Journal of Obesity and Overweight
Volume 9 | Issue 1
ISSN: 2455-7633

Research Article Open Access

Being in the Grip of Bulimia: New Evidence on how Bulimia Relates to Addictive Behavior

Daniela Iorio[1] **and Michelle Sovinsky**[2,*]

[1]University of Mannheim and CEPR
[2]Alma Mater Studiorum, Universitaídi Bologna

[*]**Corresponding Author:** Michelle Sovinsky, Alma Mater Studiorum, Universitaídi Bologna, Germany, Tel: 1716887592, E-mail: michelle.sovinsky@gmail.com

Citation: Daniela Iorio, Michelle Sovinsky (2023) Being in the Grip of Bulimia: New Evidence on how Bulimia Relates to Addictive Behavior. J Obes Overweig 9(1): 103

Received Date: June 20, 2023 **Accepted Date:** July 20, 2023 **Published Date:** July 21, 2023

Abstract:

Using longitudinal data that tracks bulimic behavior among young girls (National Heart, Lung, and Blood Institute Growth and Health Study), we examine (1) whether the persistence in bulimia nervosa (BN) can be attributed to slow learning about the deleterious health effects of BN or if it reflects tolerance formed from an addiction; and 2) whether bulimic behavior is consistent with addiction criteria as stated in the Diagnostic and Statistical Manual of Mental Disorders DSM-IV. To address the endogeneity of past behavior, we use instrumental variables, and show that past BN positively and significantly impacts current BN after controlling for individual heterogeneity. When accounting for BN ”stock,” the parameter estimates of past behavior are not negative, which casts doubt on the importance of learning. Making the case for treating BN as an addiction has important policy implications. First, it suggests that the timing of educational policy and treatment is crucial: preventive educational programs aimed at instructing girls about the deleterious health effects of BN, as well as treatment interventions, will be most effective if provided in the early stages. Second, it would put those exhibiting BN on more equal footing (from a treatment reimbursement perspective) with individuals with drug or alcohol addictions.

Keywords: Eating disorders; Bulimia Nervosa; State Dependence; Addiction JEL Code: I12, I18

Background

Eating disorders (ED) are a growing health concern. Estimates from the National Eating Disorders Association indicate that as many as 20 million women in the US are battling with an ED [1]. It is estimated that up to 4% of females in the United States will engage in the bingeing/purging form of an ED, bulimia (BN) during their lifetime [2]. They typically start when they are teenagers. However, the onset age appears to be dropping, where the behavior is increasingly seen among children as young as 10 [3]. Bulimia is especially serious given that a primary characteristic is the increasingly compulsive nature of the behavior. Individuals suffering from BN report requiring more of the behavior to produce the same effect, parallel to the behavior associated with drug addictions. Also, it is well-documented that addicts exhibit higher BN prevalence rates relative to non-addicts [4]. These findings suggest that there may be an addictive component to BN. On the other hand, a common set of traits may predispose an individual to excessive behaviors. That is, some individuals may have strong (unobservable) tastes for bingeing and purging which are persistent over time or evolve slowly. As a result, the propensity to engage repeatedly in bulimic activities may arise solely from differences across individuals (individual heterogeneity) and/or could be driven by (true) state dependence, which is consistent with the potentially addictive nature of BN (i.e., a randomly chosen person becomes chemically/ biologically addicted to the process over time if they binge and purge now). Previous studies overlooked the relative importance of state dependence versus individual heterogeneity in explaining BN persistence. A notable exception is [5], which, to the best of our knowledge, is the first work to document that unobserved heterogeneity plays a role in the persistence of BN, but strikingly up to two-thirds of BN persistence is due to true state dependence (i.e., the causal effect of lagged BN). Having established robust evidence of state dependence in BN in [5], the purpose of this work is now to use econometric techniques to examine the addictive nature of BN. Specifically, we examine whether persistent behavior can primarily be attributed to tolerance or to slow learning about the deleterious health effects of BN.

In order to draw a quantitative link between addiction and state dependence, we use the National Heart, Lung, and Blood Institute Growth and Health Study (henceforth NGHS). A notable aspect of the data is that for each respondent it contains information about an Eating Disorders Inventory index developed by a panel of medical experts, which was designed to assess the psychological characteristics relevant to bulimia [6], and a number of indices that measure a respondent's potential for personality traits/disorders that are highly correlated with BN, such as tendencies toward perfectionism, feelings of ineffectiveness, and interpersonal distrust [6].

