

# Mortality in Anorexia Nervosa

Patrick F. Sullivan, M.D., F.R.A.N.Z.C.P.

---

**Objective:** The author's goal was to shed light on the debate regarding the mortality rate over time associated with anorexia nervosa. **Method:** He conducted a meta-analytic study using weighted linear regression to combine crude mortality proportions from 42 published studies to estimate the mortality associated with anorexia nervosa over time. **Results:** The crude rate of mortality due to all causes of death for subjects with anorexia nervosa in these studies was 5.9% (178 deaths in 3,006 subjects). The aggregate mortality rate was estimated to be 0.56% per year, or approximately 5.6% per decade. **Conclusions:** The aggregate estimated mortality rate for subjects with anorexia nervosa is substantially greater than that reported for female psychiatric inpatients and for the general population.

(Am J Psychiatry 1995; 152:1073-1074)

---

Although there is general agreement that anorexia nervosa carries a greater risk of mortality, there is substantial disagreement as to the magnitude of the risk. Several factors contribute to this situation. First, the literature has many methodological limitations (1, 2). Second, with few exceptions (3-5), the mortality data reported are difficult to interpret. The statistic most commonly reported is crude mortality or the proportion of subjects who were dead at follow-up. Crude rates of mortality due to all causes of death vary widely, from zero in many studies to over 20%.

One problem with crude mortality proportions is that the length of follow-up is ignored. Because death is a probabilistic event, more deaths are expected over longer periods of time. Neglecting length of follow-up is thus a crucial omission. Another problem is that the actual number of deaths is not adjusted for the number of expected deaths during the follow-up interval. The standardized mortality ratio—the ratio of the observed to the expected number of deaths over follow-up expressed as a percentage—is one solution to this problem. Standardized mortality ratios of 136% (5), 471% (5), and 601% (4) have been reported in groups of subjects with anorexia nervosa in the United Kingdom. Because only a few studies have reported standardized mortality ratios, a researcher attempting to summarize the literature on mortality in anorexia nervosa is forced to ignore a large body of data.

This paper describes a method of aggregating the

published crude mortality data that takes into account length of follow-up and number of subjects. The result is an estimate of the mortality rate associated with anorexia nervosa during follow-up.

## METHOD

Forty-two studies of the outcome of anorexia nervosa were identified through manual and computerized searches. (Thacker [6] provided an accessible introduction to the rationale of meta-analysis.) Each of these studies provided a definition of anorexia nervosa, specified the mean length of follow-up, and included mortality data. Eight studies were excluded, six because no definition of anorexia was given, one because the length of follow-up was unspecified and incalculable, and one because the methodology was uninterpretable. When one study group was described in several reports, the most recently reported data were used. Citations for these studies are available on request.

The technique used to aggregate these data was weighted linear regression. Each study was treated as a data point; the dependent variable was the crude mortality proportion, the independent variable was the mean length of follow-up, and the sample size was a weighting variable. Thus, a larger study with longer follow-up had greater impact on the regression line than a smaller study of shorter duration. The goal of this analysis was to obtain the slope of the regression line fitted to these data as an aggregate estimate of the mortality rate associated with anorexia nervosa.

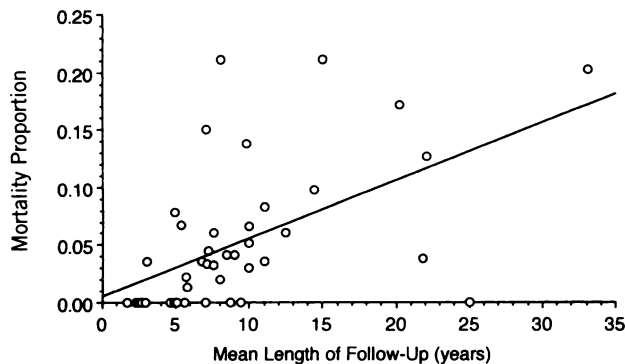
There are several assumptions implicit to this analysis. The first was that mean length of follow-up is an adequate summary of the observation period of the study. The actual length of follow-up for each subject is preferable and would enable the application of survival analytic methodology. The second assumption was that the subjects in each study had essentially the same condition. This assumption was not strictly true because a variety of diagnostic criteria for anorexia nervosa were applied. However, it is possible that these criteria identified essentially the same condition. The third assumption was that the denominator of crude mortality was the total original number of subjects. The conservative approach was to assume that untraced subjects were alive and hence not adjust the denominator. The fourth assumption was that a variety of filters biased the composition of the study groups (7) and that the 42 reports varied widely in their secular, geographic, and treatment-related characteristics, but that the diversity of these studies was, in fact, an advantage and allowed a truer estimate of the mortality rate in anorexia nervosa.

---

Received June 16, 1994; revision received Oct. 17, 1994; accepted Nov. 10, 1994. From the University Department of Psychological Medicine, Christchurch School of Medicine. Address reprint requests to Dr. Sullivan, University Department of Psychological Medicine, Christchurch School of Medicine, P.O. Box 4345, Christchurch, New Zealand.

