CAN A RATIONAL CHOICE FRAMEWORK MAKE SENSE OF ANOREXIA NERVOSA?

By

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ABSTRACT: Can a rational choice modeling framework help broaden our understanding of anorexia nervosa? This question is interesting because anorexia nervosa is a serious health concern, and because a rational choice approach may shed useful light on a condition which appears to involve "choosing" to be ill. We present a model of weight choice and dieting applicable to anorexia nervosa, and the sometimes-associated purging behavior. We assess what that model, and an alternative way of thinking about anorexia, imply about the "rationality" of the choices involved. We also present empirical evidence about factors possibly contributing to anorexia nervosa; results are consistent with our modeling approach. A concluding section considers policy implications. We offer this analysis as a consciousness-raising way of thinking about the condition.

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INTRODUCTION

Can a rational-choice framework help broaden our understanding of anorexia nervosa (AN)?[1] We ask this question for two reasons. First, anorexia is interesting in and of itself; it primarily afflicts adolescents and young women, and creates serious health risks for those afflicted. We ask whether a rational choice approach, embodied in a rudimentary economic model of dieting, can shed useful light on the choice to maintain a dangerously low body weight.

Second, anorexia offers an opportunity to explore the boundaries of rational-choice approaches to human behavior. In previous work on smoking and multiple (or yo-yo) dieting, we investigated one such boundary, the rationality of self-defeating choices.[2] Our approach was to see how useful it might be to model harmful behaviors with the rational choice assumptions endemic to most mainstream economic analysis.

Anorexia presents a stern challenge to the rational-choice approach. Some medical authorities, for example, judge anorexia to be an illness, which would seem to locate it "across the border," beyond the boundary of what rational choice models can usefully conceptualize. Why, after all, would someone choose to be dangerously ill? However, if anorexia is indeed an illness, it is one whose onset is entangled with behavioral choices regarding radical calorie restriction**,** and it is worth asking whether and when such behavioral choices can be described as rational choices. The question is not merely academic: physicians caring for anorexic patients who refuse treatment must decide whether to compel treatment or risk allowing a patient to come to harm. This decision requires, in turn, deciding whether a patient's refusals reflect her real wishes or are, instead, "the disease talking" (Tan 2003: 1246).

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[1] We employ "anorexia" and "anorexia nervosa" interchangeably.

[2] Smoking: Suranovic, Goldfarb and Leonard 1999; Goldfarb, Leonard and Suranovic 2001. Dieting: Goldfarb, Leonard and Suranovic 2006; Suranovic and Goldfarb 2007. (Hereafter GLS).

This paper proceeds as follows. Section I provides background information about anorexia nervosa, including its relation to bulimia, and introduces two contrasting theoretical views of the causes of anorexia. Section II sets out the basics of the GLS (2006) model of weight choice, weight change and dieting. In Section III, we modify the model to encompass anorexia, and examine purging, which is sometimes but not always an associated behavior. Section IV discusses the implications for rationality: whether and in what sense extreme dieters rationally "choose" to be anorexic. Section V explores statistically the empirical correlates of risk for anorexia, such as higher income, higher education, and strict parenting; results are consistent with our modeling approach. In Section VI, we briefly consider some policy implications.

SECTION I: FACTS ABOUT ANOREXIA NERVOSA

The American Medical Association (AMA) describes anorexia nervosa as

> "[a]n eating disorder characterized by intense fear of being fat, by severe weight loss . . . . Sufferers have distorted body image and 'see' themselves as fat even when they are of normal weight or even emaciated. Anorexia nervosa primarily affects teenage and young adult women and occasionally young men…(I)t is difficult to treat and sometimes fatal." (AMA 1989, p. 112).

The American Psychiatric Association (APA) lists similar criteria for the psychiatric diagnosis of anorexia in its *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV):

> (1) "Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g., weight loss leading to maintenance of body weight less than 85% of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected)."
>
> (2) "Intense fear of gaining weight or becoming fat, even though underweight."
>
> (3) "Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight."
>
> (4) "In postmenarcheal females, amenorrhea, i.e., the absence of at least three consecutive menstrual cycles." (American Psychiatric Association 2000, section 307.1).

We emphasize two especially salient aspects of anorexia: first, a body weight well below "minimally normal weight," and, second, impaired judgment, which manifests as "distorted body image," or "disturbance in the way one's body weight is experienced." Impaired judgment in our model is interpreted as an extremely low *desired* weight, combined with the inability to perceive extremely low weight and/or its health dangers.

Ninety percent of all anorexia nervosa cases occur among females (APA 2000). The incidence is nonetheless fairly low in the female population, with a lifetime prevalence of between 0.5 and 1.0 percent (Hudson et al 2007). For males, the prevalence is estimated at 0.05 percent. Those afflicted are typically young. In the National Comorbidity Survey Replication (NCS-R), a 2001-2002 survey on the mental health of the U.S. population, the onset of anorexia occurred at ages ranging from 13 to 25, with a mean age of onset of 18.9. It is rarely seen in women over age 40 (APA 2000). The NCS-R survey also shows that the disorder is most prevalent among whites (90%) and among those living in the mid-west and southern regions of the country (81%).

Anorexia is dangerous; one study estimates that nearly 6 percent of sufferers die from its complications (Birmingham et al. 2005), the highest mortality rate of any psychiatric illness (Sullivan 2002). By comparison, the all-cause death rate for US women aged 10 to 44 was approximately 0.075 percent in 2005 (CDC 2008). For some, recovery from anorexia can occur after one episode, while others develop a chronic condition (Steiner and Lock 1998). About 20 percent of those who have anorexia also display bulimic behavior, i.e. bingeing and purging.[3,4]

[3] Sodersten at al (2006) note that most bulimic patients "have a history of anorexia and their bulimic behavior is preceded by brief periods of starvation. We view bulimia and anorexia as two phases of the same disorder." However, anorexics are underweight and bulimics are not, so "the patients are conspicuously, but only superficially different." (p. 573). Since we are modeling extreme underweightedness (in a sense to be defined within the model) as a crucial characteristic, we treat anorexia as importantly different from bulimia.

The APA diagnosis criterion specifies a weight that is 85% (or less) of a minimally normal weight for age and height. Not surprisingly, this places anorexics at the extreme left tail of the Body Mass Index (BMI) distribution, between the 5th and 10th percentiles. This corresponds to a BMI range of 17.1-18.9 for young females ages 15-29 (Hebebrand et al. 1996). For comparison, the US Centers for Disease Control considers BMIs in the range of 18.5 to 24.9 to be of normal weight for men and women over the age of 20. To give a more concrete idea of what this 85% criterion means, Table 1 shows the minimum normal weight for females by height; 85% of this minimum weight (the anorexia nervosa indicator weight), and the BMI associated with that AN indicator weight. Not all people with body weight below 85% of the healthy minimum are anorexic. An "abnormally" low body weight is thus necessary but not sufficient for anorexia -- also required is impaired judgment.

Causes of anorexia

Researchers disagree on the causes of anorexia nervosa. Broadly speaking, there are two theories. The first regards anorexia's characteristic symptoms as the *consequence* of severe calorie deprivation brought on by starvation dieting and, in many cases, obsessive exercise**.** In this view, championed by Sodersten et al. (2006), calorie deprivation causes not only extreme weight loss but also the accompanying impaired judgment, along with psychiatric symptoms of depression, anxiety and "obsessive behaviors and thoughts," especially about food.[5] The

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[4] Goeree, Ham and Iorio (2008) investigate some empirical correlates of bulimia, and explore empirically "whether bulimic behavior satisfies the economic definition of addiction." (p.1).

[5] Sodersten, Bergh and Zandian (2006) provide both a scholarly overview of what is known about anorexia and a very useful conceptualization of the underlying nature of the condition. They begin by observing that our human ancestors were subject to "erratic fluctuations" in the availability of food, so that "only those who have been able to cope have survived." Evolutionary pressure created "thrifty genes," which allow intake of large amounts of food in good times, making "survival possible in the subsequent and inevitable periods of famine" (Diamond 2003). But these "thrifty genes" are a "disadvantage in present day society where food is continuously abundant" (Sodersten et al 2006, p.573).

impaired judgment and psychiatric symptoms associated with anorexia, no less than a lower body temperature and slowing heart rate, are thus seen as the *result* of starvation, and not the cause (ibid: 573).[6]

From a choice perspective, the Sodersten et al. (2006) view says that the dieter does not choose to subject herself to the impaired judgment and psychiatric symptoms associated with anorexia. Instead, she chooses a severe reduction in calories, risking (knowingly or not) the impaired judgment and psychiatric symptoms that can turn extremely low weight into anorexia nervosa.