We exploit these longitudinal data on individuals' history of bulimic behavior to estimate a dynamic model where the past behavior may affect the current tendency towards BN. As in any dynamic model, we first need to address the endogeneity of the past behavior. To this end, we consider the lags of the personality traits/disorders as instruments for past BN, and use instrumental variables techniques to examine whether persistent behavior can be attributed to tolerance or to slow learning about the deleterious health effects of BN. Our results cast doubt on slow learning as a driving force in state dependence. We first show that the past four years of behavior positively and significantly impacts current behavior when controlling for individual heterogeneity. We also find that when accounting for the ”stock” of bulimic behavior, the parameter estimates of past behavior are not negative, which casts doubt on the importance of learning. Finally, we link our findings to the Diagnostic and Statistical Manual of Mental Disorders DSM-IV [7] addiction criteria, and combine our results with other evidence in the medical literature to make the case that BN should be considered an addiction.

Our work is related to the growing literature on food addiction, which considers that processed foods may be addictive and hence lead to eating behaviors that exhibit addictive components [8-11]. The primary way in which our study differs from previous work is that we use estimates from a dynamic model of BN behavior to show that a significant part of the persistence in BN can be attributed to true state dependence (and not to unobserved het- erogeneity) that is not the result of slow learning. This provides evidence that BN exhibits tolerance, which is one of the DSM-IV criteria for addictive behavior. In addition, our data has the advantage that all individuals were evaluated regarding bulimic behaviors independent of any diagnoses or treatment they had received.

Treating BN as an addiction has important policy implications. First, if BN reflects an addictive component, policy timing is crucial and policy interventions will be more effective if provided in the early stages. Second, making the case for BN as an addiction would put those exhibiting BN on more equal footing (from a treatment reimbursement perspective) with individuals abusing drugs or alcohol. Recent estimates show that only 6% bulimics receive mental health care [12], while a majority of states cover treatment for alcohol and drug addiction [13]. Finally, the typical coverage by insurance companies for eating disorders failed to provide adequate reimbursement for the most basic treatment as recommended by the American Psychiatric Association [14].

Methods

Data

We use longitudinal data collected by the National Heart, Lung, and Blood Institute Growth and Health Study for 2,379 girls starting in 1988, when the girls were aged 9-10. The same cohort was interviewed once a year until 1997. The follow-up rate was 89% after ten years. Participants were recruited from three clinical centers: University of California at Berkeley, University of Cincinnati/Cincinnati Children's Hospital Medical Center, and Westat, Inc./Group Health Association. Berkeley recruited from public and parochial schools in the Richmond Unified School District, chosen for equal representation of Black and White children and minimal racial income disparity. Cincinnati recruited from schools in greater Cincinnati (which includes inner city, urban residential, and suburban areas), aiming for a racially and socioeconomically representative sample of Hamilton County. We stat randomly selected 9 to 10 years old girls from potentially eligible families enrolled in the prepaid medical program of Group Health Association in Washington, DC. To address the lack of White girls in the Group Health Association, a Girl Scout troop from the predominantly White clinic area was recruited. Examinations were conducted in schools in Berkeley and Cincinnati, while Group Health Association clinics served as the examination sites in Washington, DC. In order to ensure consistent data collection across the three centers, a designated "master trainer" was selected from the collaborating investigators. This master trainer then proceeded to train and certify a local trainer at each site. These local trainers were responsible for training, certifying, and overseeing the data collection conducted by the field staff at their respective sites.

Girls were eligible for enrolment if identified as Black or White (Hispanics and other ethnic groups were excluded), were within two weeks of age 9 or 10 at the time of the first visit, had parents of the same race, and completed a household demographic information form with parental consent. Throughout the 5 years of the study, the children are seen at 1-year intervals. Parental data collected at baseline included demographic data on education, income, family composition, diet, physical-activity, and eating behaviors. Further details on the methodology and the selection criteria can be found in [29]. The survey is an exogenously stratified sample, designed to be equally distributed across race, income, and parent's education as the descriptive statistics in Table 1 confirm.