Supported by a research training fellowship from the Health Research Council of New Zealand.

**FIGURE 1. Crude Rate of Mortality Due to All Causes of Death and Mean Length of Follow-Up in 42 Studies of the Outcome of Anorexia Nervosa**



## RESULTS

Of the 42 studies of 3,006 individuals diagnosed as having anorexia nervosa, there were 178 deaths over follow-up, representing a crude mortality proportion of 5.9%. In the 38 studies where the cause of death was specified ( $N=164$ ), complications of an eating disorder accounted for 89 deaths (54%), suicide for 44 (27%), and unknown or other causes for 31 (19%). The crude mortality proportion due to all causes in these 42 studies ranged from 0% to 21.1% (median=3.6%). The mean length of follow-up ranged from 1.7 to 33.0 years (median=7.6). The number of subjects in these studies ranged from 11 to 332 (median=49.5). The year in which these study groups were first assembled ranged from 1920 to 1980 (median=1965).

The linear regression model of the 42 studies of mortality in anorexia nervosa with crude mortality due to all causes of death as the dependent variable, mean length of follow-up as the independent variable, and number of subjects as the weighting variable was significant ( $F=23.0$ ,  $R^2=36.5\%$ ,  $df=1, 40$ ,  $p<0.00005$ ). The  $y$  intercept was not significantly different from zero, but the slope of the regression line was highly significant ( $t=4.79$ ,  $p<0.00005$ ). The slope estimate was 0.00562 ( $SE=0.00117$ ).

The regression line and the data points for the 42 studies are depicted in figure 1. The regression slope estimate suggests that mortality due to all causes of death over follow-up in subjects diagnosed as having anorexia nervosa was 0.56% per year ( $SE=0.12\%$ ) (95% confidence interval=0.33%–0.79%). Extrapolation to a 10-year span yielded a mortality rate of 5.6% per decade (95% confidence interval=3.3%–7.9%).

## DISCUSSION

The purpose of this paper was to aggregate the published data on mortality in anorexia nervosa in order to estimate mortality over time. The technique employed was

weighted linear regression with each study representing a data point defined by its crude mortality proportion, mean length of follow-up, and number of subjects.

The analysis yielded an estimate of the rate of mortality due to all causes of death in clinical groups of subjects with anorexia nervosa of approximately 0.56% per year or 5.6% per decade. There was no indication that the statistical assumptions of the technique were violated, and the aggregate estimate thus appears sound.

The acceptability of this estimate hinges on whether the assumptions were valid. The most problematic assumption was whether the mean length of follow-up accurately reflected the actual follow-up duration. Without access to the raw data, it is impossible to know whether the calculated regression mortality rate truly approximated the actual death rate. In a simulated data set, however, the regression slope was numerically quite close to the true value, although it tended to overestimate the annual hazard rate from survival analysis.

It is likely that the aggregate annual death rate associated with anorexia nervosa is greater than in other populations. The aggregate annual mortality rate associated with anorexia nervosa is more than 12 times higher than the annual death rate due to all causes of death for females 15–24 years old in the general population (0.00045 deaths per year) and more than 200 times greater than the suicide rate in the general population (0.00002 suicides per year) (8). The aggregate annual mortality rate associated with anorexia nervosa is more than twice that of a national study group of female psychiatric inpatients 10–39 years old (0.0021 deaths per year) (9).

These data highlight the status of anorexia nervosa as a serious psychiatric disorder with a substantial risk of mortality.

## REFERENCES

1. Hsu LKG: Outcome of anorexia nervosa: a review of the literature (1954–1978). *Arch Gen Psychiatry* 1980; 37:1041–1046
2. Steinhausen HC, Glanville K: Follow-up studies of anorexia nervosa: a review of research findings. *Psychol Med* 1983; 13:239–249
3. Isager T, Brinch M, Kreiner S, Tolstrup K: Death and relapse in anorexia nervosa: survival analysis of 151 cases. *J Psychiatr Res* 1985; 19:515–521
4. Patton GC: Mortality in eating disorders. *Psychol Med* 1988; 18:947–951
5. Crisp AH, Callender JS, Halek C, Hsu LKG: Long-term mortality in anorexia nervosa: a 20-year follow-up of the St George's and Aberdeen cohorts. *Br J Psychiatry* 1992; 161:104–107
6. Thacker SB: Meta-analysis: a quantitative approach to research integration. *JAMA* 1988; 259:1685–1689
7. Hoek HW: Review of epidemiological studies of eating disorders. *Int Rev Psychiatry* 1993; 5:61–74
8. Rogot E, Sorlie PD, Johnson NJ, Schmitt C: A Mortality Study of 1.3 Million Persons: US National Longitudinal Mortality Study. Bethesda, Md, National Heart, Lung, and Blood Institute, 1992
9. Zilber N, Schufman N, Lerner Y: Mortality among psychiatric patients—the groups at risk. *Acta Psychiatr Scand* 1989; 79: 248–256