Obesity and BMI in the aging population - an epidemiologic perspective

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Fetma är ett snabbt växande hot mot folkhälsan och är nu en av de största orsakerna till ohälsa i världen. På grund av ökande livslängd och den tillhörande ökande populationen av äldre, blir det mer och mer viktigt att undersöka sambandet mellan fetma och åldrande. Fetmaepidemin existerar inom alla delar av det nordiska samhället, dock finns det visst belägg för att äldre kvinnor är mindre utsatta än andra delar av befolkningen. Trots att viss ökning av vikt är normal under åldrandet, förblir den accepterade definitionen av fetma (BMI ≥30) densamma för alla vuxna oavsett ålder. Forskningen ger vissa indikationer att risken för dödlighet på grund av övervikt är högre bland de yngre vuxna än bland de äldre.

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The epidemic of obesity

Definitions

The prevalences of overweight and obesity are increasing at an alarming rate worldwide, as documented in a WHO technical report entitled "Obesity: Preventing and Managing the Global Epidemic (1). Obesity is frequently defined as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired, but there has been much debate about how to define "excessive", and whether the same definitions can be used in populations with different age, gender and ethnic backgrounds. For the purpose of monitoring global trends in overweight and obesity in a consistent manner, a simplified classification system has been widely adopted based on cut-points of body mass index (BMI=weight in kg divided by height in meters squared) (1). Specifically, a BMI above or equal to 25 kg/m^2 is referred to as *overweight*, and a BMI above or equal 30 kg/m^2 is referred to as *obese*. Values above 30 kg/m^2 are further subdivided into 3 graded classes of obesity, as described in *table 1*. BMI values between 18.5 kg/m^2 and 24.9 kg/m^2 are within *normal range* while values below 18.5 kg/m^2 are considered *underweight*. It is important to emphasize the fact that current WHO criteria for overweight and obesity in adults are not age- or sex-specific, but rather are fixed for all adult age groups of both genders. According to the WHO MONICA studies, which used these cutpoints to estimate prevalences of obesity in the 1980's, the lowest rates in Europe were observed in Göteborg, Sweden, with observed prevalences under 10% in men and women (1). Substantially higher rates were observed in other countries, particularly in central and eastern Europe.

Table 1 Classification of overweight in adults according to BMI (from 1).

Classification	BMI (kg/m2)	Risk of co-morbidities
Underweight	<18.5	Low (but risk of other clinical problems increased)
Normal range	18.5-24.9	Average
Overweight	≥ 25	
Pre-obese	25-29.9	Increased
Obese class I	30.0-34.9	Moderate
Obese class II	35.0-39.9	Severe
Obese class III	≥ 40.0	Very severe

The waist-hip circumference ratio and the waist circumference are frequently employed as alternative measures of central obesity which have proved useful for studying obesity-related health risks. Commonly used cut-points for the WHR are 1.0 in men and 0.85 in women, while waist circumference values of 102 cm and 88 cm in men and women respectively are considered to indicate substantially increased risk of metabolic complications (1).

As mentioned previously, the cut-points for overweight, obesity, and central obesity are not differentiated according to age. In this context, it is important to emphasize that the group of elderly - defined as 65 years of age and older - is extremely heterogeneous regarding factors such as prevalence of disease, socio-economic conditions, and even age *per se,* with an age span of more than 40 years. Differences exist in body composition and its relation to disease in this higher age group compared to young adults. Thus, use of a fixed cut point for all ages results in misclassification in overweight and obesity particularly in the elderly.

Secular trends in BMI by age

Using the standard WHO definitions, the prevalence changes in older and younger adults may be monitored within populations over time. In Sweden, age-specific secular trends in overweight have been reported from a nationally representative survey of Swedes aged 16 years and above (2). As shown in *figures 1 and 2*, prevalences of overweight in men and women increased between the early 1980's and the late 1990's in all age and sex groups. The largest increments were seen in middle-aged men and in younger women. Interestingly, although there was a suggestion of some increases in overweight among middle-aged and older female cohorts, these trends did not reach statistical significance.

With regard to the gender differences observed in older populations at the national level, this finding has been replicated in the geron-tological and geriatric population studies in Göteborg, Sweden –the H70 studies. Specifically, mean BMI levels increased from 25.7 kg/m^2 among 70-year-old men examined in 1971 to 26.9 kg/m^2 in 70 year olds examined in 1993, corresponding to increases in both height (+3 cm) and particularly weight (+7 kg) (3). In contrast 70 year old female cohorts did not on average differ in body mass index, although heights and weights both increased.