Table 1: Means and Standard Deviations

Variable	Mean	Standard Deviation			Minimum	Maximum
		Overall	Between	Within		
ED•BN Index*	1.279	2.682	1.968	1.91	0	21
Distrust Index*	3.589	3.492	2.783	2.233	0	21
Ineffectiveness Index*	2.752	3.915	3.158	2.494	0	29
Perfectionism Index*	6.468	3.29	2.543	2.177	0	18
Age*	14.363	2.991	1.028	2.561	9	21
European American	0.48	0.499			0	1
Parents High School or Less	0.255	0.436			0	1

Parents Some College	0.393	0.488			0	1
Parents Bachelor Degree or More	0.352	0.477			0	1
Income less than $20,000	0.318	0.466			0	1
Income in [$20000, $40000]	0.315	0.465			0	1
Income more than $40,000	0.367	0.482			0	1

Variable labels are: ED•BN Index (The Eating Disorders Inventory Bulimia subscale).

* For those variables that change over time we report the Standard deviation overall, within and between individuals.

Outcomes

Our outcome variable is a measure of bulimic behavior (yit), which is constructed based on questions asked every other year in the NGHS starting when the girls were aged 11-12. These questions about BN were refined to be easily understood by young respondents [15]. These include 1) I eat when I am upset; 2) I stuff myself with food; 3) I have gone on eating binges where I felt that I could not stop; 4) I think about bingeing (overeating); 5) I eat moderately in front of others and stuff myself when they are gone; 6) I have the thought of trying to vomit in order to lose weight, and 7) I eat or drink in secrecy. The responses (”always”=1, ”usually”=2, ”often”=3, ”sometimes”=4, ”rarely”=5, and ”never”=6) were used to construct an Eating Disorders Inventory Bulimia subscale (hereafter the ED-BN index). A response of 4-6 contributes zero points to the ED-BN index; a response of 3 contributes 1 point; 2 contributes 2 points; and 1 contributes 3 points. The ED-BN index is the sum of the contributing points. A value greater than 10 indicates clinical bulimia. Note that the answers to the individual questions are not available in the data. See [6] for details. The index is widely used to assess the psychological traits relevant to bulimia [16]. As Table 1 indicates, the mean ED-BN index is 1.2.

In Table 2, we report the centiles of the ED-BN index. The median ED-BN index is 0, and 5 percent of the respondents report a score higher than seven. As shown in Figure 1, which reports the histogram of the ED-BN index in the first and last waves, the distribution of the ED-BN index is relatively stable over time.

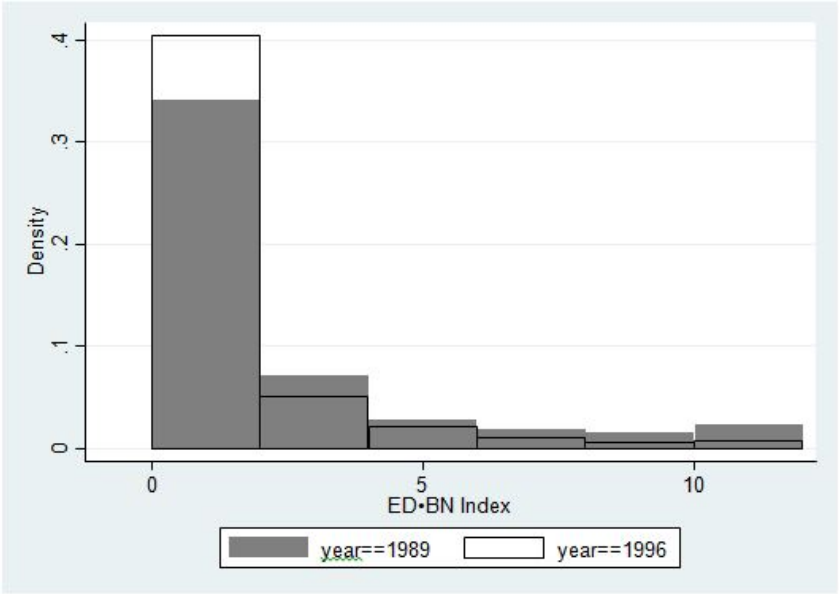

Figure 1: ED-BN Histogram First and Last Waves

Table 2: Centiles

Variable	Percentiles			
	25th	50th	75th	95th
ED•BN Index	0	0	1	7
Distrust Index	1	3	5	11
Ineffectiveness Index	0	1	4	11
Perfectionism Index	4	6	9	12