The second theory regards severe calorie deprivation not as a cause but as a consequence of an underlying condition that pre-exists the decision to restrict calories. One version of this theory posits a neuroendocrine abnormality. Frank et al. (2005), for example, argue that anorexics have atypical dopamine receptors, which could "contribute to the pathophysiology of AN" (Frank et al 2005, p. 908).[7] Another version of this theory proposes that pre-existing psychological disorders cause the calorie deprivation decision. Whatever the underlying mechanism, whether physiological or psychological in origin, this theory sees the underlying mechanism as causing *both* starvation dieting and the accompanying impaired judgment and psychiatric symptoms.

So, where the Sodersten et al. (2006) view says that anorexia nervosa begins after severe calorie deprivation, the theoretically rival view says that anorexia nervosa begins before the choice to restrict calories is made. In Section IV of the paper, we consider the implications for

[6] On this account, anorexia can also result from *unintentional* weight loss, brought about, for example, by a parasitic infection, or the side effects of medication (Brandenberg, B.M. and A.E. Andersen 2007).

[7] The Frank et al. (1995) study compares recovered anorexics to nonanorexics, and concludes that observed differences in dopamine absorption existed prior to the onset of AN. But it could also be true that the starvation associated with anorexia *caused* the differential response to dopamine, that is, that changes in the neuroendocrine system where not the cause but the consequence of starvation or weight loss.

rational choice theory of each alternative; both the view that starvation causes impaired judgment and psychiatric symptoms, and the rival view that starvation, impaired judgment and psychiatric symptoms are all caused by a pre-existing condition. A striking result of our discussion is that these alternative views do not necessarily invalidate the use of the GLS model to analyze anorexia.

SECTION II: THE GLS MODEL OF WEIGHT CHOICE, CHANGE AND DIETING

The GLS (2006) model contains two building blocks: factors that determine an individual's weight (calorie consumption and expenditure), and factors that determine that individual's utility. These building blocks combine to determine the individual's optimal weight/food consumption combination. The resulting equilibrium can display "optimal overweightedness" or "optimal underweightedness," ideas that appear in Levy 2002. GLS 2006 uses the weight/calorie consumption choice framework to generate explanations for dieting behavior. To conceptualize anorexia, we expand the utility side of the model**.**

Determinants of weight production

Because weight change**s** when calorie intake differs from calorie expenditure, the determinants of weight change are those that affect calorie intake, calorie expenditure, or both (GLS 2006, p.117). The largest source of calorie expenditure is basal metabolism (i.e., "basal metabolic rate," hereafter BMR), which measures the number of calories expended merely to maintain the operation of one's vital organs and nervous system. The BMR does not include energy expended on physical activity (even simply walking) or the digestion of food.[8] A person's BMR is affected by weight, height, age, extent of lean muscle mass, and other factors. Total daily caloric expenditure is typically calculated for an individual by multiplying the BMR by an exercise or activity factor.

[8] See BMR entry at Wikipedia: http://en.wikipedia.org/wiki/Basal_metabolic_rate

In Figure 1, the line, E_1, represents the relationship between calorie intake, F, and weight levels, W, drawn for a given level of calorie expenditure. The line should be interpreted as "the physical 'production' relationship between food and weight, holding the activity, or exercise level, constant. For a given level of energy use—as determined by the individual's lifestyle—the greater the average food intake each period, the higher the realized weight" (GLS 2006, p. 118). The E_1 line is derived using the Harris-Benedict equations from the physiology literature, which indicate that BMR, and hence food consumption needed to maintain weight, rises linearly with weight.[9] A positive intercept arises because BMR depends on age and height in addition to weight. Thus, individuals of different heights or ages would have different intercepts, with the intercept shifting downward with age.[10]

In addition to the "production" relationship between food intake and weight, there is a budget constraint; a horizontal line at the maximum food intake possible given the individual's income. Two possible budget constraints are displayed in Figure 1; F_1 represents a higher income and F_2 a lower income.

Determinants of the Utility of Various Weight/Calorie Consumption Combinations

Facing this weight/calorie intake constraint, what combination of weight and food consumption does the utility-maximizing individual choose? To answer this question, we need to add a description of this individual's preferences. In GLS (2006), we argue that the individual is likely to have some desired level of weight W*, based on appearance considerations, health concerns or both. Departures from this desired weight generate disutility from three possible

[9] The Harris-Benedict equations are described more fully in SG 2007.

[10] As the physiology literature indicates and documents, the source of this downward shift with age is that BMR declines with age. As GLS 2006 notes, "Whitney, et al [1998] for example, note that 'BMR begins to decrease in early adulthood …at a rate of about 2 percent/decade. A reduction in voluntary activity as well brings the total decline in energy expenditure to 5 percent/decade'" (Whitney 1998, p.263)

sources: negative appearance effects, negative health effects, and increases in "task costs". Negative appearance effects can be internal or external (or both). Internal effects stem from dislike of one's own body image. External effects come from the reactions of others to one's appearance. Task costs include daily life annoyances such as a difficulty in finding clothing that fits, difficulty in performing certain physical activities, and so forth (GLS 2006 p.119).

In Figure 1, U_1, U_2, and U_3 are U-shaped indifference curves representing utility levels for combinations of food consumption and weight. The U shape is based on the following considerations. We assume the individual in question does indeed have a desired weight W*. For any weight below W*, an additional pound gained for fixed food intake raises utility since it moves the person closer to her ideal weight. In contrast, for any weight above W*, an additional pound added at constant food intake reduces utility. On the other hand, for any specific weight, an increase in food intake raises utility since food is a "good." The implication is that this individual's indifference curves are U-shaped, with the minimum point of each indifference curve—the place where the slope changes from negative to positive— at W*.[11]

Equilibrium with "Optimal Overweightedness"

Consider a woman whose energy expenditure is represented by E_1, facing the non-binding budget constraint F_1. Since she can choose any point along E_1, she maximizes utility by choosing point B in Figure 1. In this case her chosen weight level W_E is *above* her most desired weight W*.

In other words, she is optimally overweight since her optimal weight, W_E, exceeds what she regards as her most desirable weight choice based on health and appearance considerations. The intuition underlying this result is that, even though at W* an extra pound of weight is bad,

[11] The indifference curves in Figure 1 "include the additional feature that, along any vertical line to the right of W*, the indifference curves get steeper as F rises. This incorporates the idea that the marginal utility of food is decreasing as F rises." (p.119). A detailed explanation is in GLS (2006) footnote 14.

additional food consumption is good. Since at W* the marginal utility of the extra calories exceeds the marginal disutility of extra weight (which is zero at W*), this person will prefer a higher weight. This weight equilibrium result, known as "optimal overweightedness," was derived in Levy (2002), using a much more mathematically complex analysis.

Other Results in GLS 2006

Two other results derived in GLS 2006 are relevant to anorexia. One problem is to explain why a dieter will restrict calories so radically as to reduce weight well below a healthy level. GLS 2006 discuss conditions that would induce dieting under typical circumstances. In each case something must happen to perturb the optimally overweight equilibrium. One such disturbance is aging, which, owing to changes in muscle mass, reduces the number of calories needed to maintain a given weight. Graphically, aging induces a downward shift in the E_1 line. If calorie intake is maintained, the result is weight gain, which, in turn, can motivate a diet.

One other relevant result from GLS (2006) is the possibility of optimal *under*weightedness. This can arise as follows. First, the indifference curves depicted above are modified to recognize that at very high levels of calorie intake, the individual can become satiated with food. This generates circular, rather than U-shaped, indifference curves. Consider an elite athlete with an extremely high activity level, say a triathlete. Her E_1 line could lie high enough that the tangency defining the optimum would fall below (to the left of) W*, on the upward-sloping part of a circular indifference curve. The triathelete eats up to a point beyond where food has positive utility. However, because of her extraordinary calorie expenditure, she is still underweight. In this case we get a result like anorexia in that the chosen consumption point departs from most desired weight W*. However, unlike the anorexic, the triathlete does not

suffer from impaired judgment; to the contrary, the triathelete, unlike the anorexic, recognizes that she is underweight, and, ceteris paribus, would prefer to be heavier.[12]

SECTION III: MODELING ANOREXIA NERVOSA

The model described above attributes the individual's most desired weight W* to a combination of health concerns and/or appearance preferences. Suppose however that we "unpack" those two aspects of preferences so that the individual has both an optimal appearance weight W_A and a perceived optimal health weight W_H.

The optimal appearance weight W_A may be greatly influenced by social factors. For example, in today's world with the social pressure to be thin, an individual may desire a weight lower than what experts deem to be the healthiest weight. However, this preference is likely to vary from person to person.

A person's actual optimal health weight W_{Hopt} is difficult to specify precisely. Physicians normally provide a range of healthy body mass indices (BMIs) for adults; that range is generally given as 18.5 to 24.9. The BMI range will translate into a range of weights for a person of a particular height. For example, the CDC considers a healthy weight for a 5'6" female to lie between 115 lbs and 154 lbs.[13] Just to pin something down, we take the average of this range for $W_{Hopt.}$ Indeed, a person might choose this as his or her perceived optimal healthy weight if the person is well informed. However, Crawford and Campbell (1999) suggest that the older or

[12] This analysis was provoked by a parental report (by a friend of one of the authors) of his athlete-daughter who viewed herself as "too thin," but simply could not eat enough to get her weight up out of the underweight range. In the GLS model, the person consumes food beyond the food satiation level (so the "last unit of food intake" has negative utility, just offsetting the positive utility of a marginal amount of additional weight). Of course, the person could move away from this "optimal underweightedness equilibrium" by expending fewer calories (becoming less of an athlete), but that is not a life choice these athletes are willing to make.

