NBER WORKING PAPER SERIES

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Working Paper 14838
http://www.nber.org/papers/w14838

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
April 2009

We thank Bernard Wolf for suggesting extending the model described in this paper to see if it could be used to analyze anorexia, Vivian Valdmanis for helpful comments on an earlier draft, and Marsha Goldfarb and Sarah Duffy for useful suggestions. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

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JEL No. D0,I0

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 of the following issue: could a rational choice approach 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 also present empirical evidence about factors possibly contributing to anorexia nervosa. 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 different reasons. First, anorexia nervosa is interesting in and of itself; it afflicts adolescents and young women, and creates serious health risks for those afflicted. After a discussion of anorexia nervosa, its incidence and effects, we ask whether a rational choice approach, embodied in an economic model of dieting, can shed useful light on the choice to maintain a dangerously low body weight.

Second, anorexia nervosa 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,[2] we investigated one such boundary, the rationality of self-defeating choices. Our approach was to see how far we could get "explaining" harmful behaviors, using the rational choice assumptions endemic to most mainstream economic analysis.

Compared to multiple diets, which GLS (2006) and SG (2007) showed can have perfectly innocuous causes consistent with rationality, anorexia nervosa provides a sterner challenge to a rational-choice approach. Some medical authorities, for example, judge anorexia nervosa to be an illness, which would seem to locate anorexia "across the border," beyond the boundary of what rational choice models can conceptualize. Why, after all, would someone choose to be dangerously ill? On the other hand, if anorexia nervosa is indeed a disease, it is one whose onset is entangled with behavioral choices regarding calorie intake and expenditure.

This paper shows how the previously developed GLS (2006) model of weight choice, weight change and dieting, aimed at generating and therefore explaining the phenomenon of

[1] Throughout the paper, we employ the term anorexia as a synonym for anorexia nervosa.

[2] Smoking: Suranovic, Goldfarb and Leonard 1999, Goldfarb, Leonard and Suranovic 2001. Dieting: Goldfarb, Leonard and Suranovic 2006; Suranovic and Goldfarb 2007. (Hereafter the initials G, L and S are used).

multiple diets, can be expanded to conceptualize and model anorexia nervosa. We offer the anorexia analysis and result as a consciousness-raising way of thinking about the condition.

With respect to the boundaries of rational choice approaches, we show how our conceptualization depends on and makes use of the well-known proposition that economic models take tastes as given, no matter how idiosyncratic, imprudent, or self-defeating tastes may appear to be.[3] Indeed, it is the distinctiveness of the individual's tastes in our model that generates anorexia nervosa. But our model also produces the interesting result that this variation in taste is "only" a matter of degree: some individuals with similar preferences will not suffer from anorexia. Taking tastes with "arguably irrational" elements as the basis for normative evaluation may be a disadvantage for normative economics. However, this example suggests it may be an advantage for doing positive economics because it allows modeling of conditions like anorexia.

This paper proceeds as follows. Section I provides some background information about anorexia nervosa, including its relation to bulimia. Section II sets out the basics of the GLS (2006) model of weight choice, weight change and dieting. Section III modifies the model to encompass anorexia, and considers how purging, which is sometimes but not always an associated behavior, might be incorporated into the model. It then considers what might trigger the onset of severe dieting leading to anorexia. Section IV presents some empirical evidence about factors possibly contributing to anorexia. Section V discusses two categories of

[3] Jon Elster (1983) has described the rationality concept used in economics as "thin rationality." A nicely succinct description of Elster's view is in Padgett 1986: "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. Elster calls this the 'thin theory' of rationality. The refusal to inquire into the genesis of preferences, however, creates a dilemma for utilitarian moral theory: 'Why should individual want satisfaction be the criterion of justice and social choice when the individual wants themselves may be shaped be a process that preempts the choice?' ([Elster 1983] 109). Elster …. (wants a).. 'broad theory' of rationality to supplement the thin…. a set of criteria by which beliefs and preferences themselves can be judged rational." (Padgett, 1986, p.26)

implications: those about the condition itself, and those concerning the application of the term "rational" to weight choices leading to anorexia.

SECTION I: BACKGROUND FACTS ABOUT ANOREXIA NERVOSA

The American Medical Association describes anorexia nervosa (AN) 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 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; hereafter APA).

Two of these features are central to the aspects of anorexia we want to model. The first aspect is a body weight below "minimally normal weight". Second is "distorted body image," or "disturbance in the way one's body weight is experienced." This second feature will be interpreted in our model as an extremely low *desired* weight.

Females account for at least 90 percent of all AN cases (APA 2000). The incidence is 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. 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). 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 AN can occur after one episode, while others develop a chronic condition (Steiner and Lock 1998).

The APA diagnosis criterion for body weight 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 5^{th} and 10^{th} 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.

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 with the following observation. Our human ancestors were subject to

"erratic fluctuations" in the availability of food, and "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).

