identification of cut-off values defining overweight and obesity for children and adolescents will vary depending on the assumptions which have been made. This is because there no consensus has yet been reached on which risk related criteria are most appropriate. For this reason, the cut-offs which are currently used to identify overweight and obesity for children and adolescents vary considerably across different countries [18,22,24].

This problem extends to infants and young children. There is currently no consensus on the definition of overweight and obesity with respect to infants and children who are younger than 2 years old. However, the 95th percentile of the weight-for-length ratio is often used to define overweight for this age group [24].

Other measures of obesity

Besides BMI, which represents a simple anthropometric measurement as mentioned above, other anthropometric measurements (i.e. skinfold thickness and circumference), which are deemed to provide more accurate estimates of body composition than BMI, may also be used. However, it should be considered that these measurements have a more limited applicability than BMI to screen and study large populations [18,25]. These two alternative measurements, skinfold thickness and circumference, are now discussed in turn in the following sub-sections.

Skinfold thickness: Skinfold thickness is often measured in children and adolescents, either at population level or at individual level, in order to provide a good estimate of total body fat [26]. This anthropometric technique relies on the fact that the amount of fat found immediately under the skin (which is known as subcutaneous fat) is deemed to be in direct proportion to a subject's total level of body fat [27]. Subcutaneous fat is estimated by taking measurements of its thickness using a skinfold caliper at different parts of the subject's body. In measuring subcutaneous fat in children, the body areas which are most commonly used are the upper arm (biceps and triceps) and under the scapula (subscapular) [28]. Skinfold thickness is more strongly correlated with total body fat tissue than BMI [29].

Measuring skinfold thickness has certain advantages and disadvantages. The first of the advantages is that, because of this stronger correlation with the subject's overall level of fatness, it is often argued that skinfold thickness measurements are more accurate predictors of health risks than BMI [15]. Secondly, as with BMI measurement, the procedure is relatively quick, inexpensive, non-invasive and requires only simple technology. The disadvantages of the technique are that, firstly, it requires the careful training of observers [30]. Secondly, skinfold measurement is subject to imprecision due to inter-observer variability. Lastly, and most importantly, it can be difficult to accurately take skinfold measurement from very obese subjects; this is clearly problematic as these subjects are often of core importance in studies of overweight and obesity [31].

Body circumference: Body circumference is another anthropometric technique that can be used to estimate fat distribution in children and adolescents [28]. The principle behind this technique is that a subject's circumference measurement reflects their fat and fat-free mass (FFM) levels, and that skeletal size is directly related to FFM [32]. Waist, hip, and thigh circumferences are often used in the prediction of body fat distribution among children and adolescents, and waist and hip circumferences are seen as particularly accurate predictors of intra-abdominal adipose tissue [28].

Measuring body circumference has certain advantages and disadvantages. The first of the advantages is that, in common with BMI, circumferences are simply measured, a process which is quick, cheap, and safe [33]. Secondly, in contrast to skinfold thickness, body circumference can always be measured without problems, even in extremely obese subjects. The first disadvantage of this method are that the interpretation of circumference measurements is often not straightforward, because circumferences are influenced by variations in muscle and bone development, and they also reflect internal as well as subcutaneous adipose tissue [34]. Secondly, simple circumference measurements appear to be similar to BMI in the screening of adiposity [30].

The Health Consequences of Obesity

As Albu has observed, "obesity is a public health concern because of its contribution to the development of a number of chronic diseases that lead to increased morbidity and increased mortality." Obesity is

most often an important risk factor in relation to chronic diseases such as type 2 diabetes, hypertension, cardiovascular diseases (particularly heart disease and stroke), metabolic syndrome, and some cancers (such as endometrial, breast, and colon cancer) [35]. The following sub-sections discuss obesity's correlation with some of the most common diseases whose prevalence has been observed to be increasing as a consequence of the growing crisis of obesity.

Obesity and Type 2 Diabetes

Very strong associations have been observed between type 2 diabetes and obesity. It has been estimated that 80% of individuals with type 2 diabetes are overweight or obese [36]. Prior studies have found that the relationship between BMI and type 2 diabetes among adults is likely to be stronger than that of any other obesity co-morbidity [24]. This was also the conclusion reached by Guh [37] who presented a meta-analysis of 89 studies which estimated the incidence of various co-morbidities related to obesity, and found that obesity (defined by BMI) showed a stronger association with incidences of type 2 diabetes than that of any other co-morbidity.

Type 2 diabetes tends to have a very low prevalence among children and adolescents, but it is still of growing concern because its prevalence is rapidly increasing. This increase is especially evident among, on the one hand, obese children and adolescents who have a strong family history of type 2 diabetes and who are from certain ethnic groups, and on the other hand, those who are markedly obese by adult standards, or a combination of these factors [38,24]. Examples of these specific risk groups were provided when the first UK children with type 2 diabetes were identified in 2000. These children were all overweight and came from a family background containing at least two generations with type 2 diabetes. More specifically, the children were eight girls of Pakistani, Indian, or Arabic origin who were aged between 9–16 years, and subsequently there was a further report of four obese white UK children with type 2 diabetes two years later [24,39,40]. It therefore appears that both obesity and a family history of type 2 diabetes can be linked to a high risk of developing type 2 diabetes among children and adolescents [41].