[13] Calculated using CDC website calculator at http://www.cdc.gov/nccdphp/dnpa/healthyweight/assessing/bmi/index.htm

heavier an individual is, the higher that person believes his or her ideal weight to be.[14] Thus, an individual's perceived optimal health weight W_H need not equal that person's actual optimal health weight W_{Hopt}.

For our purposes, we will label the low and high weights from the official guidelines as W_{Hmin} and W_{Hmax}, respectively, representing a person's minimum healthy weight and maximum healthy weight. These of course will vary with a person's height. Any person who weighs more than their W_{Hmax} would be considered overweight, (or obese if very overweight). Anyone whose weight is below their W_{Hmin} would be considered underweight and potentially anorexic when more than 15% below W_{Hmin}.

Next, we'll assume that a person's overall optimal (or most desired) weight W* is a linear combination of W_H and W_A such that:

$$W^* = s\, W_A + (1 - s)\, W_H \qquad (1)$$

The parameter *s* defined on the interval [0,1] represents the importance a person places on appearance considerations, and $(1 - s)$ represents the importance placed on health concerns.

The potential for anorexia can now be modeled by assuming a disparity between a person's perceived ideal weight and their most healthy weight. Consider Figure 2, which amends Figure 1 by adding vertical lines at W_{Hmin}, W_{Hopt} and W_{Hmax} (and omitting line F_2). All three of these lines are drawn to the right of W*, the minimum point on the indifference curve map, which reflects the person's perceived ideal weight. Such a "low W*" configuration might represent an individual with the following characteristics. First, the person's perceived ideal healthy weight might be well below W_{Hopt}. Second, the person's ideal appearance weight is

[14] Fabrice Etile (2007) uses French data to analyze the effects of social norms on the individual's perceived ideal body weight. He finds that "(s)ocial norms regarding body shape have a significant effect on perceptions of ideal BMI only for those women who want to lose weight." But, consistent with the Crawford and Campbell result quoted in the text, Etile finds that "(f)or many women and for all men, ideal BMI is almost exclusively determined by habitual BMI." The average age of individuals in the Etile sample is 50 years of age. Etile, 2007, p.945.

likely to be lower than W_{Hmin}. Finally, the importance placed on appearance (represented by the parameter *s*) is likely to be high relative to the person's concern for health.

A combination of these factors would lead to a W* that is to the left of W_{Hmin}. If desired weight W* is sufficiently low, then the "overweightedness equilibrium," W_E, for our individual can also lie to the left of W_{Hmin}, the situation pictured in Figure 2. If W_E is less than 85% of W_{Hmin} then the individual is at risk for anorexia.[15]

There are several notable features of this analysis. First, risking anorexia can be a *utility-maximizing choice*, based on the individual's preferences, beliefs, and constraints. One might well classify her choice as "harmful," or "imprudent" or "self-defeating," but her choice is consistent with the "thin rationality" of rational-choice models, which takes preferences as exogenous, and does not inquire into the genesis of preferences or their relationship to self-interest.[16] That is, she chooses rationally when she chooses what she most prefers, given her beliefs and constraints.

Second, although the severe dieter's weight is below W_{Hmin}, making her weight so low as to be unhealthy, she still views herself as overweight, since her actual weight W_E exceeds her desired weight W*. This "not thin enough" self-image is a characteristic condition of anorexia. That is, the model is consistent with individuals who, though extremely underweight, continue to view themselves as overweight, even fat.

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[15] Oswald and Powdthavee (2007) use a rational choice set-up to generate something interpretable as anorexia, by making utility depend upon one's weight *relative to the weight of others.* They obtain the result that increases in average weight generate increases in the individual's weight so long as the individual's utility function is convex. If it is concave, however, then rising average weight can generate falling weight for the "concave utility" individual. While falling weight is not related explicitly to anorexia (indeed, the term "anorexia" is not used explicitly), the article does present a different rational choice way of generating a phenomenon akin to anorexia.

[16] "Thin rationality" is thin because it "leaves unexamined the beliefs and the desires that form the reason for the action whose rationality we are assessing, with the exception that they are stipulated not to be logically inconsistent" (Elster (1983: 1). Padgett's (1986) summary says: "Economists, public choice theorists, and other utilitarians have achieved great strides by vigorously insisting that preferences and beliefs are exogenous … (C)onsistency and computational sophistication are the only psychological axioms required."

Contrast this outcome with the optimal underweightedness equilibrium of the triathlete described above. The too-thin triathlete's ideal weight W* is *above* the utility-maximizing weight W_E she chooses; whereas the anorexic's ideal weight W* is *below* the utility-maximizing weight W_E she chooses. That is, the triathlete would like, other things equal, to be less thin, while the anorexic wants to be thinner still.

Third, while the person depicted in Figure 2 is at risk for anorexia nervosa (assuming W_E is less than 85% of W_{Hmin}), other cases that look very similar will not involve anorexia nervosa. Suppose, for example, that the W_{Hmin} line lies slightly to the *left* of the individual's optimal weight choice, W_E. She is not anorexic, in the sense that her actual weight is not quite below the healthy minimum, even if it is below her most healthy weight, W_{Hopt} . Thus, there is a continuum between degrees of "thinness-by-choice"; some of those levels "cross the line" and appear very harmful/anorexic, while others with the same kind of gap between the individual's most healthy weight W_{Hopt} and the actual weight chosen W_E, do not cross the line into anorexia nervosa.

Anorexia and Purging.

Purging-- induced vomiting to control weight-- can be, but need not be, a behavior exhibited by those with anorexia nervosa. As mentioned above, Sodersten et al. (2006) indicate that around 20 percent of anorexics may purge.

Clearly some 80% of anorexics view purging as an unacceptable choice, so their situation is described by Figure 2 above. However, a simple adjustment to the model may help explain why some anorexics view purging as acceptable. This involves modifying the weight/food constraint. To do this, we begin by picking a point (a weight/food intake combination) on the food-weight constraint in the absence of purging, labeled JN in Figure 3. At weight W_0 (point T in Figure 3), purging provides the following opportunities: first, more food could be eaten, say

up to the amount at R, with the extra food purged afterwards, so as to maintain the same weight, W_0. A second scenario is that the same initial amount of food F_0 could be consumed, but a lower weight achieved because some of the food intake F_0 is purged. This implies moving *horizontally to the left* of T by the amount that weight could be reduced, generating point Z in Figure 3. This horizontal shift will not in general be of the same size as the vertical shift in the previous alternative; the vertical shift is determined by the amount of purging "physically achieved," while the horizontal shift is determined by the amount of weight avoided that is associated with the purge achieved. These two new points Z and R define a new food-weight constraint, the line PG, achievable with a particular amount of purging activity. In fact, the slope of PG is the same as JN because the slope gives the number of units of food intake needed to "generate" one unit of weight.

When purging is costless, the individual essentially faces a new constraint line PG that lies above the original (no purging) food weight constraint JN. Indeed the more one is willing to purge, the higher PG will lie. Figure 3 shows the new "purging inclusive" equilibrium at point V, which is at a lower weight and higher food intake than the non-purging equilibrium (point T). As one might expect, purging allows a lower equilibrium weight for the anorexic, and since the equilibrium V is on a higher indifference curve, a higher utility as well.

However, the analysis thus far has implausibly assumed that purging is costless. In fact, many individuals are likely to consider regular vomiting as very unpleasant and undesirable. In other words, a kind of psychological utility cost may arise because purging is unpleasant to engage in, and/or because it is socially unacceptable. In terms of our diagrammatic analysis, if the expected psychic disutility caused by purging is greater than the increase in utility caused by moving from indifference curve U_1 to U_2 then the person will not purge. Indeed, it may be the

very high cost of purging, or at least the presumption that the cost is high, that accounts for the fact that most anorexics do not purge.[17]

The Onset of Severe Dieting

How can we conceptualize the onset of radical calorie deprivation? First, a "potential anorexic" has to have an appearance weight, W_A, well below the health minimum $W_{Hmin.}$ Second, it is likely that the severe dieter values appearance more than health, that is, has an *s* parameter sufficiently high to generate to generate a desired weight W* below the health minimum W_{hmin}.

Consider an individual who, initially at time t_0 , does not restrict calories excessively. But then a change occurs, inducing severe dieting. What might set off this change? That is, what might cause a leftward shift in the utility curves. one that pushes desired weight, W* (which was above W_{Hmin} at t_0) below W_{Hmin}? Why, in other words, does appearance weight, $W_{A,}$ fall, and/or *s* rise, assuming no change in W_H?