Anorexia nervosa begins with a severe reduction in calorie intake, followed by an increase in physical activity, an effect that "may be related to stimulation of dopamine transmission in the striatum . . . . Ovarian cyclicality ceases…Subsequently lowering of body temperature and slowing of heart rate occur as anorexia develops…these physiological changes are caused by the shortage of food." (p. 573). There are also associated "psychiatric symptoms" of depression, anxiety and "obsessive behaviors and thoughts," especially about food. About 20 percent of those who have anorexia also "display bulimic behavior, i.e.—bingeing and purging."[4,5]

Importantly, Sodersten et al. regard anorexia (and bulimia) as *consequences* of starvation. Contrary to some prior views, they argue that the impaired judgment and psychiatric symptoms associated with anorexia are *result* of the underlying starvation/eating disorder, and not the cause.

Their view, consistent with the modeling approach we take below, says that the individual chooses a severe reduction in calories, risking though not guaranteeing that physiological starvation will cause the impaired judgment and psychiatric symptoms that make

[4] Sodersten at al (2006) go on to discuss the link between bulimia and anorexia. They 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.

[5] 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).

anorexia so dangerous. In other words, the individual does not choose to be anorexic as such, she risks (knowingly or not) anorexia by the prior choice to starve herself.

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, and those determining the individual's utility. These building blocks combine to determine the individual's optimal weight/food intake combination. In GLS 2006, the resulting equilibrium can display "optimal overweightedness" or "optimal underweightedness," ideas that appear earlier in Levy 2002. GLS 2006 uses the weight/food choice framework to generate explanations for dieting behavior.

For purposes of conceptualizing anorexia, we set out the two building blocks. We then show how an expansion of the utility side can generate anorexia.

Determinants of weight production

GLS 2006 notes that "the physiology literature predicts weight (will) change when calorie intake differs from calorie expenditure. Therefore 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.[6] 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.

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

In Figure 1, the line, E1, represents the relationship between food intake ("calories consumed"), F, and weight levels, W, drawn for a specific level of energy 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 E1 line is derived using the Harris-Benedict equations from the physiology literature, which indicate that BMR, and hence food intake needed to maintain weight, rises linearly with weight.[7] 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.[8]

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/Food Intake Combinations

Facing this weight/food 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. Movements away from this desired weight might generate disutility from three

[7] The Harris-Benedict equations are described more fully in SG 2007.
[8] 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)

possible sources: negative appearance effects, negative health effects, and increases in "task costs". Negative appearance effects can be internal or external. 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*.[9]

Equilibrium with "Optimal Overweightedness"

Consider a woman whose energy expenditure is represented by E1, facing the non-binding budget constraint F_1. Since the individual can choose any point along E1, 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/or appearance

[9] As is pointed out in GLS (2006), 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.

considerations. The intuition underlying this result is that, even though at W* an extra pound of weight is a bad, more food consumption is a good. Since at W* the marginal utility of the extra food intake exceeds the marginal disutility of extra weight (which is zero at W*), this person will choose a higher weight to raise utility. 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

Several other results derived in GLS 2006 have some relevance to the issue of anorexia. One problem in understanding anorexic behavior is to explain why an individual will diet to such a degree that their weight falls seriously below the healthy level. GLS (2006) discuss conditions that would generate dieting in typical circumstances. In each case something must happen to change the optimally overweight equilibrium point. 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 E1 line. If calorie intake is maintained, the result is weight gain, which, in turn, can motivate a diet.

Another type of disturbance can involve a change in the person's optimal weight W_E. For example, the diagnosis of a weight-related medical condition may suddenly change a person's desired weight W*, thereby shifting the indifference curves and the optimal weight leftward and setting up the preconditions for a diet. Neither of these situations seems to correspond to the motivations of anorexics, so an explanation for their dieting would have to be found elsewhere.

One other relevant result from GLS (2006) is the possibility of optimal underweightedness. This can arise as follows. First, the indifference curves depicted above are

modified to recognize that at high levels of calorie intake, the individual can become satiated with food. This generates circular, rather than U- shaped, indifference curves. Consider an athlete with an extremely high activity level, say a triathlete. Her E1 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 burning of calories, she is still underweight. In this case we get a result like anorexia in that the chosen consumption point lies below the weight W* that might be best for the individual. However, unlike the anorexic, the triathlete does not believe that she is overweight; to the contrary, the triathelete, unlike the anorexic, recognizes that she is underweight.[10]

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. It is likely, in today's world with the social pressure to be thin, to desire a weight lower than what is deemed by physicians to be one's most healthy weight. However, this can vary from person to person.

[10] 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 opt for.

A person's actual optimal health weight W_{Hopt} is difficult to narrow to a precise value. 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.[11] We might surmise that a person's most healthy actual weight W_{Hopt} is the average of this range, just to pin something down. 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 heavier an individual is, the higher that person believes their ideal weight to be.[12] 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 considered anorexic if 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:

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

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

[12] 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.

The parameter *s* defined on the interval [0,1] represents the weighting (or importance) the individual places on appearance considerations. $(1 - s)$ represents the weight/importance placed on health concerns.