Obesity and hypertension

Hypertension is one of the most common global diseases and, as such, it is an important public health issue around the world. An obese individual faces a five times higher risk of hypertension than an individual who is at a normal weight level. Around 60% of hypertension cases are believed to be associated with overweight or obesity [36]. It has been demonstrated that there is an increased risk of developing hypertension at a BMI ≥23, and also that blood pressure usually improves along with weight reduction [42].

Although it is usually thought of as a condition which affects older adults, hypertension is in fact also found in some children and adolescents. The rates of hypertension in children and adolescents are increasing, and this is broadly attributed to the epidemic of childhood obesity [43]. A report on this issue by Tu offered further insights into the influence of excess bodyweight on blood pressure levels among children [44]. Authors analysed data from a cohort of healthy children recruited from schools in Indianapolis, and examined them longitudinally. The prevalence of high blood pressure among the children was observed to be low and was roughly the same across the different BMI levels up to the 85th percentile of BMI. Once the 85th BMI percentile was exceeded, however, a marked increase in high blood pressure rates was noted.

Obesity and cardiovascular disease (CVD)

Obesity is now considered to be a major independent risk factor for the development of cardiovascular disease (CVD) [38,45]. This association has been shown to exist among both men and women. Moore & Pi-Sunyer found that the risk of CVD increased with increasing levels of obesity, and that it follows that weight loss can lead to an improved cardiovascular condition [38]. As has been discussed above in relation to type 2 diabetes, ethnic differences also play a significant role in the relationship between obesity and CVD risk; so, for example, African American individuals may be at a lower risk at a given BMI than white people, while individuals of Asian descent are most at risk. This is likely to be due to ethnic differences in average body-fat distribution [24].

It had previously been thought that obese children and adolescents were not at risk of developing CVD until adulthood. However, contrary to this belief, it has recently been shown that obese children and adolescents can, in fact, have both short-term and long-term CVD symptoms [46]. Indeed, the association of obesity with CVD has been traced at relatively young ages [47]. McGill Jr for instance, found in their study that obesity among male adolescents and young adults is correlated with accelerated coronary atherosclerosis [48]. McGill, Jr. et al. also indicated that their findings were consistent with the results of some long-term cohort studies [49,50], which had showed that the existence of obesity at a young age can be used as a predictor for coronary heart disease in later life. The authors added that when taken together, their own results and those of the cohort studies which they cited show that obesity among adolescents and young adults can accelerate the development of atherosclerosis decades before any clinical signs of the condition appear. The authors concluded that obesity "is an important modifiable contributor to coronary atherosclerosis and efforts to control childhood obesity are justified for the long-range prevention of coronary heart disease as well as other chronic diseases" [48].

Other health consequences of obesity

Considerable evidence exists which illustrates that excess bodyweight is a significant risk factor in the development of non-communicable diseases, such as respiratory diseases, chronic kidney diseases, musculoskeletal disorders, gastrointestinal and hepatic disorders, lower physical functioning performance and psychological problems [9]. As an example of the last condition listed here, Strauss observed that overweight children who are as young as five might develop a negative self-image, while obese adolescents can show lower levels of self-esteem which carry symptoms of feelings of sadness, loneliness, and/or nervousness [51]. These individuals are consequently more likely to engage in high-risk behaviours such as smoking or underage drinking.

The Economic Consequences of Obesity

The global epidemic of obesity imposes large financial burdens on national economies, due to the increased risk of the costly chronic illnesses associated with obesity and of the consequent increased healthcare requirements [21]. Overweight and obesity involve societal costs which are frequently classified into two distinct categories: direct and indirect costs. The former category includes direct medical costs which include prevention, diagnostics, treatment services, pharmaceuticals, and other costs involved in delivering health services. The latter, indirect costs are more wide-ranging and relate both to morbidity and mortality costs, e.g. the economic activity and wealth lost from decreased productivity and absenteeism, and the future economic

wealth lost due to premature death, respectively [38]. Examples of these direct and indirect costs are now given in turn.

With regard to the direct costs of overweight and obesity, a recent systematic review conducted by Withrow & Alter assessed the literature between 1990 and June 2009 and estimated that obesity accounted for between 0.7% (from a French study) and 2.8% (from a US Study) of total national healthcare expenditure [52]. It also calculated that obese individuals had medical costs which were approximately 30% higher than their peers with normal bodyweights.

Turning to the indirect costs of obesity, Trogdon carried out a review of the existing literature reviews and found obesity to have a negative impact on workplace productivity and indirect costs in many developed societies [53,54]. When they are compared with counterparts at normal bodyweights, obese workers were observed to miss more days from work due to short-term absences and/or longer-term disabilities.

Conclusion

Dramatic increases have been observed in the prevalence of overweight and obesity among children and adolescents around the world over the past thirty years and, as has been mentioned above, a number of recent epidemiological studies have found that this problem of overweight and obesity even extends to children of fewer than two years of age. With regard to the health consequences of obesity, several studies have reported that the most important consequence of being overweight or obese during these early years of life is the tracking of adiposity through childhood to adulthood; this is critical because early obesity which then tracks onwards to adult life is likely to contribute to the establishment of numerous chronic diseases.

The global epidemic of obesity which has been reported carries the implication of enormous financial burdens on national economies, due to the increased risk of the numerous chronic illnesses which are associated with obesity and the consequent expense of increased healthcare capabilities to treat them. The extensive literature review by Lanigan argued that children's early lives are a critical period of time with regard to the possible development of overweight and obesity in later life, and are therefore also a vital time period within which prevention can take place [55]. If this prevention is successful, then some of the massive healthcare costs associated with obesity might be avoided.

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