Empirical Framework

We wish to examine the associations between past and current bulimic behavior and to assess the role played by slow-learning on current behavior. To do so, we regress the outcome variable on lags of the ED-BN index (yit-1 and yit-2), demographic characteristics (Di, discussed shortly), and personality traits (Xit, discussed shortly). The vit is a normally distributed shock that accounts for non-observable time changing factors. Specifically, we estimate

$$y_{it} = \beta_O + \beta_{1yit-1} + \beta_{2yit-2} + \beta_3 D_i + \beta_4 X_{it} + v_{it} \quad (1)$$

where we cluster the observations at the individual level to control for any unobserved shock that correlates observations within an individual and report robust standard errors to control for heteroskedasticity. As in any dynamic model, we need to address the endogeneity of lagged behavior. In order to obtain a consistent estimate of β1 we use an instrumental variables (IV) approach, namely the Two-Stage-Least-Squares (henceforth, 2SLS) approach. In particular, we use the time changing portion of the personality traits Xit-1 as excluded instrumental variables to obtain an estimate of β1 that reflects only state dependence.

To formally illustrate the identification strategy and keep the notation simple, let us focus on the case with only one endogenous variable (yit-1). The argument can be easily extended to the case with two endogenous variables (yit-1 and yit-2). The first-stage equation is given by

$$y_{it-1} = v_O + v_1 X_{it} + v_2 X_{it-1} + v_3 D_i + e_{it-1} (2)$$

and the second-stage equation is given by

$$y_{it} = r_O + r_{1yit-1} + r_{2Xit} + r_3 D_i + v_{it} \quad (3)$$

To avoid the weak IV problem, our results depend on Xit-1 making a sufficient contribution to the prediction of yit-1 conditional on Xit and Di.We then form

$$\hat{y}_{it-1} = \hat{v}_O + \hat{v}_1 X_{it} + \hat{v}_2 X_{it-1} + \hat{v}_3 D_i + e_{it-1} (4)$$

and substitute into the second stage equation to get

$$y_{it} = (r_O + r_1 \hat{v}_O) + (r_2 + r_1 \hat{v}_1) X_{it} + r_1 \hat{v}_2 X_{it-1} + (r_3 + r_1 \hat{v}_3) D_i + v_{it} (5)$$

As it is common in the estimation of dynamic models, identification of state dependence comes from the coefficient on v^2Xit-1. As in the work of [5], our results hinge on v^2Xit-1 being correlated with yit conditional on Xit and Di, In words, the identification assumption is that the lagged personality characteristics only affect current BN through lagged BN, conditional on the current values of the personality characteristics and the (time-invariant) demographics. If this condition did not hold, we would expect to see

the over identifying restrictions violated [17], but this is not the case in our work, as we show in section 3.1. Figure 2 shows the posited relationship between the instrumental variables (i.e., lagged values of the personality indices), the outcome variables, and the covariates. This approach requires variation in the personality traits over time, which we discuss in more detail in section 2.6.