Choosing to be Anorexic

A choice to be anorexic 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 likely to be lower than W_{Hmin}. Finally, the weighting or 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 W* is sufficiently to the left, then the "overweightedness equilibrium," W_E, for our individual will 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 potentially anorexic.

There are several notable features of this analysis. First, this anorexia is a *utility-maximizing choice*, based on the individual's preferences and constraints. One might well classify these preferences as "harmful," or "imprudent" or "self-defeating," but the framework, and this individual's choice, is perfectly 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.

Second, although this individual'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 is more than 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 clinically extremely underweight, continue to view themselves as overweight, even fat. This outcome contrasts with the optimal underweightedness equilibrium for the "too-thin athlete" derived in GLS (2006) and described above. The too-thin athlete's ideal weight W* is *above* the utility-maximizing weight W_E she chooses; in contrast, the anorexic's ideal weight W* is *below* the utility-maximizing weight W_E she chooses. That is, the athlete would like, other things equal, to be less thin, while the anorexic views herself as not thin enough.

Third, while the case in Figure 2 is classifiable as 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 very slightly to the *left* of the individual's weight choice, W_E. She is now not anorexic, in the sense that her weight is not at an unhealthy level. It remains true, however, that there is a gap between the weight she wants and 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.

Fourth, we typically think of illness as something the individual does not choose. He or she "catches" it, or inherits it in his or her genes. In contrast, AN as modeled here is a case where

the individual who obeys the tenets of rational choice models indirectly *chooses* to be ill. In more philosophical terms, what we have here is a conflict between two different senses of rationality: the rational-choice sense of getting what one wants (satisfying one's preferences) and the ordinary language sense of acting with good reasons. So is it good to get what you want? A philosopher might say "it depends on whether one's preferences are prudent." An anorexic's preferences appear to be imprudent.

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 considered possible, 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 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. [13]

[13] 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 Onset of Anorexia

Individuals who become anorexic were presumably not anorexic at an earlier point in time. How can we conceptualize the onset of these anorexia-inducing eating habits? Using the framework specified above, a "potential anorexic" has to have a W_A well below the health minimum W_{Hmin} in order to get a low-enough-for-anorexia W*. But one of two additional conditions must also hold to reach this low W*. The much more likely one is that he or she has a high enough "s" so that W* is below the health minimum W_{hmin}. A second, perhaps less likely, possibility is that the individual is badly misinformed about his or her optimal health weight W_{Hopt}; he or she mistakenly views this healthy weight as way below its true value, so that his or her perceived W_H is below the true W_{hmin}. Notice that the second alternative suggests the possibility of imperfect information as a source of anorexic choices.

Now consider an individual who, initially at time t_0, does not have anorexic eating habits. A change then takes place which provokes the individual to adopt an eating regimen potentially leading to anorexia. What might set off this change? Using our modeling framework, we need W*, which was above W_{Hmin} at t_0, to then fall below it. Using equation (1) above, this can happen because (i) W_A falls, and/or (ii) *s* rises, assuming no change in W_H.

So what factors might generate a downward shift in W_A and/or a rise in *s*? Researchers have identified 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 families (Steiner and Lock 1998; Tozzi et al. 2003; Schwartz et al. 1982).

This suggests that the following scenario is plausible. As the individual becomes a teenager, her consciousness of and the importance of appearance are likely to grow (s rises), and the desirability of being "attractively thin" (causing a fall in W_A) is also likely to escalate, especially for females. These changes in desired image, and the growing importance of such concerns, is extremely likely, we hypothesize, to be spurred by peer views about what is "cool" (and the teasing that takes place if one is not), the images of desirable thinness in fashion and "personality" magazines and TV coverage, and the look of glamorous young female movie stars and fashion models. Schwartz et al. (1982) propose that the combination of a culture that places high emphasis on 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.

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. An alternative view, which we note only in passing because it seems far less plausible to us, is that the maturing teen previously ("always") had anorexic eating preferences, but her realm of control over her eating was quite limited as (say) an eight year old. As she matured, her ability to choose/control how much she ate expanded considerably, as she got more and more "out from under" her parent's supervision at meals.

This framework also suggests some possible (though not necessarily highly promising) counter-measures to the growth in anorexic eating habits. We consider these in the concluding section of the paper.

SECTION IV: SOME EMPIRICAL EVIDENCE ON FACTORS CONTRIBUTING TO ANOREXIA

In a recent empirical study, Costa-Font and Jofre-Bonet (2008) 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.

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. Ideally, we would like to examine actual cases of anorexia nervosa, but since it is such a rare condition, data that are suitable for a rigorous empirical examination are not available. Instead, we examine the characteristics and behaviors of young females that may put them at risk for developing anorexia nervosa.

Using four years of data from the 1997 National Longitudinal Survey of Youth (NLSY97), we consider whether a teenage girl is possibly at-risk for anorexia and possible at a "severe risk". These variables are generated using the following: (1) the response to a survey question that the respondent is currently trying to lose weight, and (2) a comparison of the female's current body weight as reported in the survey to the minimum normal weight for height shown in Table 1. 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. All other females are considered not at-risk. 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 regression variable 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), 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 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 a general form of heteroskedasticity according to White (1980). 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 missing observations on these variables.[14] 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, mother overweight or obese, and father overweight. These body weight results make sense since children of overweight parents are likely to be overweight themselves and therefore not at risk for anorexia.