Interestingly, this type of age and gender specificity in BMI trends has also been reported in Finland. Between 1982 and 1997, strong secular increases in body mass index were seen among young adult Finns (25-34 years) of both sexes (4). In contrast, among

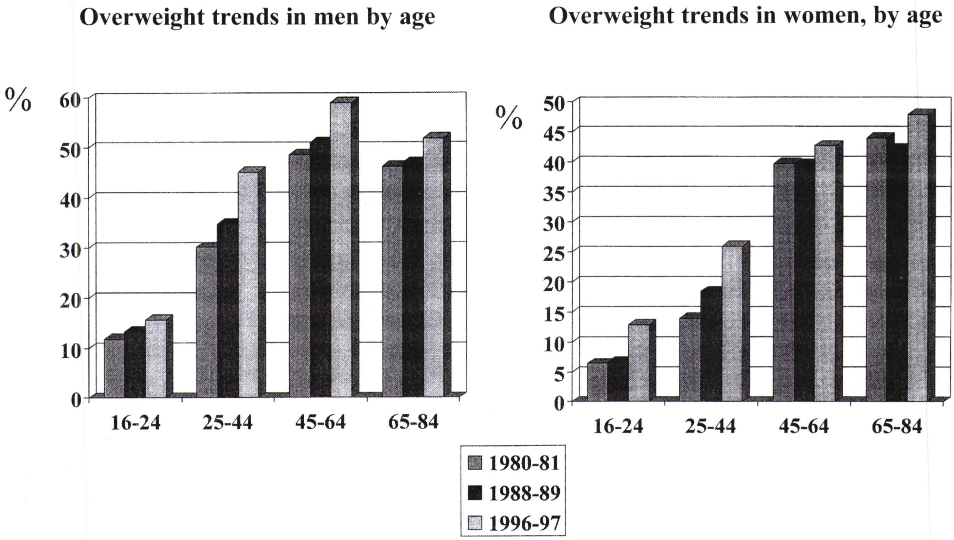

Figure 1-2. Secular trends in overweight prevalence (% BMI >25) among Swedish men and women, by age group, adapted from (2).

somewhat older Finns (55-64 years), secular increases in obesity were prominent in men only. As in the Swedish populations described previously, no such increases were found in older Finnish women. Thus, the population of older Finnish (like the Swedish) women appear to have been least affected by the epidemic of obesity, in contrast to the situation in younger women and in men of all ages.

Secular trends in central obesity

Interest in the distribution of body fat as a risk marker has resulted in the collection of waist and hip circumference measures in a number of cohort studies. Based on these measurements, investigators have been able to describe cohort differences in fat patterning, as well as BMI. A secular increased icentralized body fat, first observed in middle-aged female cohorts in Sweden (5) was subsequently confirmed in Finnish men and women, most clearly in older (55-64y) female cohorts (6). Recent examination of data from 70-year old women in Gothenburg has provided further evidence of masculinization of body fat patterning in older female populations (Cabrera C et al, unpublished).

70-åriga kvinnliga kohorter undersökta under 70-talet resp 90-talet hade samma BMI, trots att längd och vikt ökade.

Weight development in normal aging

Cross-sectional studies

The two principal methods to assess the effect of age on BMI or fatness are the cross-sectional and longitudinal designs; comparisons between these two approaches have been extensively documented for a number of age-related indicators (7). Briefly, the cross-sectional approach is characterized by measurements made at approximately the same time on a large number of subjects covering the entire adult age span. Age changes are not measured directly but are inferred from differences in mean values observed in different age groups or from the overall regression of the measurement on age. Caution is necessary in this approach, since differences between age groups include birth cohort as well as age effects. Moreover, since the occurrence of many diseases increases with advancing age, one of the primary problems in attributing differences between groups of subjects to aging *per se* is the necessity of excluding subjects with prevalent diseases that influence body composition. Finally, effects of differential mortality complicate interpretation of cross-sectional descriptions of weight "development", since death occurs more frequently among old than young subjects. By age 70 the population available for study may represent only about half of the original birth cohort (7). In summary, due to loss to follow up from early mortality, cross-sectional comparisons are of limited value when studying how individuals age.

Överviktsprevalensen hos män börjar sjunka efter 60 års ålder

Using cross-sectional data, a typical pattern of age-related prevalence can be seen above in Figures 1-2. Specifically, these data show that the prevalence of overweight in men has a distinct peak around the 7[th] decade of life at which time the fraction of overweight men decreases. The picture was somewhat different in female samples, which in this study displayed no pattern of decreasing BMI at older ages. In other studies of elderly women, a delayed or less pronounced peak may emerge, compared to male cohorts.

The longitudinal approach

In contrast, the longitudinal method is characterized by serial measurements of BMI or fatness on the same subject as aging occurs, thus identifying age changes in individuals.