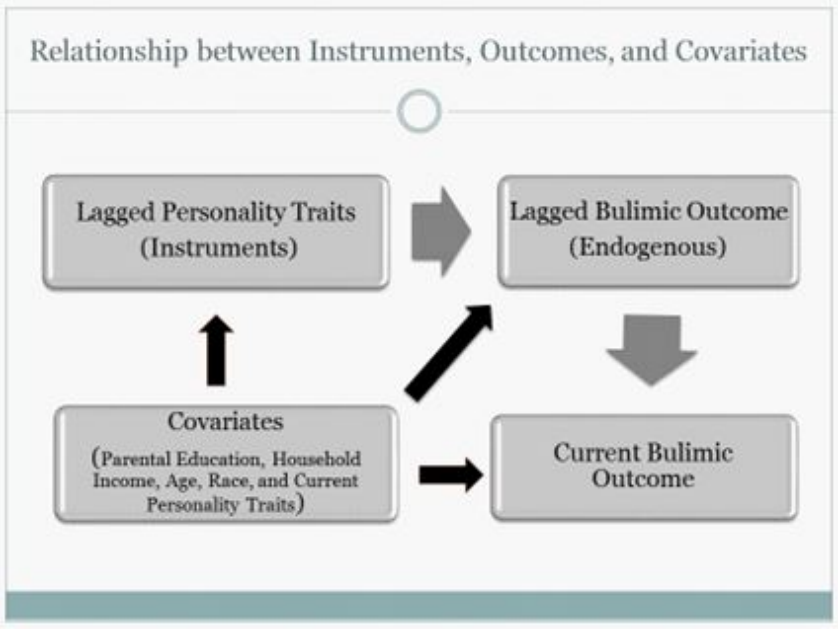

Figure 2: Relationship between Instruments, Outcomes, and Covariates

Lagged Outcomes

To examine how past bulimic behavior affects the current propensity to engage in BN we propose a number of measures of past behavior. We first consider an AR (2) process, that is both yit-1 and yit-2 matter in explaining yit (this is the specification presented in equation 1). We then construct an"intensity" stock variable that is the sum of the ED-BN index over all previous periods. We also consider a "threshold" stock in which past behavior contributes to the stock only if the girl engaged in more intense BN behavior in the past (defined as a value of the ED-BN greater than 6). The threshold stock reflects the idea that a person learns the harmful consequences of BN only when the intensity of the past behavior is relatively high. Note that while such stock measures could be problematic in samples with older individuals (as earlier behavior would be out of sample and thus unobserved), this is not an issue in our sample since the girls are quite young when first interviewed. We present summary statistics on the persistence in the ED-BN index to motivate our dynamic estimation. To look at persistence in the ED-BN index we consider four categories: equal to 0, in the range [1-5], in the range [6-10], and greater than 10. Table 3 provides the transition rates across two year intervals for these categories. Note first that the higher is the ED-BN category the lower is the probability of having an index value of 0 two years later (i.e., at time t + 1). Second, the higher the category for the index in t, the more likely the ED-BN index lies between 6 and 10 in t + 1. Finally the higher the ED index in t, the more likely is the girl to be in the greater than 10 category at t + 1, i.e., the more likely she is to have clinical bulimia. For instance, the conditional probability of having clinical bulimia in t + 1 given that a girl has it in t is 20%, while the same probability for someone with a ED-BN index in the range [1-5] in t is 2% and it is less than 0.5% for someone with an index equal to zero in t. The same general pattern comes through when we consider a more narrow breakdown of the ED-BN index. If we simply look at the correlation between the index in t and the index in t+ 1, we estimate it to be 0.48, and, not surprisingly, this estimate is very statistically significant. In conclusion, there is substantial persistence in the ED-BN index and the incidence of clinical BN, motivating our use of dynamic models.

Table 3: Transition Probabilities of ED-BN and Personality Traits

ED•BN Index Range at t	ED•BN Index Range at t+2			
	0	[1,5]	[6,10]	>10
0	80.32	17.76	1.5	0.43
[1,5]	51.65	40.01	6.5	1.84
[6,10]	31.68	42.32	17.97	8.04
>10	21.62	38.38	20	20
Distrust Index Range at t	Distrust Index Range at t+2			
	1	[2,4]	[5,10]	>10
1	55.44	15.07	3.76	25.74
[2,4]	24.26	41.83	15.89	18.01
[5,10]	8.93	26.98	40.86	23.23
>10	7.61	8.16	25.79	58.44
Ineffectiveness Index Range at t	IneffectivenessIndex Range at t+2			
	0	[1,4]	[5,10]	>10
0	54.53	15.74	2.52	27.21
[1,4]	24.7	49.22	7.31	18.77
[5,10]	9.33	35.81	33.36	21.5
>10	7.56	12.61	26.22	53.61
Perfectionism Index Range at t	Perfection ism Index Range at t+2			
	4	[4,6]	[7,10]	>10
4	46.22	20.84	10.61	22.32
[4,6]	20.99	32.62	24.42	21.96
[7,10]	8.16	16.67	45.29	29.88
>10	6.26	6.16	28.06	59.53

Note: Time interval is two years.

Covariates

We construct a number of variables to control for the impact of covariates on bulimic behavior. First, we include time-invariant demographics (captured in Di). These include parental (or guardian) educational attainment (in brackets), household income (in brackets), age, and race (European American or African American). Second, the NGHS contains questions used to measure personality traits/disorders, such as tendencies toward: perfectionism (the perfection- ism index), feelings of ineffectiveness (the ineffectiveness index), and interpersonal distrust (the distrust index). These covariates are denoted by Xit. The perfectionism index is based on subject responses to six items: 1) In my family everyone has to do things like a superstar; 2) I try very hard to do what my parents and teachers want; 3) I hate being less than best at things; 4) My parents expect me to be the best; 5) I have to do things perfectly or not to do them at all; 6) I want to do very well. The subjects are offered the same responses, and the responses are scored in the same way as the ED-BN index.