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

[14] Missing values for variables in each sample are replaced with sample means to preserve the observations. The sample size for the models with the father variables is reduced because no replacement is made for father's education or father's parenting style.

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, spending more nights a week eating dinner with the family is associated with a lower probability of being at risk, but more family fun days are not associated with this lower probability. 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 two 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, father parenting style has little effect on the probability of severe risk.

SECTION V: CONCLUSION

This paper has expanded a rational maximizing model of weight determination to enable it to generate the "unhealthily-low" weight choices associated with anorexia. Put differently, this rational choice modeling framework generates the possibility of weight level choices that subject the individual to anorexia. This paper also provides an empirical investigation of factors associated with higher probability of being at-risk for anorexia. This concluding section considers two issues:

(1) This paper initially posed the question whether this economic-model-generated explanation for anorexia sheds light on (raises our understanding of) the phenomenon. Does this kind of modeling provide a consciousness-raising way of thinking about the condition? One aspect of this issue, though not the only one, is whether this model sheds any light on policy options.

(2). This explanation of anorexia is generated by a rational choice model. But even if the model is viewed as having some usefulness—the issue raised in item (1) above -- is it

appropriate in some larger sense to apply the term "rational" to these anorexia-generating weight choices?

We first address issue (2) about rationality in the broad sense, then consider issue (1) about the model's usefulness, including any possible policy implications.

In what sense does the term "rational" apply to weight choices leading to anorexia? Our framework shows how a particular structure of tastes—in particular, a W* below some health minimum weight—can generate anorexia. But in what sense, if at all, is the individual making a *rational choice to be anorexic?* Suppose we combine our modeling framework with the Sodersten et al (2006) proposition that the relative starvation involved in these unhealthy weight choices impairs the individual's judgment and leads to "psychiatric symptoms" of depression, anxiety and "obsessive behaviors and thoughts."

If impairment of judgment in fact takes place, then the descent into anorexia cannot be described as a fully rational choice, since the individual's judgment "on the path to anorexia" would seem to be impaired; in the absence of that impairment, he or she might exit that particular path, reversing direction.[15] The anorexic develops false beliefs regarding her own body image, the fattening effects of certain foods, and so forth. Moreover, the starvation-induced impairment makes it difficult to correct these false beliefs. The anorexic thus is no longer in the "tent of rationality," even if her initial choice to radically restrict calories was in some sense rationally defensible.

[15] An instructive analogy involves the possible adaptation of our modeling framework to the choice to be "morbidly obese". Our figure 2 contains a vertical line at the "health-max weight". A morbidly obese individual would be someone who chose, based on his preferences, a weight above the health max level. But here the analogy to anorexics breaks down: there appears to be no deluded behavior resulting from being morbidly obese. Thus, the choice appears "rational" in our sense.

Consider an analogy to the decision to take up smoking. One scenario is that the teenage potential smoker is well informed about the health risks of smoking, but poorly informed about the risks of getting hooked (in SGL 1999, this risk is modeled in the magnitude of quitting costs). Indeed, there is survey evidence that beginning smokers underestimate the probability they will still be smoking five years later. In an investigation of time preference and alcohol consumption, Bishai (2003) finds that people's time preferences change over time with individuals becoming more patient as they age. He also finds that this patience is also correlated with less drinking and less drunkenness. The implication is that teenagers may start on a harmful consumption path that they otherwise would not start if they were older. By analogy, it may be the case that the potential anorexic is well informed about the health risks of being "merely" underweight, but not well informed about the risks of starvation impairing future judgment. So in this version of the story, the anorexic is someone who chose to be underweight, but failed to appropriately anticipate the risks of impaired future judgment.[16]

There is also an interesting contrast between this conception of anorexia, and much of the literature dealing with other forms of harmful behavior (overeating, saving too little, exercising too little, smoking, etc.). These forms of behavior are frequently—though not always—modeled as problems of self-control or weakness of will. The behavioral economics approach, for example, models these problems as a species of time inconsistency, in which the individual is more impatient in the near term than in the distant future. In one version of this story, the different rates of time preference are personified as multiple selves—the myopic, impulsive

[16] We discussed above the GLS 2006 model's explanation of the athlete's "optimal underweightedness," a phenomenon quite different from anorexic underweightedness. In terms of our "impaired judgment" story, an important distinction between the two cases is that the athlete *knows* she is underweight and *wants* to gain weight, but cannot. The underweight anorexic *does not perceive herself* as underweight, and *certainly does not want* to gain weight.