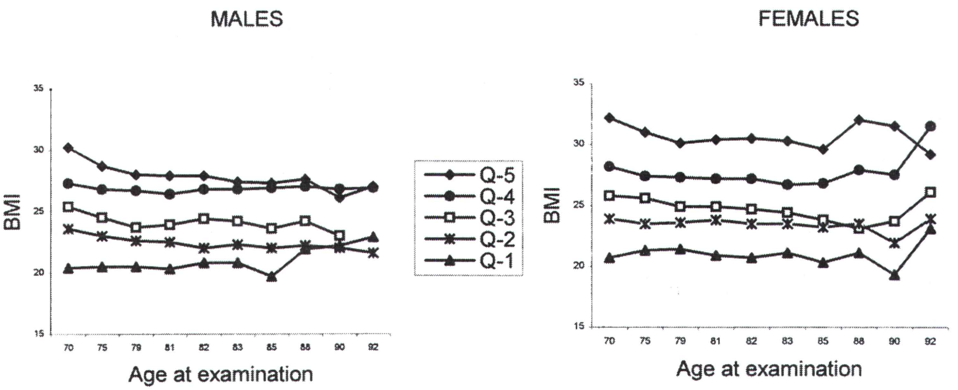

Figure 3. Longitudinal changes in body mass index (BMI) quintiles from age 70 (from 8)

This type of study will typically observe losses of both weight and height in the elderly, which together may or may not also result in loss of body mass index. Some of the limitations of cross-sectional studies of aging can be minimized or overcome by a longitudal design. An example of longitudinal data on BMI in 70-year olds are given in *Figure 3* (8). These data also raise some problematic issues in studying BMI in the elderly that are not overcome by the longitudinal design, for instance, spinal compression in very elderly women may result in underestimates of height and thus overestimates of BMI, contributing both random variability and bias to the age-trends. It should also be kept in mind that the sample size in longitudinal studies of the very old become inevitably quite small and selective.

In population-based epidemiologic studies, BIA (bioelectric impedance) is generally the method of choice. Direct measures of body composition, collected longitudinally, have shed light on the components that are contributing to changes in weight, height and BMI. Longitudinal body composition studies have generally documented that weight losses in elderly populations consist disproportionately of body cell mass, particularly in males; by age 70 human skeletal muscle has lost 40 percent of its maximal weight relative to early adult life (9).

Age-related changes in body composition result in a higher fraction of body fat and more centralized fat in the elderly than young adults at any given BMI and also decrease the sensitivity of BMI cut points with respect to body fatness in the aged. Waist circumference and waist-hip ratio, in contrast to BMI, may in some instances be better correlates of total body fatnes in the elderly.

Hälsokonsekvenserna av BMI-förändringar under åldrandet är inte väl utforskat

Impact of age on the effect of obesity on mortality and morbidity

Age, body weight and health

The health consequences of these changes in BMI and body composition during the aging process are not well understood. Although there is general agreement that obesity is associated with a number of major conditions such as coronary heart disaease, hypertension, cerebrol vascular disease, glucose intolerance and osteoarthritis of the weight-bearing joints, much of the research on obesity-related comorbidities has been conducted in middle-aged or relatively young adults (10).

The relation of geriatric obesity to total mortality is even less clear. For a number of years, there has been an ongoing debate on whether the impact of obesity on mortality is in any way modified by age. A 1985 paper by Andres based on data from the Build Study (11) has driven the discussion as to whether an individual's optimal BMI level changes with advancing age. These data suggested that the BMI associated with the lowest mortality shifted upwards in older age groups. Specifically, in this re-analysis of published data from subscribers to 25 North American life insurance companies, the ”nadirs” or points of minimal mortality on the BMI-mortality curve were shown to increase across age groups. When viewed in this way, the optimal BMIs were 21.4 and 19.5 kg/m^2 in young men and women respectively, compared to 26.6 and 27.3 kg/m^2 in men and women in their 60s. Smokers and non-smokers were not distinguished in this study, so it was not possible to assess the extent to which differential smoking patterns in different age, BMI and mortality groups were influencing the calculation of optimal body mass index.

These ideas have subsequently been tested in a number of smaller prospective studies. For instance, in a recent study on 70-year-olds in Göteborg, Sweden, it has been confirmed that the BMI ranges with lowest mortality were relatively high (27-29 in males and 25-27 in females) and smoking habits did not significantly modify the BMI-mortality relationship (12).