Researchers point to a number of possible causes, including adjustment to puberty, teasing by peers, maternal preoccupation with dieting, cultural pressures and acculturating by immigrants, early life traumas, and dysfunctional family relationships (Steiner and Lock 1998; Tozzi et al. 2003; Schwartz et al. 1982).

These potential causes suggest the following plausible scenario. As the individual enters her teens, her consciousness of and the importance of appearance are likely to grow (*s* rises), and

[17] One reason for the high cost may be unfamiliarity with the process. The very thought of purging may be sufficiently distasteful to prevent its occurring. However, if a person tries purging once or twice, she may learn that the physical activity is less unpleasant than expected. Furthermore, purging in private can avoid the negative social ramifications and thereby reduce the cost of purging. Thus, experience and secrecy, if achieved, could turn a non-purger into a purger. On the other hand, as Goeree, Ham and Iorio (2008) point out, there are serious potential health costs from " binge and purge cycles including electrolyte imbalances that can cause irregular heart beats, heart failure and death, inflammation and possible rupture of the esophagus from frequent vomiting, tooth decay, gastric rupture, muscle weakness, anemia and malnutrition." (p.1).

the appeal of being "attractively thin" (causing a fall in W_A) is also likely to increase, especially for females. These changes in desired body image, and the growing importance of such concerns, are likely, we hypothesize, to be induced by social pressures to fit in with desirable peer groups (and the isolation one feels if one does not fit in), by the images of desirable thinness in fashion and "personality" magazines and TV coverage, and by the look of glamorous young female movie stars and fashion models. Schwartz et al. (1982) argue that the combination of a culture that values thinness and where the roles of women are complex and evolving, puts young girls, especially those from white, middle or upper class families, at high risk for developing anorexia nervosa.[18]

IV. Rationality and Anorexia Nervosa: Choosing to be Anorexic?

Our model shows how a particular structure of preferences—in particular, a W* below some health minimum weight—can generate anorexia. But when, and in what sense, can an extreme dieter be described as making a rational choice? From a thin-rationality perspective, a starvation dieter acts rationally when her choice is consistent with her (given) preferences and beliefs. As Elster puts it: "if an agent has a compulsive desire to kill another person, and believes that the best way (or a way) of killing that person is to stick a pin through the doll representing him, then he acts rationally if he sticks a pin through the doll" (1983: 4). A hunger striker starving herself for political goals is not judged irrational or ill, insofar as her choice to starve, however dangerous, is seen to be consistent with her preferences and beliefs.

But a more substantive conception of rational choice inquires into the rationality of preferences and beliefs (including beliefs about causes) that provide reasons for choice.

[18] An entirely different explanation is based on family background and psychological reactions. Schwartz et al. (1982) describe a theory where anorexia results from the effects of an impaired mother-child relationship beginning early in life. The authors describe arbitrary mothering behaviors that result in the child failing to accurately perceive internal cues of hunger and satiation. Anorexia then becomes a way for the adolescent child to gain control over self.

Consider first the rationality of the dieter's beliefs. The choice to radically restrict calories, if successful, leads to weight loss. It also can lead, in the Sodersten et al. (2006) view, to impaired judgment, the inability to perceive extremely low weight as dangerously unhealthy and unattractive. The anorexic – the emaciated young women who says, "I'm fat," or "celery is fattening" -- holds objectively false beliefs. How are we to conceptualize objectively false beliefs in the context of rationality?

One way is imperfect information. In this scenario, the starvation dieter does not know the health risks of excessively low weight, or mistakenly believes a healthy weight to be well below its true value, analogous to the smoking initiate who is unaware of the health risks of smoking or mistakenly believes them to be lower than their true value. An implication is that better information provision can lead the would-be starvation dieter to revise upward her desired health weight, W_H, and, thereby, increase her optimal weight equilibrium. False beliefs of imperfect-information sort can, at least in principle, be remedied.

But anorexia seems less a problem of bad information, than of impaired judgment. It is not so much that the starvation dieter fails to understand at what weight thinness becomes unhealthy, or the risks of being too thin; instead, anorexics fail to see that they *are* too thin. With impaired judgment, the emaciated woman's false belief that she is overweight cannot be corrected by informing her that she is, in fact, not overweight.[19] Let us call false beliefs that are incorrigible, i.e., immune to more accurate information, irrational beliefs.

Indeed, it is irrational belief that makes anorexia insidious, for, unlike the cyclical dieter, who ultimately slows calorie restriction upon realizing her goal, the anorexic, though already too

[19] The anorexic's false beliefs are harmful, but false beliefs can, in principle, work beneficially. Consider "positive thinking." The baseball hitter who believes that he *will* get on base more than half the time has false beliefs – no hitter gets on base more than half the time. But if so believing enhances hitting performance, then false beliefs can be beneficial, that is, can promote welfare.

thin, wants to be thinner still. The psychological consequences of starvation – impaired judgment – take over, so that weight loss begets more weight loss (Rumney 2002: 23). In the context of our model, it is as if the judgment-impaired anorexic continually lowers her goal weight, shifting W* ever leftward because she continually views herself, no matter how emaciated, as overweight.

On the more substantive view of rationality, where a choice is rational when determined by a rational set of beliefs and preferences (Hausman and McPherson 2006: 46), irrational beliefs – the skeletal figure who judges herself fat – preclude substantively rational choice. The emaciated woman's judgment-impaired choice to continue a starvation diet is not substantively rational, founded as it is upon irrational beliefs. The substantive rationality standard, unlike the thin-rationality standard, judges the anorexic's choice to continue dieting not rational.

When false beliefs harden into irrational beliefs, a substantively rational choice becomes a substantively non-rational choice. Consider an analogy to the decision to take up smoking. Teens are generally well informed about the health risks of smoking, but they are less well informed about the risks of getting hooked. Indeed, survey evidence suggests that novice smokers consistently underestimate the probability they will still be smoking five years later. Ex ante, better information about the risks of addiction could help, but by the time many smokers learn (by experience) the difficulty of quitting, they are "trapped," that is, smoking is bad, but quitting is worse (GLS 1999).

By analogy, it can be the case that the potential anorexic is well informed about the health risks of being underweight, but not well informed about the risk of impaired judgment induced by starvation. The potential anorexic underestimates the risk that her future calorie-deprived self may develop irrational and (and self-harming) beliefs. In this version of the story,

the anorexic begins dieting with a false but not irrational belief about the risks of starvation-induced impaired judgment, but when starvation impairs judgment, the starvation dieter becomes anorexic, and her choice to continue dieting is no longer rational.[20] The severe dieter who began "inside the tent" of rationality, leaves it (perhaps unknowingly) when her judgment becomes impaired.

Now suppose we consider instead the rival theoretical view regarding anorexia's onset, the view that regards severe calorie restriction as caused by a pre-existing physiological or psychological propensity to anorexia, as with Frank et al. (1995), who find atypical dopamine receptors in anorexics. What are the implications for rationality under this alternative view?

Here, where the affliction comes first, the case for rationality in choice would seem even weaker. But it will depend upon how we conceptualize the affliction. Consider first a woman who is physiologically predisposed to anorexic behavior, possessing atypical dopamine receptors, which make her "anhedonic," or extremely insensitive to the rewards of tasty calories. If we conceptualize her as having weight preferences that greatly emphasize appearance over health, then from the *thin-rationality* standpoint, which does not inquire into the genesis or prudence of one's preferences and beliefs, her choice of a dangerously low weight can be said to be rational.

What if, instead, the causal disorder is psychological in nature? As with the case of starvation-caused impairment, if the psychological disorder impairs judgment via irrational beliefs, then a *substantive-rationality* standpoint judges as non-rational the choice to pursue a dangerously low weight.

[20] Indeed, the view that calorie restriction precedes the onset of impaired judgment suggests that the timing of information provision may be crucial. Getting information about risks to the potential anorexic *before* impaired judgment sets in may have a much higher payoff than information that arrives after judgment becomes impaired. Goeree, Ham and Iorio (2008) suggest similar policy implications about bulimia.

But thin rationality requires only that the choice be consistent with given preferences and possibly-incorrect beliefs. So, even here, the maximizing dieter may be choosing rationally in the *thin rationality* sense, however imprudent or self-defeating that choice appears. The anorexic, like the hunger striker, may not know what is good for her, but she knows what she prefers. Lastly, it could be true that the psychological disorder also impairs the ability to choose consistent with one's preferences and beliefs. In this case, the choice to maintain a dangerously low weight is judged non-rational even by the accommodating thin-rationality standard: the anorexic does not know (or cannot correctly act upon) what she prefers.