"doer" versus the farsighted, resolute "planner". The self-destructive behavior is associated with weakness-of-will, modeled as a failure to control the impulsive, indulgent choices of the doer self.[17]

Anorexia nervosa is a strikingly different form of self-destructive behavior, since it is not a failure of self-control. Indeed, it is if anything a case of very successful self-control: no weakness of will here. Indulging in what the individual views as "eating too much" would work to ameliorate the problem. In a way, anorexics are victims of self-control, not of its absence. It is not surprising, then, that some of the empirical correlates of risk for anorexia, such as higher income, higher education, and strict parenting, characterize home environments in which children can develop a relatively greater capacity for self-control.

What insights about anorexia might this paper's view of that condition yield? In our framework, the initial decision to restrict calories results from a set of preferences about weight that yield a weight optimum below what current medical knowledge suggests is a healthy minimum. This view has the attraction that it provides a seemingly-plausible explanation of why an individual might behave in a way that generates an unhealthily low weight. Another attraction is its consistency with (it generates the prediction that) the anorexic's continuing to view herself as "not thin enough." Moreover, the view has the following interesting additional feature: it portrays the anorexic's situation leading to that decision as being at one end of a continuum of possibilities: as explained in section III above, other cases of tastes that look very similar will not involve anorexia nervosa. 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

[17] For a seminal article on this view, see Thaler and Sheffrin, 1981. For a general noneconomist-friendly discussion of possible applications of behavioral economics insights to policy design, see Thaler and Sunstein 2008.

kind of gap between a most healthy weight and the actual weight chosen, do not cross the line into anorexia nervosa.

Consider someone who feels that the model has some attractive features as an explanation of the anorexic's mindset. That person may well also wonder whether the model generates any implications about policies preventing anorexia or to promote recovery among those with the condition. We address whether the model has any policy "handles".

A fundamental point follows from the fact that this model has the individual *choosing* his weight. The existence of choice *implies the possibility of policy interventions aimed at influencing that choice*. What sorts of policies aimed at influencing choices does the model imply?

Equation (1) above can shed some light on the possibilities. In equation 1, a dangerously low desired weight W* requires a low "desired appearance" weight W_A and a high "share of W_A " proportion s. So to get an increase in W*, an increase in W_A or a decrease in s is necessary. Information policies that raise consciousness about the true health minimum W_{hmin}, combined with raising consciousness about the risks of impaired judgment and debilitating psychological effects of anorexia can increase the weight (1-s) given to health minimum. Moreover, an understanding of these devastating psychological effects may cause a rise in the "desired appearance" weight W_A . This might happen if the individual understands that displaying psychiatric disorders does not generate a desirable persona attractive to friends and other peers.

Indeed, the idea that the weight reduction precedes the onset of psychiatric disorders 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.[18]

The policy handles just described all involve getting better information about the dangers of low weight to potential anorexics. The ability of such policies to actually influence teenage behavior is uncertain at best. On the one hand, the seemingly limited effectiveness of anti-smoking campaigns on teens suggests some doubt about the effectiveness of such policies. Indeed, in a review of these studies in the U.S., Goel and Nelson (2006) find mixed and inconclusive evidence of the effectiveness of advertising restrictions in reducing smoking. On the other hand, the dire health consequences of smoking are likely to be perceived as only emerging far in the future; in contrast, the debilitating effects of psychiatric disorders would presumably be understood by the teenager to be "what's happening now" or certainly pretty soon. That is, teens might perceive the threat from anorexia as much more immediate and pressing. Changes in broader societal attitudes about the attractiveness of extreme thinness would also, this model suggests, counteract tendencies to anorexia.

A different set of insights about policy implications are provided by our empirical investigation of at-risk factors for anorexia. Important factors appear to be higher income, white versus black or Hispanic, and parenting styles. The first two sets of variables might suggest something about how informational campaigns might be targeted. The parental style variables, on the other hand, seem difficult for public policy to affect.

[18] Goeree , Ham and Iorio (2008) suggest based on other literature that "a primary characteristic of BN is the increasingly compulsive nature of the behavior." (p.1). This is consistent with their finding that bulimia is an addiction. Thus, " it is important to instruct a wide range of young women on the addictive nature on BN and the importance of getting help, even in the initial stages of bingeing and purging behaviors." (p.19).