The ineffectiveness index is based on subject responses to ten items: 1) I feel I can't do things very well; 2) I feel very alone; 3) I feel

I can't handle things in my life; 4) I wish I were someone else; 5) I don't think I am as good as other kids; 6) I feel good about myself; 7) I don't like myself very much; 8) I feel I can do whatever I try to do; 9) I feel I am a good person; 10) I feel empty inside. The scoring rule is as follows: ”always”=1, ”usually”=2, ”often”=3, ”sometimes”=4, ”rarely”=5, and ”never”=6 in questions 1,2,3,4,5,7, and 10; and ”always”=6, ”usually”=5, ”often”=4, ”sometimes”=3, ”rarely”=2, and ”never”=1 in questions 6,8, and 9. A response of 4-6 on a given question contributes zero points to the ineffectiveness index; a response of 3 contributes 1 point; a response of 2 contributes 2 points; and a response of 1 contributes 3 points. The ineffectiveness index is a sum of all contributing points.

The distrust index is based on subject responses to seven items: 1) I tell people about my feelings; 2) I trust people; 3) I can talk to other people easily; 4) I have close friends; 5) I have trouble telling other people how I feel; 6) I don't want people to get to know me very well; and 7) I can talk about my private thoughts or feelings. The scoring rule is as follows: ”always”=1, ”usually”=2, ”often”=3, ”sometimes”=4, ”rarely”=5, and ”never”=6 in questions 5 and 6; and ”always”=6, ”usually”=5, ”often”=4, ”sometimes”=3, ”rarely”=2, and ”never”=1 in questions 1, 2, 3, 4, and 7. A response of 4-6 on a given question contributes zero points to the distrust index; a response of 3 contributes 1 point; a response of 2 contributes 2 points; and a response of 1 contributes 3 points. The distrust index is a sum of all contributing points.

The correlations between the ED-BN index and the perfectionism, ineffectiveness, and dis- trust indices are 0.23, 0.44, and 0.21, respectively. These are consistent with papers in the medical literature who document the high comorbitity of BN with personality characteristics and report several personality traits that increase risk for BN [18-20]. Table 2 reports the centiles of the perfectionism, ineffectiveness, and distrust indices.

We should note that our sample is limited by the fact that the personality indices are not available in wave 7. However, we can double our sample size if we assume that the personality indices values vary smoothly from waves 5 to 9, and use interpolated values in wave 7 when we estimate the 2SLS model.

Instrumental Variables

As mentioned above, our identification assumption is that, once we condition on the current values of personality traits and demographics, lagged personality characteristics affect current BN through lagged BN. This is a reasonable assumption as long as personality traits evolve over time. Therefore, before turning our attention to the 2SLS estimates, we quantify the short-term changes (for intervals of two years) in personality traits.

Table 3 reports the two-year transition rates of the personality traits. (The index ranges are based on the centiles presented in Table 2.) The fraction of respondents whose personality trait index remains stable over the interval is on the diagonal of the transition matrix. Note that, while there is persistence in the personality traits, for each trait about 50% of the sample experiences changes in their personality indices. These findings indicate a relatively significant level of change in personality traits in the short term. This likely arises because our sample is a cohort of young girls over a developmental period (12-19 years old on average), which is characterized by rapid physical, cognitive, and social change. Our finding of short-term changes in personality indices are consistent with other studies that examine individual-level changes over similar age periods in personality development, rather than rank-order stability or mean-level change of personality traits [21,22]

Results

In this section, we discuss the results aimed at determining if bulimic behavior exhibits tolerance or can be explained by slow learning.

Tolerance or Slow Learning?

Note that a positive association between past and current BN (i.e., state dependence) is necessary for BN to reflect tolerance, but it

is not sufficient. In fact, there may be competing explanations that generate state dependence, but that do not involve tolerance or increased use over time. For instance, it may be that individuals are initially uncertain of the deleterious side effects associated with bulimia, but they slowly learn through experimentation that BN is harmful. The slow learning explanation for state dependence has the implication that the longer individuals have experienced bulimic behavior the less likely they are to experience it in the future. We now explore the potential for the slow learning explanation, and test whether we can rule it out. We first consider an AR(2) process, that is both yit-1 and yit-2 matter in explaining yit, and then construct an ”intensity” stock variable that is the sum of the ED-BN index over all previous periods. We also consider a ”threshold” stock in which past behavior contributes to the stock only if the girl engaged in more intense BN behavior in the past (de- fined as a value of the ED-BN greater than 6). The threshold stock reflects the idea that a person learns the harmful consequences of BN only when the intensity of the past behavior is relatively high. Note that while such stock measures could be problematic in samples with older individuals (as earlier behavior would be out of sample and thus unobserved), this is not an issue in our sample since the girls are quite young when first interviewed. The results in Table 4 provide strong evidence against the slow learning interpretation. All results are based on 2SLS estimation where we treat the lagged ED-BN index as endogenous and include demographics and personality indices (using interpolated values in wave 7).

