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Controversies in Obesity Mortality: A Tale of Two Studies

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Introduction

Two recent studies have produced starkly conflicting estimates of the annual number of deaths attributable to obesity in the United States. Mokdad et al. (2004) estimated that poor diet and exercise accounted for 400,000 deaths in 2000, making this the second-leading actual cause of death. In contrast, Flegal et al. (2005) estimated that obesity was associated with 111,909 deaths in 2000. Both studies were published in *The Journal of the American Medical Association*, and both studies included authors affiliated with the Centers for Disease Control and Prevention (CDC).

The conflicting estimates have greatly animated the debate on obesity policy. The Mokdad et al. study has frequently been used to underscore concerns about increasing obesity in the United States; some researchers and policy makers have proposed voluntary and regulatory policies to prevent obesity. Critics of such policies quickly cited the Flegal et al. study as proof that the obesity epidemic is "overhyped" and that policies to reduce obesity are unnecessary.

In this issue brief, we explain how the studies arrived at their differing estimates. Understanding the differences between the estimates will illuminate future debate about obesity and identify areas where additional study is needed. In comparing and contrasting the studies, we focus on five areas: differences in scope, errors, differences in variables, differences in methods, and differences in data.

Differences in Scope

The two studies have very different scopes. The goal of Mokdad et al. was to replicate and update to 2000 a previous study (McGinnis and Foege, 1993) that attempted to estimate the number of deaths associated with nine actual causes of death in 1990. Thus, they looked at nine different causes of death, used previously developed methods for attributing deaths to these causes, and looked at the trend in deaths for each cause between 1990 and 2000. They also examined deaths associated with poor diet and exercise, rather than deaths associated with obesity alone.

In contrast, Flegal et al. (2005) focused solely on deaths associated with obesity. This focus allowed them to develop more refined methods for estimating obesity-related deaths. They also focused only on deaths in 2000. Thus, they did not identify trends in obesity-related deaths.

Errors

Mokdad et al. identified an error in their article and *The Journal of the American Medical Association* subsequently published an erratum. Correction of the error reduced the estimated number of deaths attributable to poor diet and activity by 35,000 to 365,000. Errors seriously erode the credibility of scientific articles. Nevertheless, the error was relatively small, and Mokdad et al.'s revised estimate of 365,000 deaths is still substantially above Flegal et al.'s estimate of 111,909 deaths.

Differences in Variables

The bold entries in Table 1 show that Mokdad et al.'s main reported estimate of 400,000 deaths for poor diet and exercise is not directly comparable to Flegal et al.'s main reported estimate of 111,909 deaths for obesity (individuals with body mass index [BMI] greater than 30). Mokdad et al. estimated that obesity alone is associated with approximately 307,000 deaths. Flegal et al. found that individuals in the overweight category (BMI between 25 and 30) had significantly fewer deaths than individuals in the normal weight category. In contrast, Mokdad et al. found that overweight was associated with excess deaths.

Differences in Methods

Both papers applied the same basic equation used for estimating excess deaths associated with a risk factor:

$$ExcessDeaths = \frac{[P_0 + \sum P_i * RR_i] - 1}{P_0 + \sum P_i * RR_i} * D,$$

where P_0 is the percentage not exposed to the risk, P_i is the percentage exposed to risk category i, RR_i is the relative risk for mortality for risk category i, and D is deaths. It can be shown that excess deaths will increase with the percentage exposed to the risk, the relative risk for mortality, and the number of deaths.

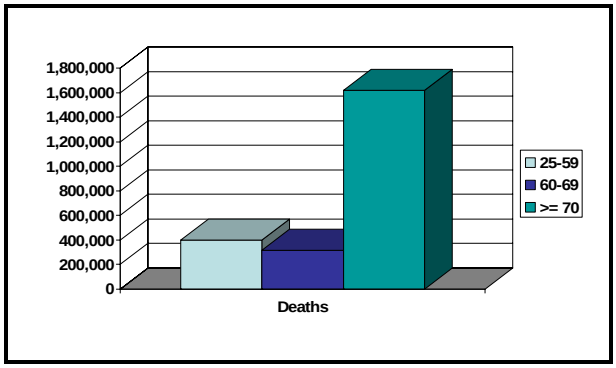
There are two major methodological differences between the studies. First, the two studies used different BMI categories to calculate baseline mortality rates. The baseline mortality rate is for a BMI between 23 and 25 in Mokdad et al. versus a BMI between 18 and 25 in Flegal et al. This difference is important because there is a U-shaped relationship between mortality and BMI, with the lowest mortality rate occurring close to a BMI of 25. Thus, the baseline mortality rate for a BMI between 23 and 25 is lower than a baseline rate for a BMI between 18 and 25. In turn, the relative risk associated with obesity will be greater with the lower baseline mortality rate. Flegal et al. showed that the estimated number of deaths associated with obesity would have increased from 111,909 to 164,836 if they had used a baseline mortality rate for a BMI between 23 and 25.