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Figure 1

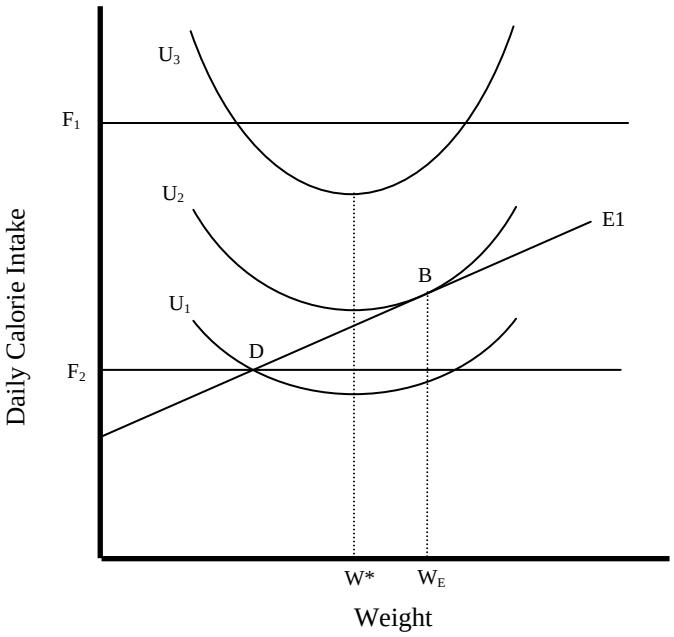

Figure 2

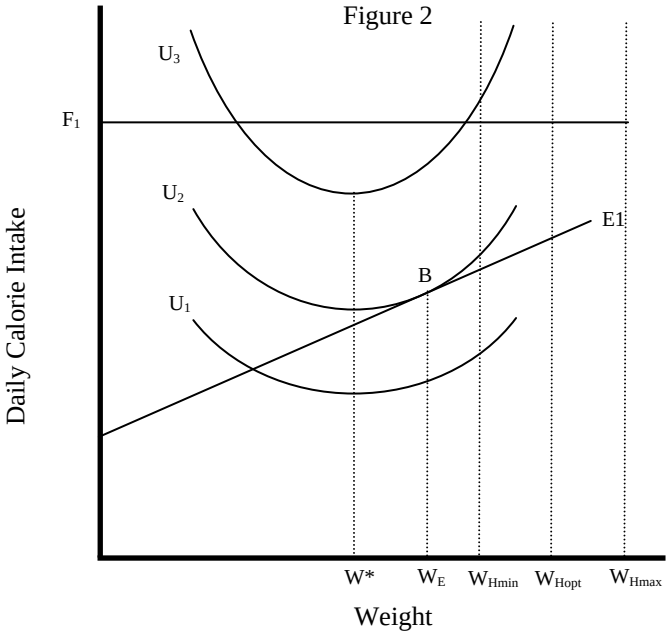

Figure 3

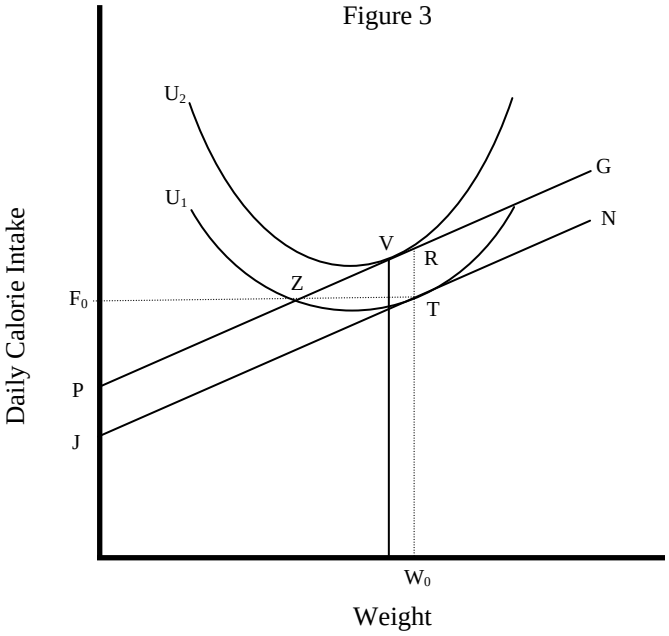

Table 1: Minimum normal weight for Females and Anorexia Nervosa Indicator Weights

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	-0.021	-0.022	-0.025	-0.022	-0.013	-0.022
	(-7.80)	(-6.58)	(-5.41)	(-4.19)	(-1.31)	(-1.56)
Black	-0.112	-0.113	-0.115	-0.115		
	(-15.47)	(-12.47)	(-6.98)	(-6.10)		
Hispanic	-0.050	-0.038	-0.056	-0.040		
	(-5.27)	(-3.23)	(-2.71)	(-1.70)		
Mixed race	-0.046	-0.014	-0.108	-0.088		
	(-1.49)	(-0.38)	(-1.89)	(-1.38)		
US citizen at birth	-0.012	0.009	0.005	0.001		
	(-1.30)	(0.71)	(0.19)	(0.04)		
High school dropout	-0.025	-0.019	-0.059	-0.033	-0.004	0.001
	(-2.37)	(-1.30)	(-1.71)	(-0.65)	(-0.29)	(0.04)
High school degree	-0.002	0.002	0.132	-0.005	0.003	0.011
	(-0.15)	(0.10)	(0.77)	(-0.03)	(0.27)	(0.56)
In college	0.039	0.033	-0.232	-0.227	0.028	0.027
	(3.46)	(2.10)	(-4.32)	(-3.74)	(2.36)	(1.49)
Number of grades repeated	-0.008	0.002	-0.034	-0.035	-0.012	-0.011
	(-1.05)	(0.18)	(-2.07)	(-1.65)	(-0.71)	(-0.43)
Works	0.014	0.016	0.042	0.039	0.014	0.013
	(2.19)	(2.02)	(3.00)	(2.48)	(1.97)	(1.24)
Youth income (in $1000s)	-0.001	-0.002	-0.003	-0.002	-0.0003	-0.001
	(-1.17)	(-1.88)	(-2.75)	(-2.56)	(-0.34)	(-0.47)
Days smoked	0.001	0.001	0.002	0.002	0.001	0.001
	(2.82)	(1.33)	(1.70)	(1.76)	(2.12)	(0.80)
One parent	-0.010	-0.008	-0.019	-0.019	0.007	0.005
	(-1.47)	(-0.84)	(-1.31)	(-1.02)	(0.53)	(0.25)
Adopted	-0.004	-0.022	0.040	0.030	-0.068	-0.081
	(-0.11)	(-0.51)	(0.61)	(0.40)	(-0.95)	(-0.79)
No parents	-0.014	-0.010	0.008	0.033	-0.006	-0.040
	(-1.58)	(-0.70)	(0.29)	(0.83)	(-0.45)	(-1.63)
Number children in household	-0.005	-0.005	-0.009	-0.010	0.004	0.005
	(-2.18)	(-1.79)	(-2.00)	(-1.77)	(1.08)	(0.95)
Parent income (in $1000s)	0.0004	0.0004	0.0004	0.001	0.0004	0.0004
	(4.16)	(3.53)	(1.25)	(1.82)	(3.17)	(2.52)
Mom education	0.003	0.001	-0.001	-0.001		
	(2.32)	(0.81)	(-0.46)	(-0.27)		
Mom underweight	-0.039	-0.047	-0.063	-0.073		
	(-1.57)	(-1.65)	(-1.15)	(-1.31)		