Finally, we note an interesting contrast between anorexia and other forms of self-harming behavior, such as overeating, smoking, saving too little, or exercising too little. These forms of behavior are sometimes modeled as problems of self-control or weakness of will. The behavioral economics approach, for example, models self-control problems as a species of time inconsistency**.** In one version the different rates of time preference are personified as multiple selves—the myopic, impulsive "doer" versus the farsighted, resolute "planner". The self-harming behaviors associated with weakness of will are treated as a failure to adequately control the impulsive, indulgent choices of the doer self.[21]

Though self-destructive, anorexia is a strikingly different form of behavior, since it does not represent a failure of self-control; it is, if anything, a case of too much self-control. In a real sense, anorexics are victims of self-control, not of its absence; unlike many who try to diet but fail, the anorexic is highly successful in cutting calorie intake.[22] It is not surprising, then, that some of the empirical correlates of risk for anorexia, such as higher income, higher education,

[21] See Thaler and Sheffrin, 1981. For a noneconomist-friendly discussion of possible applications of behavioral economics insights to policy design, see Thaler and Sunstein 2008.

[22] Even those with impaired judgment may lack the willpower and stamina required to resist the body's hunger mechanisms.

and strict parenting, characterize highly-disciplined home environments in which children develop a relatively greater capacity for self-control. We explore these and other factors that correlate with risk for anorexia in the next section.

SECTION V: SOME EMPIRICAL EVIDENCE ON FACTORS CONTRIBUTING TO ANOREXIA

Ideally, we would like to empirically test the extended GLS framework, and attempt to shed light on the nature of the relationships between anorexia nervosa, mental illness, and genetic or environmental contributing factors. However, because of the low prevalence of AN, data on sufferers and their histories are extremely rare, and available data does not allow for the kind of in-depth empirical examination we would like. What we can do is empirically examine some of the characteristics and behaviors of young females that may put them *at risk* for developing anorexia nervosa. This exercise will enable us to test one of the predictions of the model, and in doing so, identify some of the factors that might go into shaping individuals' preferences.

Our model implies that, other things equal, individuals who are less obsessed with being thin and have a higher desired appearance weight are less likely to develop anorexia. A number of observable factors may explain differences in desired appearance. For example, white women may view being thin as much more desirable than do African-American women:

> "A persistent belief is that cultural norms to be thin are not as strict for African American women as they are for Caucasian women. …Caucasian women stigmatized obesity more that African-American women did….Women base their judgment of their bodies on what men of their culture desire…Caucasian men reported thinness as being more important in women they date than their African-American counterparts. African-American women think… that African-American men prefer larger women." (Reel et al, 2008, p, 322)

Suppose this characterization of differences in views about the desirability of thinness is correct. In terms of our model, these differences translate into an expectation of a higher desired appearance weight on average among African American women than among white women. This would in turn generate the prediction from our model that, controlling for other factors, there would be a negative effect from an African-American control variable on the risk of anorexia. In the section below, we test this prediction, as well as that of some other factors that can generate differences in desired appearance. Smoking and hours spent watching TV are two other examples discussed below. We note in passing that our model is also consistent with the fact that the incidence of anorexia among males is much lower than among females.[23]

To set our broader empirical exploration in a wider context, consider a recent empirical study by Costa-Font and Jofre-Bonet (2008). They focus on social pressure as the primary determinant of anorexia among women. The authors use European data from 2003 to examine the factors associated with variables they call "anorexia" and "severe anorexia". The former is the probability that a female is extremely thin but perceives herself as too fat, and the latter adds the requirement that the female reports eating healthily enough. The determinants of interest include the body mass index of peers, defined as women in the same age group in the same region, and women's magazine circulation per capita in the country. They find that peer BMI is negatively associated with the probabilities of being classified as anorexic and severely anorexic (according to the authors' definitions), but find no association with women's magazine circulation. Their research also points to the presence of unobserved factors influencing both body image and extreme thinness.

[23] As noted in the text, our model implies that individuals less obsessed with being thin and therefore having a higher desired appearance weight are less likely to be anorexic. Teen and young adult males do not seem to face the social pressure to be very thin that females face. Our empirical work reported below focuses solely on females, but as we report earlier in the paper, the incidence of anorexia among young males is much lower than among young females.

In the same spirit as Costa-Font and Jofre-Bonet (2008) we also analyze the determinants of extreme thinness and poor body image, but we include a broader range of variables suggested by the previous literature. Using four years of data from the 1997 National Longitudinal Survey of Youth (NLSY97), we consider a female to be "at-risk" if she is trying to lose weight and weighs less than the minimum normal weight for her height. We consider a female to be a "severe risk" if she is trying to lose weight and weighs less than 85 percent of the minimum normal weight for her height. All other females are considered not at severe risk. We regress the probability of being at-risk and the probability of being at severe risk on a host of factors suggested by previous research as correlates or predictors. Given the longitudinal nature of the data, we also account for unobserved individual-level characteristics with the inclusion of individual fixed effects.

Table 2 shows the means for the individual and family characteristics of the respondent. The individual variables include the following: respondent's age, race, citizen status at birth, current educational status (high school dropout, high school graduate, in college; with attending high school as the omitted reference category), number of grades repeated, work status, youth earned plus unearned income, and the number of days per month the respondent smokes cigarettes. Cigarette smoking is considered as it may represent teenagers who desire to be thin (cigarettes suppress appetites, see Cawley et al. 2004), who have a propensity towards risk, or who want to defy authority.

Characteristics of the family include: family composition (lives with one parent, lives with no parents, lives with adoptive parents; lives with two parents as the omitted reference category), number of children under age 18 in the household, parental income, mother's years of schooling, and mother's weight status (underweight, overweight, obese; normal weight as the

omitted category). Since maternal weight was only recorded in 1997, we assign the 1997 weight status across all four waves of the panel. We also include characteristics specific to the father, including father's education and weight status. However, many individuals have missing responses for the father characteristics, so we show models with and without these characteristics.

Because the prior literature about the determinants of anorexia nervosa points to an impaired mother-child relationship, we use variables designed to represent the quality of family life for the child. First, we include the number of days per week the respondent typically eats dinner with the family and the number of days per week the respondent reports having fun with the family. Second, the NLSY97 asks the respondents to describe the parenting style of each parent in terms of supportiveness and strictness. The responses to these questions were combined by the survey designers to generate four types of parenting styles: uninvolved, authoritarian, authoritative, and permissive. Uninvolved parents are those that are permissive and not very supportive. Authoritarian parents are strict and not very supportive. Authoritative parents are strict and very supportive, and lastly, permissive parents are permissive and very supportive. We include these indicators for mothers and, in some regression models, for fathers. These parenting styles refer to parents that live with the child, unless this variable is missing. In the latter case we use the parenting style of the non-resident parent (10 percent of the responses involve non-residential parents.)

The 1997 wave of the NLYS97 asked respondents additional family life questions. We include for 1997 only the number of hours per weekday the respondent spends doing homework, the number of hours per weekday the respondent watches television, and the number of days per week the respondent exercises 30 minutes or more. The time spent watching television may be

related to the respondent's exposure to media images regarding the "ideal" woman, while exercise and homework time may indicate the respondent's attention to their mind and body.

Also available from the 1997 questionnaire is an index of family risk. This index measures the physical environment of the home and neighborhood, enriching activities, religious behavior, school involvement, family routines, and characteristics of the parents (see Child Trends, 1999, for more details). The index ranges from 0 to 21, with higher values representing greater risks of the child developing health and behavioral problems.

Table 2 shows sample means for the pooled years and for each year individually. The separate years indicate how the variables change over time. Consider the variable for "at-risk for anorexia". In the first wave of data, when the girls are 14 years old on average, the probability of being considered at-risk is 0.21. The sample means show that this risk falls considerably as the girls age. A similar statement can be made for the severe risk indicator. Here, 4 percent of the sample is considered at severe risk in 1997, and this falls to 1 percent by 2000. Note that these proportions are still much higher than the estimated national figures for anorexia nervosa, where the lifetime prevalence is 0.5 to 1.0 percent. Clearly not all individuals who are at-risk will actually develop the disease.

Regression results for the probability of being at-risk for anorexia are shown in Table 3, and the results for severe risk are shown in Table 4. We estimate the probabilities using a linear probability model with standard errors corrected for intra-individual clustering according to Huber (1967). Six models are shown in each table. The first two columns use data on female adolescents from the 1997, 1998, 1999 and 2000 waves of the survey. The second column includes the father variables which reduces the sample size because of a significant number of missing observations on these variables. The next two columns are for the 1997 data only, and

include those variables specific to this wave along with the individual and family characteristics. Again, these models are shown with and without the father characteristics. The last two columns contain all four waves of data, but include individual respondent fixed effects. The fixed effects account for unobserved individual-specific, time invariant characteristics. Their inclusion will help shed light on whether measurable variables in the survey can predict being at-risk for anorexia, or if these variables merely reflect some underlying personality of the individual. Note that time-invariant variables (race, citizenship, parent education, and parent weight status) must be excluded from the fixed effects models.