Table 1. The Studies Focus on Different Variables

	Mokdad et al. (2004)	Flegal et al. (2005)
Excess deaths from obesity	~307,000	**111,909**
Excess deaths from overweight	~43,000	-86,094
Excess deaths from other poor diet and lack of physical activity	15,000	N/A
Error	35,000	N/A
Total	**400,000**	25,814

Second, Flegal et al. stratified their analysis by a series of risk factors, including three age categories. Age is especially important, for three reasons. First, the prevalence of obesity varies with age, with fewer individuals aged 70 and older being obese. Second, the excess relative risk associated with obesity is smaller for individuals aged 70 and older. Third, age is closely associated with death; the 70 and over category accounts for nearly two-thirds of all U.S. deaths (Figure 1). With their approach, Flegal et al. obtained estimates 20% lower than they would have obtained if they had used the less refined approach applied in Mokdad et al.

Figure 1. Age Matters: Most Deaths Occur Among the Elderly



Differences in Data

The two studies used different data to calculate the relative risks associated with obesity, and this makes a major difference in the estimates. Mokdad et al. used data from six epidemiological studies, including nationally representative data from the first wave of the National Health and Nutrition Examination Survey (NHANES I). Flegal et al. used combined data from the three waves of NHANES; they limited their analysis to NHANES data because these data are nationally representative and more recent than the data used by Mokdad et al. The relative risks derived from the combined NHANES I, II, and III data used by Flegal et al. are lower than the corresponding relative risks from the six studies used by Mokdad et al. This difference leads to substantially lower estimates of obesity-related deaths.

Flegal et al. also estimated the number of obesity-related deaths using the relative risks calculated separately from the NHANES I, II, and III datasets (Table 2). The estimate based solely on NHANES I is fairly close to the estimates in Mokdad et al., whereas the estimates based on NHANES II and III are much lower. This pattern reflects the fact that the obesity-related relative risks derived from NHANES II and III are much lower than the relative risks derived from NHANES I. Put another way, the lower relative risks in NHANES II and III suggest that being obese today may have less of an effect on mortality than it used to have.

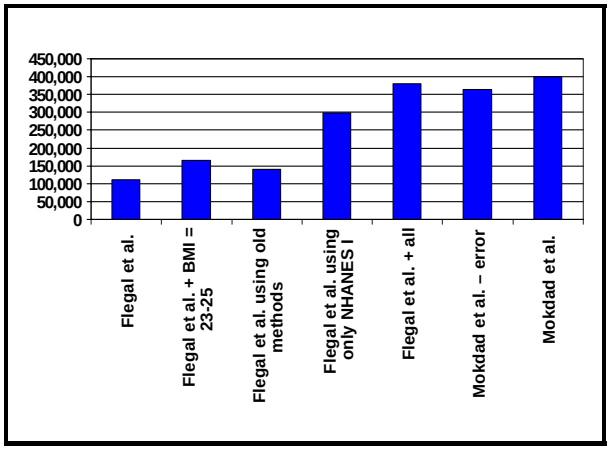
Relative Importance of the Differences

Figure 2 shows the relative importance of the differences between the studies. Flegal et al.'s main estimate of obesity-related deaths is shown at the far left of the figure, and Mokdad et al.'s main estimate is shown at the far right. The figure also shows the separate effects on Flegal et al.'s estimate of changing the baseline BMI, applying Mokdad et al.'s less refined methods, and using only NHANES I data. Of these, using

Table 2. Effects of Using Different Data Sources

	Excess Deaths from Overweight and Obesity (Mokdad et al., 2004)	Excess Deaths from Obesity (Flegal et al., 2005)
Base results	350,000	111,909
NHANES I	343,038	298,808
NHANES II	N/A	26,917
NHANES III	N/A	43,650

Figure 2. Relative Importance of the Differences Between Studies



the NHANES I data produces by far the largest effect on estimated deaths. The fifth bar in the figure shows the aggregate impact of the differences (the effects for the differences are simply summed).

Discussion

By using more recent data and stronger methodology, Flegal et al. provide the best current estimates of obesity-related deaths. They clearly show that their estimates are very sensitive to the relative risk of mortality associated with obesity. Future research should continue to develop better methods to more precisely estimate this relative risk. Additional research should also test whether the relative risk of mortality associated with obesity is decreasing over time.

Does the fact that Flegal et al.'s estimate of obesity-related deaths is lower than previous estimates mean that obesity is not an important problem? No. Although Flegal et al.'s estimate is lower, it still represents about 1 in 20 U.S. deaths. It would still rank second on a revised list of the actual causes of death. Moreover, their estimate represents only a current estimate of obesity-related deaths, not an estimate of the trend in obesity-related deaths. Other things being equal, this trend will be closely related to increases in the prevalence of obesity, which doubled between 1980 and 2000. Finally, although mortality is an important measure of the burden of a disease, it is not the only one. Obesity also has significant impacts on morbidity, health care costs, and quality of life.

References

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