Mom overweight	-0.023	-0.018	-0.022	-0.010		
	(-2.81)	(-1.81)	(-1.24)	(-0.54)		
Mom obese	-0.064	-0.059	-0.064	-0.046		
	(-8.16)	(-5.93)	(-3.63)	(-2.18)		
Mom parent style: Uninvolved	0.042	0.044	0.072	0.107	0.053	0.058
	(3.98)	(3.45)	(3.04)	(3.72)	(4.59)	(3.66)
Mom parent style: Authoritarian	0.073	0.065	0.089	0.099	0.055	0.049
	(6.27)	(4.82)	(4.03)	(3.77)	(4.18)	(2.77)
Mom parent style: Authoritative	-0.0001	-0.002	0.000	0.027	0.007	0.001
	(-0.01)	(-0.25)	(0.03)	(1.48)	(0.76)	(0.06)
Number of days eat with family	-0.005	-0.006	-0.005	-0.004	0.001	-0.0001
	(-2.73)	(-2.68)	(-1.31)	(-0.92)	(0.46)	(-0.04)
Number of days have fun with family	0.0005	0.0001	-0.003	-0.002	-0.002	-0.004
	(0.20)	(0.05)	(-0.66)	(-0.42)	(-0.55)	(-0.99)
Dad education		0.002		0.001		
		(1.19)		(0.36)		
Dad underweight		-0.122		-0.113		
		(-4.73)		(-1.94)		
Dad overweight		0.033		0.025		
		(2.83)		(1.12)		
Dad obese		-0.012		-0.012		
		(-0.92)		(-0.44)		
Dad parent style: Uninvolved		-0.004		-0.039		0.003
		(-0.44)		(-1.63)		(0.19)
Dad parent style: Authoritarian		0.040		0.027		0.036
		(3.39)		(1.18)		(2.31)
Dad parent style: Authoritative		0.010		-0.036		0.019
		(0.96)		(-1.77)		(1.36)
Time spent doing homework			-0.005	-0.003		
			(-1.08)	(-0.49)		
Time spent watching TV			0.007	0.004		
			(1.49)	(0.66)		
Number of days exercise			0.015	0.016		
			(2.22)	(2.00)		
Family risk index			-0.001	0.001		
			(-0.14)	(0.10)		
1998	-0.012	-0.013			-0.020	-0.011
	(-1.24)	(-1.18)			(-1.15)	(-0.42)
1999	-0.025	-0.027			-0.037	-0.017
	(-2.48)	(-2.29)			(-1.38)	(-0.46)
2000	-0.036	-0.032			-0.053	-0.024
	(-3.24)	(-2.46)			(-1.43)	(-0.46)
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	-0.010	-0.011	-0.015	-0.017	-0.005	-0.004
	(-8.58)	(-7.63)	(-6.39)	(-6.20)	(-1.14)	(-0.57)
Black	-0.019	-0.020	-0.040	-0.041		
	(-7.08)	(-6.09)	(-5.71)	(-5.23)		
Hispanic	-0.013	-0.012	-0.027	-0.028		
	(-3.67)	(-2.58)	(-3.00)	(-2.72)		
Mixed race	0.001	0.013	-0.035	-0.028		
	(0.10)	(0.67)	(-1.39)	(-0.90)		
US citizen at birth	-0.001	0.006	0.015	0.014		
	(-0.33)	(1.25)	(1.67)	(1.28)		
High school dropout	0.006	0.007	0.027	0.048	0.002	-0.0004
	(1.67)	(1.29)	(1.25)	(1.40)	(0.30)	(-0.04)
High school degree	0.013	0.013	0.148	0.016	0.016	0.017
	(3.84)	(3.45)	(1.15)	(0.95)	(3.73)	(2.98)
In college	0.014	0.022	-0.013	-0.010	0.016	0.021
	(4.07)	(4.30)	(-0.98)	(-0.53)	(4.01)	(3.18)
Number of grades repeated	0.004	0.002	0.001	-0.001	-0.008	-0.012
	(1.42)	(0.50)	(0.20)	(-0.07)	(-0.93)	(-1.21)
Works	0.002	0.004	0.003	0.003	0.006	0.010
	(0.74)	(1.17)	(0.49)	(0.42)	(1.86)	(2.26)
Youth income (in $1000s)	-0.0002	-0.0004	-0.001	-0.001	0.0001	-0.0001
	(-1.07)	(-1.90)	(-2.10)	(-1.99)	(0.20)	(-0.35)
Days smoked	0.0001	0.0001	-0.0003	-0.0004	0.00005	0.0002
	(0.74)	(0.47)	(-0.89)	(-0.83)	(0.21)	(0.56)
One parent	0.000	-0.003	-0.004	-0.004	0.000	0.002
	(-0.11)	(-0.72)	(-0.57)	(-0.45)	(0.06)	(0.19)
Adopted	-0.007	-0.005	0.012	0.023	-0.019	-0.034
	(-0.60)	(-0.25)	(0.37)	(0.56)	(-1.62)	(-0.93)
No parents	-0.003	-0.004	0.005	0.019	-0.003	-0.010
	(-0.98)	(-0.83)	(0.39)	(0.87)	(-0.57)	(-0.89)
Number children in household	-0.001	-0.002	-0.003	-0.003	-0.002	-0.004
	(-0.95)	(-1.37)	(-1.14)	(-1.14)	(-1.56)	(-1.63)
Parent income (in $1000s)	-0.00002	0.000004	-0.0002	-0.0001	-0.0001	-0.0001
	(-0.48)	(0.09)	(-1.68)	(-1.26)	(-1.18)	(-0.84)
Mom education	-0.0001	-0.0003	-0.0003	-0.0003		
	(-0.21)	(-0.50)	(-0.30)	(-0.23)		
Mom underweight	-0.002	-0.001	-0.038	-0.033		
	(-0.18)	(-0.10)	(-1.91)	(-1.38)		