Table 4: Two-Stage Least Squares Estimates of ED-BN Persistence

Variables	1	2	3	4
One Period	0.149***	0.120*	0.140***	0.136***
	(0.035)	(0.065)	(0.042)	(0.045)
Two Periods		0.111***		
		(0.037)		
Stock Variables				
Intensity Stock (sum of ED•BN Index)			0.007	
			(0.017)	
Threshold Stock (sum of binary if ED•BN Index > 6)				0.138
				(0.269)
Control Variables				
European American	•0.134* (0.084)	•0.064 (0.076)	•0.130* (0.069)	•0.131* (0.069)
Age	• 0.065***	0.048*	•0.070***	•0.071***
	(0.018)	(0.026)	(0.02)	(0.02)
Parents Some College	• 0.066	•0.040	•0.065	•0.061
	(0.097)	(0.09)	(0.081)	(0.082)
Parents Bachelor Degree or more	• 0.035	0.044	•0.032	•0.029
	(0.105)	(0.1)	(0.092)	(0.093)
Income in [$20000, $40000]	• 0.240***	•0.022	•0.237***	• 0.237***
	(0.097)	(0.093)	(0.083)	(0.083)
Income more than $40,000	• 0.288***	•0.112	•0.286***	• 0.287***
	(0.094)	(0.1)	(0.089)	(0.089)
Distrust Index	• 0.002	0.012	•0.003	• 0.003

	(0.015)	(0.012)	(0.01)	(0.011)
Ineffectiveness Index	0.230***	0.191***	0.230***	0.230***
	(0.022)	(0.016)	(0.012)	(0.012)
Perfectionism Index	0.096***	0.044***	0.095***	0.095***
	(0.013)	(0.012)	(0.01)	(0.01)
Constant	1.138***	•0.849*	1.212***	1.227***
	(0.33)	(0.467)	(0.335)	(0.339)
Sample Size (N)	5426	3402	5426	5426

Standard errors robust to heteroskedasticity and intra•group correlation are reported in parenthesis. * indicates significant at 10%; ** significant at 5%; *** significant. One Period is two years. The excluded case is parents without tertiary education, African American, income less than $20,000.

Table 5 Reports the first-stage results of the 2SLS regressions to investigate the issue of weak instruments. Note that the lags of the perfectionism and ineffectiveness indices are significant in all specifications.

Table 5: First-Stage Least Squares Estimates

Columns in Table (4)	**(1)**	**(2)**		**(3)**	**(4)**		
Measures of past ED•BN Index (Instrumented Variables):							
	One Period	One Period Two Periods		One Period Intensity Stock		One Period Threshold Stock	
IVs for one lag:							
Distrust Index	• 0.002	• 0.034		• 0.010		• 0.010	
	(0.015)	(0.025)		(0.02)		(0.02)	
Ineffectiveness Index	0.250***	0.214***		0.253***		0.253***	
	(0.013)	(0.025)		(0.019)		(0.019)	
Perfectionism Index	0.165***	0.169***		0.187***		0.187***	
	(0.014)	(0.025)		(0.019)		(0.019)	
IVs for two Lags (or Stock in Columns (3) & (4)) of:							
Distrust Index			• 0.016		• 0.050***		• 0.002
			(0.019)		(0.017)		(0.002)
Ineffectiveness Index			0.272***		0.285***		0.019***
			(0.017)		(0.016)		(0.001)
Perfectionism Index			0.191***		0.162***		0.009***
			(0.018)		(0.015)		(0.001)