Considering the outcome "at-risk" for anorexia, the results for the pooled years and only for 1997 generally show the same results. In these models, the factors that are associated with a higher probability of being at-risk for anorexia include working, smoking, higher parental income, and in the pooled years only, being in college. The factors associated with a lower probability of risk of anorexia include older ages, black, Hispanic, high school dropout, number of grades repeated (1997 only), higher youth income, more children in the household, and mother overweight or obese. These body weight results make sense since children of overweight mothers are likely to be overweight themselves and therefore not at risk for anorexia. Note that the prediction from our model that African-Americans would be less likely to be anorexic, is confirmed in these results.

The variables designed to represent the quality of family life are also associated with being at-risk for anorexia. Compared to the permissive parenting style, teenage girls with mothers categorized as uninvolved or authoritarian have a much higher probability of being at risk. Girls with mothers categorized as authoritative are at a risk no different from those with a permissive mother. Having a father with an authoritarian parenting style also increases the

probability of being classified as at-risk, although none of the other father parenting groups is different from the permissive group in the pooled years.

In the pooled years, spending more nights a week eating dinner with the family is associated with a lower probability of being at risk. In the 1997 data, the number of days the respondent exercises for thirty minutes or more is positively associated with the likelihood of being at-risk, while minutes watching television, doing homework, and the family risk index have no statistically significant associations.

The fixed effects models are informative in that they indicate which factors are associated with the probability of being at-risk for anorexia after controlling for unobserved individual characteristics. The most striking results from these models involve family income and parenting styles. Each additional $10,000 of family incomes is associated with a 0.4 percentage point increase in being at risk. Having an "uninvolved" mother or an "authoritarian" mother each increase the risk by approximately 5 percentage points over the permissive mothers. Authoritarian fathers increase the risk by 3.6 percentage points. These models also show that females in college are more likely to be at risk, as are those who are working and those who smoke on more days, but these last three results only hold in the models without the father variables included.

Table 4 shows the results for the severe risk indicator. In general, the results are similar to that of Table 3, although one noticeable difference is that parental income is no longer a statistically significant determinant of the risk. However, similar to the previous table, being older is associated with a lower risk, as is being black or Hispanic. Working is associated with a higher risk in the fixed effects models. Holding age constant, females with a high school degree or who are in college are at a higher risk than those in high school. Having an overweight or

obese mother is associated with a lower probability of severe risk. As was found for the at-risk variable, maternal parenting style matters. Having an "uninvolved" or an "authoritarian" mother each increase the risk by 1 to 2 percentage points over the permissive mothers. However, paternal parenting style has little effect on the probability of severe risk.

SECTION VI: CONCLUSION

This paper has employed a utility maximizing model of weight determination, one that generates unhealthily low weight choices, where the severe dieter nonetheless views herself as not thin enough. The model also accommodates a continuum of underweightedness; some overly thin people are not anorexic, while others cross into illness.

We have also considered whether and to what extent the decision to maintain an extremely low weight can be seen as a rational choice. Both thin and substantive conceptions of rationality were considered, as well as rival theoretical views of anorexia's etiology. Lastly, we explored which empirical correlates put young women at greater risk for becoming anorexic. Our empirical results confirm our model's prediction that young African American women are less likely to be anorexic.

What are the policy implications of this analysis? The policy challenges for reducing the incidence of anorexia are daunting. First, anorexia is a young person's disease – mean age of onset is just under 19. Though anorexia is extremely dangerous for those afflicted, a relatively low percentage of dieters become anorexic, both because so many millions of young women are dieting, and because maintaining radical calorie deprivation is hard, as evidenced by the millions who fail to do it. Teenagers are already prone to "yes, but it won't happen to me" thinking, and the average dieting teen can make this claim with some plausibility.

Second, and perversely, the economist's policy strategy of deterring self-destructive behavior by raising its price, has no obvious analogue here. Young consumers are especially responsive to price increases, and excise tax increases have successfully deterred some youth smoking, for example, and proposed taxation of sugary drinks may prove to reduce obesity. But how to raise the cost of starvation dieting? Subsidizing fattening food or taxation of excessive thinness, even if efficacious, would be perverse in a culture where more than half the population is overweight or obese.

Third, informational approaches offer some promise, especially if targeted to those groups at greatest risk. Our analysis suggests that the broad factors correlated with greater risk for young women are higher income, white versus black or Hispanic, and strict parenting styles. Information campaigns might target adolescent girls from wealthier white households, but these households are already more likely to be informed about health risks.

In Section IV, we saw that starvation dieters with false beliefs – those do not know the health risks of excessively low weight, or mistakenly believe a healthy weight to be well below its true value – might, with accurate information provision, be induced to revise upward their desired health weight, W_H, and, thereby, reach a higher optimal weight equilibrium. Better information about the arguably less-well-known hazards of starvation – impaired judgment, psychiatric symptoms – could also help deter some severe dieters, especially those whose false beliefs have not yet hardened into irrational beliefs. But, given the teenage audience, anti-anorexia messages may prove no more effective than have anti-tobacco messages.[24] And there is the further complication that messages targeted to those groups at risk for anorexia will likely

[24] Goel and Nelson (2006) find mixed and inconclusive evidence of the effectiveness of non-price policies such as health messages and advertising restrictions in reducing smoking. On the other hand, the health consequences of anorexia are closer in time than those of smoking, which could make anti-anorexia messages more effective. It might also be that anti-anorexia messages targeted to teens would be more effective by emphasizing the risks to appearance – a slender physique may seem attractive, but a human skeleton does not.

also reach the larger population at risk for obesity. It may be that public-health instruments for preventing anorexia are too blunt to be effective, and that efforts should focus upon "secondary prevention" – treatment that reduces the duration or adverse effects of anorexia (Battle and Brownell, p. 758).

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Figure 1

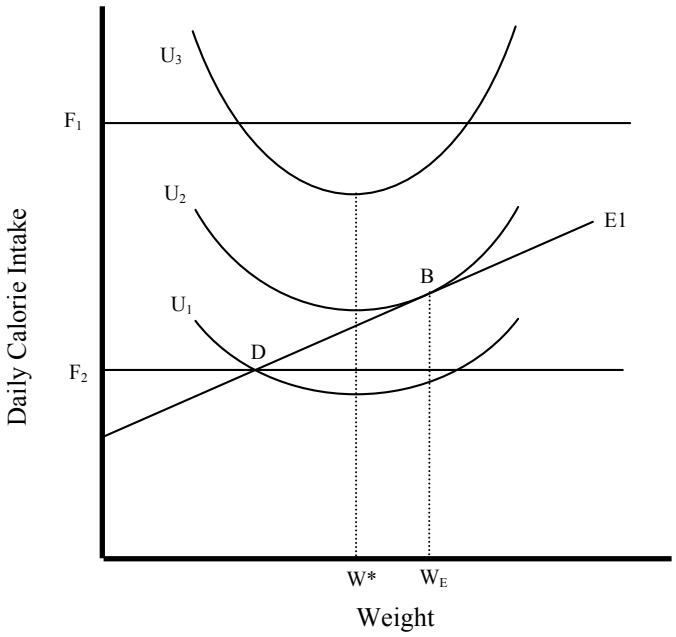

Figure 2

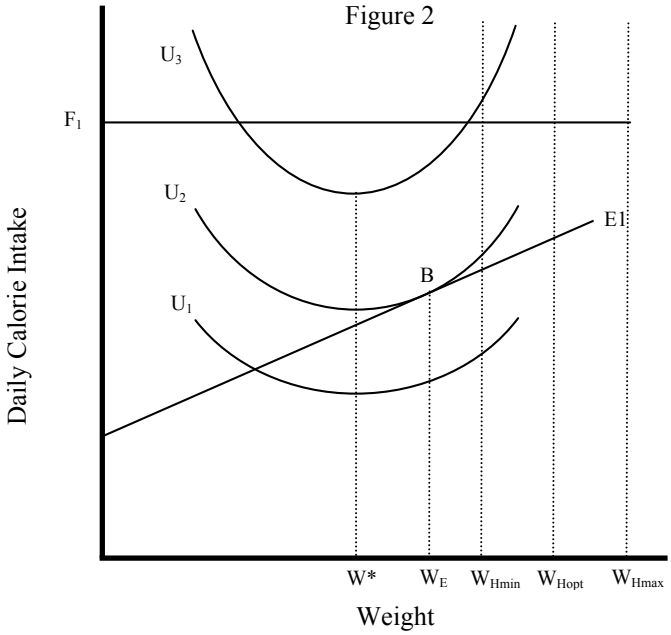

Figure 3

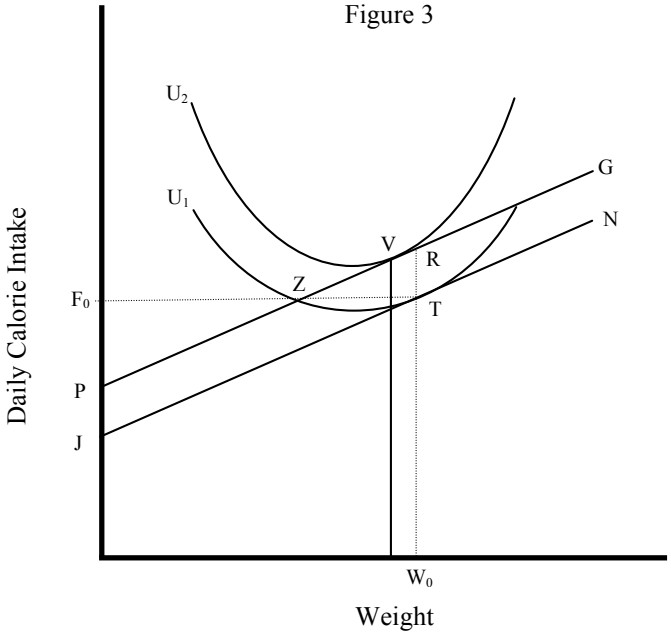

Table 1: Minimum normal weight for Females and Anorexia Nervosa Indicator Weights