Mom overweight	-0.007	-0.008	-0.011	-0.012		
	(-2.40)	(-2.04)	(-1.34)	(-1.28)		
Mom obese	-0.010	-0.012	-0.016	-0.016		
	(-3.53)	(-3.08)	(-1.86)	(-1.53)		
Mom parent style: Uninvolved	0.010	0.008	0.027	0.030	0.013	0.016
	(2.22)	(1.55)	(2.25)	(2.11)	(2.47)	(2.13)
Mom parent style: Authoritarian	0.015	0.018	0.016	0.015	0.013	0.023
	(2.98)	(2.87)	(1.53)	(1.18)	(2.23)	(2.64)
Mom parent style: Authoritative	-0.003	-0.002	0.001	0.006	-0.0003	0.001
	(-0.92)	(-0.45)	(0.12)	(0.71)	(-0.07)	(0.12)
Number of days eat with family	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(-0.83)	(-0.88)	(-0.27)	(0.33)	(0.50)	(0.49)
Number of days have fun with family	0.001	0.001	0.0002	0.002	0.002	0.003
	(0.90)	(1.07)	(0.07)	(0.59)	(1.21)	(1.56)
Dad education		-0.0002		-0.0004		
		(-0.32)		(-0.24)		
Dad underweight		0.007		0.047		
		(0.31)		(0.76)		
Dad overweight		0.003		0.009		
		(0.73)		(0.83)		
Dad obese		0.001		-0.002		
		(0.22)		(-0.17)		
Dad parent style: Uninvolved		-0.003		-0.008		-0.010
		(-0.68)		(-0.74)		(-1.74)
Dad parent style: Authoritarian		0.007		0.017		0.001
		(1.40)		(1.43)		(0.08)
Dad parent style: Authoritative		-0.007		-0.014		-0.009
		(-1.64)		(-1.43)		(-1.48)
Time spent doing homework			0.001	0.003		
			(0.39)	(0.62)		
Time spent watching TV			-0.001	0.000		
			(-0.54)	(-0.14)		
Number of days exercise			0.003	0.006		
			(0.96)	(1.53)		
Family risk index			-0.004	-0.004		
			(-1.60)	(-1.39)		
1998	-0.007	-0.006			-0.014	-0.020
	(-1.76)	(-1.34)			(-1.91)	(-1.74)
1999	-0.006	-0.003			-0.020	-0.023
	(-1.49)	(-0.65)			(-1.69)	(-1.31)
2000	-0.004	-0.006			-0.022	-0.034
	(-0.94)	(-1.43)			(-1.41)	(-1.39)
n	15,377	10,632	3,966	3,185	15,377	10,632

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