The notion that the BMI-mortality association may be modified by age was also fueled by population-based data from Norway (13). This study illustrated that the U-shaped association that is typically observed between BMI and mortality, upon stratification by age, lost its curvilinearity in the older age-groups, implying that there was no excess mortality risk identifiable at either extremely high or low BMI levels in the elderly cohorts. Despite suggestions from this and other studies that age may modify the risk of obesity, there are no age-specific cut-points in popular usage. As mentioned above, the WHO cutpoints of obesity do not increase for older age groups, and it is generally recommended that weight gain after attainment of adult height should be less than 5 kg.

Different risk estimators may yield different conclusions vis-a-vis age

Stevens recently re-evaluated this question using a National Cancer Society data base (14). In her recent review, the problem was decomposed into 2 parts: whether the BMI-mortality nadir increases with age, and whether the mortality risks associated with obesity decrease with age. With regard to the first question, analysis of data in non-smoking individuals suggested that the BMI associated with minimal mortality did not increase with age. To address the second question, a series of epidemiological approaches was used, and it was concluded that different measures of risk give profoundly different answers. For instance, risk ratios displayed a monotonic decrease in successive age groups, suggesting diminishing obesity-related hazards in the elderly. In contrast, mortality rate differences displayed a monotonic increase with age. This latter observation reflects the higher death rate in older age groups, making obesity a larger contributer to the risk difference.

Another approach to addressing this question requires direct examination of body compostion data, rather than weight for height. It has been speculated that increased body fatness in elderly populations may in fact predict excess risk, while increased lean body mass may operate in the opposite direction. In a prospective study of 60-year old Swedish men followed 22 years, a typical U-shaped BMI-mortality curve was observed. However, when decomposing the body mass into fat and lean mass components, opposite associations were detected, with high lean mass appearing to exert a protective effect. Based on this study it was concluded that maintenance of lean mass is the optimal body composition goal in the elderly, and that full understanding of the BMI-mortality association necessitates use of body composition data. (15). Other recent research on elderly Swedish populations has suggested that the excess mortality at the low end of BMI-mortality curve can be explained by early mortality, possibly associated with preexisting

Trots en välkänd ärftlig komponent i fetman, kan gener inte förklara de stora sekulära trender som är observerade i genetiskt stabila samhällen

disease, in males (12). However, the U-shaped curve persisted in elderly females after exclusion of early deaths.

Etiological considerations

Genes or environment?

Despite the well-known hereditary component to obesity, genes cannot explain the large secular trends in obesity that have been observed in many genetically stable societies, although genetic factors may explain different susceptibilities in individuals exposed to today's common obesity promoting environment. For instance there is evidence that dietary fat and physical activity may trigger obesity in individuals with familial susceptibility to obesity (16,17). Thus it is of interest to examine which lifestyle factors are most likely to be contributing to the obesity problem in elderly populations. By comparing population trends in body mass index with corresponding trends in diet, physical activity and smoking, we cannot demonstrate causal relations, but such data may be considered for descriptive purposes.

Lifestyle trends

We have Swedish data comparing lifestyle trends across various 70 year old cohorts examined between 1971 and 1993. As stated previously, BMI trends differed significantly between men and women, increasing dramatically among 70 year old males, but hardly changing at all in 70 year old women. In this context, it is of interest to note that parallel trends were seen for dietary intake in men, whose average energy consumption rose significantly by 147 kcal/day, compared to a corresponding increase of 35 kcal (non-significant) in women (3) Examples of specific energy sources that have contributed to this difference include proportion of energy from cooking fat and spread, which showed decreases in both sexes, although particularly in women (3). During this same period, leisure-time physical activity patterns were stable, with approximately 20% of men and women reporting being completely sedentary at both points in time (18). Smoking habits represent the one lifestyle influence that seems to track the BMI trends most consistently, i.e. increases in obesity among 70-year males were accompanied by decreases in smoking in this group, while smoking increased among 70-year females during a period of weight stability. It is not well understood which other lifestyle influences may have contributed to weight stability in elderly women over this period, although it must be kept in mind that this is a period of increasing participation of women in the labor force and escalating cosmetic as well as health-related weight concerns.

Future directions

Over the past 50 years the proportion of Nordic populations over 60 years of age has increased by around 50% and average life expectancies have correspondingly risen in most areas. Thus, it may be expected that obesity among elderly populations will represent a growing public health concern. Although it appears that the obesity epidemic may not have hit contemporary elderly Nordic women, it must be remembered that today's increasingly overweight younger populations, including young women, will contribute to the burden in future years. In anticipation of this situation, it will be important to pursue further research in the following areas:

(i) Documentation of the effects of obesity on geriatric endpoints such as dementia;

(ii) Investigation of whether extended longevity of modern populations is affecting overweight and normal weight individuals proportionately;

(iii) Better understanding of whether intentional weight losses in elderly over-weight dieters will promote health and longevity.

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