Height (feet)	Minimum normal weight for females (in pounds)	Anorexia nervosa indicator weight= 0.85*minimum weight	BMI associated with anorexia nervosa indicator weight
4'10" or less	111	94.35	19.72
4'11"	114	96.90	19.57
5'0"	116	98.60	19.25
5'1"	119	101.15	19.11
5'2"	122	103.70	18.96
5'3"	125	106.25	18.82
5'4"	128	108.80	18.67
5'5"	132	112.20	18.67
5'6"	135	114.75	18.52
5'7"	139	118.15	18.50
5'8"	142	120.70	18.35
5'9"	145	123.25	18.20
5'10"	147	124.95	17.93
5'11"	150	127.50	17.78
6'0" or more	152	129.20	17.52

Source: NCS-R Diagnostic Algorithm, DSM-IV Anorexia Nervosa

Table 2
Sample Means, NLSY97 Females

	All years (n=15,377)	1997 (n=3,966)	1998 (n=3,844)	1999 (n=3,812)	2000 (n=3,755)
At risk for anorexia	0.17	0.21	0.18	0.15	0.12
Severe risk for anorexia	0.02	0.04	0.02	0.01	0.01
Is trying to lose weight	0.50	0.50	0.50	0.49	0.49
BMI	22.80	21.76	22.71	23.13	23.65
Age	16.32	14.43	16.01	16.95	18.00
Black	0.26	0.27	0.27	0.26	0.26
Hispanic	0.20	0.20	0.20	0.21	0.21
Mixed race	0.01	0.01	0.01	0.01	0.01
US citizen at birth	0.81	0.81	0.81	0.81	0.81
High school dropout	0.08	0.02	0.08	0.09	0.11
In high school (omitted category)	0.72	0.97	0.82	0.64	0.44
High school degree	0.07	0.00	0.03	0.10	0.16
In college	0.13	0.00	0.07	0.16	0.28
Number of grades repeated	0.16	0.14	0.16	0.16	0.17
Works	0.52	0.44	0.51	0.53	0.62
Youth income (in $1000s)	1.52	0.67	0.95	1.77	2.73
Days smoked	4.69	2.77	4.46	5.43	6.19
One parent	0.30	0.32	0.31	0.29	0.27
Adopted	0.01	0.01	0.01	0.01	0.01
No parents	0.12	0.05	0.09	0.13	0.21
Number children in household	1.91	2.42	2.09	1.65	1.44
Parent income (in $1000s)	43.88	41.99	41.51	44.97	47.18
Mom education	12.60	12.62	12.58	12.60	12.58
Mom underweight	0.02	0.02	0.02	0.02	0.02
Mom overweight	0.30	0.30	0.30	0.30	0.30
Mom obese	0.25	0.25	0.25	0.25	0.25
Mom parent style: Uninvolved	0.16	0.12	0.17	0.18	0.16
Mom parent style: Authoritarian	0.14	0.14	0.16	0.15	0.12
Mom parent style: Authoritative	0.35	0.39	0.35	0.33	0.32
Mom parent style: Permissive (omitted category)	0.35	0.35	0.33	0.34	0.39
Number of days eat with family	4.26	4.63	4.32	4.17	3.90
Number of days have fun with family	2.06	2.39	2.00	1.96	1.86
Dad education	13.01	13.04	13.01	13.02	12.98
Dad underweight	0.01	0.01	0.01	0.01	0.01
Dad overweight	0.44	0.45	0.45	0.44	0.44
Dad obese	0.22	0.22	0.22	0.23	0.23
Dad parent style: Uninvolved	0.24	0.16	0.28	0.30	0.24
Dad parent style: Authoritarian	0.21	0.22	0.22	0.20	0.19
Dad parent style: Authoritative	0.28	0.33	0.26	0.25	0.27
Dad parent style: Permissive (omitted category)	0.27	0.28	0.24	0.25	0.30
Time spent doing homework		1.42			
Time spent watching TV		2.76			
Number of days exercise		4.18			
Family risk index		2.75			

Table 3
At-Risk for Anorexia Nervosa

	All years		1997 only		All years, fixed effects included	
	Father variables excluded	Father variables included	Father variables excluded	Father variables included	Father variables excluded	Father variables included
Age	-0.0210	-0.0223	-0.0246	-0.0220	-0.0130	-0.0217
	(-6.61)	(-5.86)	(-5.41)	(-4.19)	(-1.31)	(-1.29)
Black	-0.1117	-0.1127	-0.1151	-0.1152		
	(-11.85)	(-10.06)	(-6.98)	(-6.10)		
Hispanic	-0.0505	-0.0382	-0.0563	-0.0404		
	(-3.88)	(-2.57)	(-2.71)	(-1.70)		
Mixed race	-0.0458	-0.0144	-0.1077	-0.0881		
	(-1.07)	(-0.30)	(-1.89)	(-1.38)		
US citizen at birth	-0.0121	0.0092	0.0045	0.0010		
	(-0.95)	(0.57)	(0.19)	(0.04)		
High school dropout	-0.0249	-0.0195	-0.0590	-0.0331	-0.0037	0.0009
	(-2.20)	(-1.23)	(-1.71)	(-0.65)	(-0.29)	(0.03)
High school degree	-0.0017	0.0016	0.1316	-0.0047	0.0034	0.0114
	(-0.14)	(0.10)	(0.77)	(-0.03)	(0.27)	(0.44)
In college	0.0395	0.0329	-0.2316	-0.2270	0.0278	0.0270
	(3.37)	(2.14)	(-4.32)	(-3.74)	(2.36)	(1.21)
Number of grades repeated	-0.0079	0.0020	-0.0335	-0.0347	-0.0122	-0.0109
	(-0.83)	(0.14)	(-2.07)	(-1.65)	(-0.71)	(-0.37)
Works	0.0145	0.0163	0.0419	0.0392	0.0144	0.0130
	(2.02)	(1.87)	(3.00)	(2.48)	(1.97)	(1.04)
Youth income (in $1000s)	-0.0009	-0.0016	-0.0026	-0.0023	-0.0003	-0.0005
	(-1.06)	(-1.85)	(-2.75)	(-2.56)	(-0.34)	(-0.39)
Days smoked	0.0009	0.0006	0.0016	0.0019	0.0010	0.0006
	(2.32)	(1.17)	(1.70)	(1.76)	(2.12)	(0.64)
One parent	-0.0102	-0.0077	-0.0192	-0.0186	0.0070	0.0047
	(-1.16)	(-0.72)	(-1.31)	(-1.02)	(0.53)	(0.20)
Adopted	-0.0037	-0.0219	0.0404	0.0297	-0.0682	-0.0808
	(-0.11)	(-0.56)	(0.61)	(0.40)	(-0.95)	(-0.68)
No parents	-0.0143	-0.0097	0.0082	0.0333	-0.0064	-0.0399
	(-1.39)	(-0.65)	(0.29)	(0.83)	(-0.45)	(-1.27)
Number children in household	-0.0049	-0.0051	-0.0092	-0.0097	0.0042	0.0054
	(-1.86)	(-1.56)	(-2.00)	(-1.77)	(1.08)	(0.78)
Parent income (in $1000s)	0.0004	0.0004	0.0004	0.0006	0.0004	0.0004
	(3.85)	(3.29)	(1.25)	(1.82)	(3.17)	(2.15)
Mom education	0.0029	0.0014	-0.0013	-0.0009		
	(1.75)	(0.65)	(-0.46)	(-0.27)		
Mom underweight	-0.0385	-0.0470	-0.0632	-0.0734		
	(-1.16)	(-1.25)	(-1.15)	(-1.31)		

Mom overweight	-0.0227	-0.0181	-0.0219	-0.0104		
	(-2.06)	(-1.43)	(-1.24)	(-0.54)		
Mom obese	-0.0639	-0.0594	-0.0644	-0.0460		
	(-6.17)	(-4.86)	(-3.63)	(-2.18)		
Mom parent style: Uninvolved	0.0421	0.0439	0.0721	0.1068	0.0535	0.0581
	(3.68)	(3.31)	(3.04)	(3.72)	(4.59)	(3.07)
Mom parent style: Authoritarian	0.0726	0.0651	0.0887	0.0995	0.0545	0.0487
	(5.67)	(4.37)	(4.03)	(3.77)	(4.18)	(2.30)
Mom parent style: Authoritative	-0.0001	-0.0025	0.0005	0.0268	0.0070	0.0008
	(-0.01)	(-0.23)	(0.03)	(1.48)	(0.76)	(0.05)
Number of days eat with family	-0.0053	-0.0059	-0.0052	-0.0042	0.0011	-0.0001
	(-2.44)	(-2.43)	(-1.31)	(-0.92)	(0.46)	(-0.03)
Number of days have fun with family	0.0005	0.0001	-0.0029	-0.0021	-0.0016	-0.0036
	(0.18)	(0.04)	(-0.66)	(-0.42)	(-0.55)	(-0.83)
Dad education		0.0022		0.0012		
		(0.93)		(0.36)		
Dad underweight		-0.1217		-0.1129		
		(-4.93)		(-1.94)		
Dad overweight		0.0328		0.0253		
		(2.30)		(1.12)		
Dad obese		-0.0120		-0.0117		
		(-0.74)		(-0.44)		
Dad parent style: Uninvolved		-0.0045		-0.0387		0.0026
		(-0.41)		(-1.63)		(0.16)
Dad parent style: Authoritarian		0.0396		0.0273		0.0356
		(3.15)		(1.18)		(1.90)
Dad parent style: Authoritative		0.0104		-0.0362		0.0192
		(0.91)		(-1.77)		(1.12)
Time spent doing homework			-0.0052	-0.0026		
			(-1.08)	(-0.49)		
Time spent watching TV			0.0069	0.0039		
			(1.49)	(0.66)		
Number of days exercise			0.0152	0.0160		
			(2.22)	(2.00)		
Family risk index			-0.0007	0.0006		
			(-0.14)	(0.10)		
1998	-0.0117	-0.0131			-0.0205	-0.0106
	(-1.34)	(-1.25)			(-1.15)	(-0.35)
1999	-0.0248	-0.0267			-0.0373	-0.0171
	(-2.43)	(-2.24)			(-1.38)	(-0.38)
2000	-0.0356	-0.0325			-0.0535	-0.0242
	(-2.89)	(-2.30)			(-1.43)	(-0.39)
n	15,377	10,632	3,966	3,185	15,377	10,632

Note: t-statistics in parentheses, intercept not shown.

Table 4
At Severe Risk for Anorexia Nervosa

	All years		1997 only		All years, fixed effects included	
	Father variables excluded	Father variables included	Father variables excluded	Father variables included	Father variables excluded	Father variables included
Age	-0.0098	-0.0115	-0.0145	-0.0169	-0.0048	-0.0037
	(-7.92)	(-7.08)	(-6.39)	(-6.20)	(-1.14)	(-0.48)
Black	-0.0190	-0.0204	-0.0399	-0.0407		
	(-5.98)	(-5.15)	(-5.71)	(-5.23)		
Hispanic	-0.0132	-0.0119	-0.0274	-0.0276		
	(-3.12)	(-2.26)	(-3.00)	(-2.72)		
Mixed race	0.0014	0.0128	-0.0347	-0.0276		
	(0.11)	(0.70)	(-1.39)	(-0.90)		
US citizen at birth	-0.0012	0.0061	0.0154	0.0140		
	(-0.27)	(1.14)	(1.67)	(1.28)		
High school dropout	0.0063	0.0073	0.0265	0.0476	0.0019	-0.0004
	(1.50)	(1.20)	(1.25)	(1.40)	(0.30)	(-0.03)
High school degree	0.0132	0.0126	0.1479	0.0156	0.0158	0.0172
	(3.88)	(3.39)	(1.15)	(0.95)	(3.73)	(2.40)
In college	0.0137	0.0216	-0.0135	-0.0096	0.0156	0.0213
	(3.93)	(4.34)	(-0.98)	(-0.53)	(4.01)	(2.61)
Number of grades repeated	0.0045	0.0020	0.0015	-0.0006	-0.0083	-0.0122
	(1.35)	(0.47)	(0.20)	(-0.07)	(-0.93)	(-0.94)
Works	0.0019	0.0039	0.0032	0.0032	0.0058	0.0103
	(0.69)	(1.11)	(0.49)	(0.42)	(1.86)	(1.97)
Youth income (in $1000s)	-0.0002	-0.0004	-0.0008	-0.0008	0.0001	-0.0001
	(-1.07)	(-1.91)	(-2.10)	(-1.99)	(0.20)	(-0.31)
Days smoked	0.0001	0.0001	-0.0003	-0.0004	0.0000	0.0002
	(0.67)	(0.42)	(-0.89)	(-0.83)	(0.21)	(0.45)
One parent	-0.0003	-0.0027	-0.0040	-0.0041	0.0003	0.0017
	(-0.09)	(-0.63)	(-0.57)	(-0.45)	(0.06)	(0.15)
Adopted	-0.0072	-0.0046	0.0124	0.0232	-0.0192	-0.0340
	(-0.61)	(-0.25)	(0.37)	(0.56)	(-1.62)	(-1.11)
No parents	-0.0026	-0.0039	0.0052	0.0189	-0.0031	-0.0096
	(-0.92)	(-0.81)	(0.39)	(0.87)	(-0.57)	(-0.70)
Number children in household	-0.0009	-0.0016	-0.0025	-0.0032	-0.0022	-0.0037
	(-0.90)	(-1.32)	(-1.14)	(-1.14)	(-1.56)	(-1.32)
Parent income (in $1000s)	0.0000	0.0000	-0.0002	-0.0001	-0.0001	-0.0001
	(-0.47)	(0.09)	(-1.68)	(-1.26)	(-1.18)	(-0.71)
Mom education	-0.0001	-0.0003	-0.0003	-0.0003		
	(-0.17)	(-0.44)	(-0.30)	(-0.23)		
Mom underweight	-0.0018	-0.0013	-0.0378	-0.0331		
	(-0.16)	(-0.09)	(-1.91)	(-1.38)		

Mom overweight	-0.0073	-0.0080	-0.0114	-0.0116		
	(-2.00)	(-1.75)	(-1.34)	(-1.28)		
Mom obese	-0.0104	-0.0122	-0.0156	-0.0158		
	(-3.04)	(-2.78)	(-1.86)	(-1.53)		
Mom parent style: Uninvolved	0.0099	0.0081	0.0273	0.0300	0.0129	0.0162
	(2.22)	(1.56)	(2.25)	(2.11)	(2.47)	(1.79)
Mom parent style: Authoritarian	0.0152	0.0176	0.0159	0.0152	0.0131	0.0225
	(2.82)	(2.72)	(1.53)	(1.18)	(2.23)	(2.22)
Mom parent style: Authoritative	-0.0029	-0.0017	0.0008	0.0061	-0.0003	0.0007
	(-0.88)	(-0.44)	(0.12)	(0.71)	(-0.07)	(0.10)
Number of days eat with family	-0.0007	-0.0008	-0.0005	0.0008	0.0005	0.0007
	(-0.78)	(-0.82)	(-0.27)	(0.33)	(0.50)	(0.43)
Number of days have fun with family	0.0010	0.0013	0.0002	0.0017	0.0018	0.0031
	(0.86)	(1.02)	(0.07)	(0.59)	(1.21)	(1.26)
Dad education		-0.0002		-0.0004		
		(-0.28)		(-0.24)		
Dad underweight		0.0074		0.0472		
		(0.34)		(0.76)		
Dad overweight		0.0033		0.0087		
		(0.65)		(0.83)		
Dad obese		0.0012		-0.0020		
		(0.19)		(-0.17)		
Dad parent style: Uninvolved		-0.0027		-0.0077		-0.0097
		(-0.65)		(-0.74)		(-1.45)
Dad parent style: Authoritarian		0.0071		0.0168		0.0006
		(1.27)		(1.43)		(0.07)
Dad parent style: Authoritative		-0.0067		-0.0139		-0.0088
		(-1.62)		(-1.43)		(-1.32)
Time spent doing homework			0.0013	0.0025		
			(0.39)	(0.62)		
Time spent watching TV			-0.0012	-0.0004		
			(-0.54)	(-0.14)		
Number of days exercise			0.0032	0.0061		
			(0.96)	(1.53)		
Family risk index			-0.0037	-0.0038		
			(-1.60)	(-1.39)		
1998	-0.0067	-0.0062			-0.0144	-0.0202
	(-1.84)	(-1.39)			(-1.91)	(-1.47)
1999	-0.0056	-0.0029			-0.0196	-0.0231
	(-1.45)	(-0.63)			(-1.69)	(-1.11)
2000	-0.0036	-0.0063			-0.0225	-0.0338
	(-0.91)	(-1.38)			(-1.41)	(-1.19)
n	15,377	10,632	3,966	3,185	15,377	10,632

Note: t-statistics in parentheses, intercept not shown.