Other Controls:							
European American	• 0.249*	• 0.244*	• 0.273*	• 0.252***	• 0.556***	• 0.252***	• 0.034***
	(0.08)	(0.095)	(0.107)	(0.081)	(0.144)	(0.081)	(0.013)
Age	• 0.078***	• 0.100***	• 0.063**	• 0.043	• 0.350***	• 0.043	• 0.020***
	(0.018)	(0.032)	(0.036)	(0.031)	(0.056)	(0.031)	(0.005)
Parents Some College	• 0.171*	• 0.116	• 0.143	• 0.167*	• 0.363**	• 0.167*	• 0.051***
	(0.095)	(0.112)	(0.128)	(0.095)	(0.169)	(0.095)	(0.015)
Parents Bachelor Degree or more	• 0.266**	• 0.133	• 0.238*	• 0.259**	• 0.611***	• 0.259**	• 0.057***
	(0.107)	(0.125)	(0.142)	(0.107)	(0.191)	(0.107)	(0.017)
Income in [$20000, $40000]	• 0.227**	• 0.325***	• 0.227**	• 0.230**	• 0.449***	• 0.230**	• 0.032**
	(0.095)	(0.113)	(0.095)	(0.095)	(0.17)	(0.095)	(0.016)
Income more than $40,000	• 0.248**	• 0.362***	• 0.248*	• 0.249***	• 0.424**	• 0.249***	• 0.020
	(0.103)	(0.121)	(0.103)	(0.103)	(0.183)	(0.103)	(0.017)
Distrust Index	0.023	0.012	0.011	0.024*	0.028	0.024*	0.005**
	(0.015)	(0.022)	(0.026)	(0.015)	(0.026)	(0.015)	• 0.002
Ineffectiveness Index	0.032**	0.021	0.036	0.032**	0.066***	0.032**	0.004*
	(0.013)	(0.022)	(0.025)	(0.013)	(0.024)	(0.013)	(0.002)
Perfectionism Index	0.019	0.063***	0.015	• 0.018	• 0.025	• 0.018	• 0.003
	(0.014)	(0.022)	(0.025)	(0.014)	(0.025)	(0.014)	(0.002)
One Lag Distrust Index			0.034		• 0.035		• 0.002
			(0.029)		(0.036)		(0.003)
One Lag Ineffectiveness Index			• 0.013		0.055*		• 0.001
			(0.027)		(0.033)		(0.003)
One Lag Perfectionism Index			• 0.005		0.009		0.005*
			(0.028)		(0.034)		(0.003)
R•Squared	0.213	0.194	0.231	0.216	0.3	0.216	0.183

Standard errors robust to heteroskedasticity and intra•group correlation are reported in parenthesis. * indicates significant at 10%; ** significant at 5%; *** signifcant at 1%. One Period is two years. The excluded case is parents without tertiary education, African American, income less than $20,000.

For comparison purposes, in the first column of Table 4 we repeat the results from Ham et al. [5], which include only the first lag of ED-BN index. We obtain an estimated coefficient of 0.14. To test if lags of personality traits are valid instruments, we consider two diagnostics: i) a test statistic for weak instruments; and ii) a Wald statistic to test the overidentifying restrictions that the instruments are valid. In calculating the former test, we take into account the fact that there will be heteroskedasticity in the first-stage regression equation for a censored dependent variable, and we use the conjecture by [23] that in the presence of heteroskedasticity, the Wald statistic should be greater than 32. We obtain a test statistic for weak instruments of 221, so we pass this test. Further, when we consider the three instruments on an individual basis, the first stage estimates of the lagged values of all the personality traits are significant, and we pass the weak IV test for the perfectionism and ineffectiveness indices. The additional first-stage estimates are available on request. In diagnostic ii), the critical value is $\chi 2(l)$; where l is the degree of overidentification. Intuitively the test can be thought of as assuming that one of the instruments is valid, and then seeing whether the other instruments have a zero coefficient in the structural equation. In this case, the overidentification test statistic is 2.74 (p-value 0.21).

In sum, both diagnostics indicate that our instruments are not weak, and the overidentifying restrictions are not rejected. We refer the reader to [5] for a thorough discussion of the methodology and tests. Column (2) specifies an AR (2) process where one and two lags of the personality indices are used as instrumental variables. Column (3) includes one lag of the ED-BN index and the intensity stock, while column (4) replaces the intensity stock with the threshold stock. In columns (3) and (4) we use the lag and the sum over all previous waves of each personality index as instrumental variables.

Our results in column (2) show that the first and second lag coefficients (recall that each lag is two years) are both statistically significant and equal to 0.12 and 0.11, respectively. These results cast doubt on slow learning as a driving force in state dependence, as the latter suggests that experiencing BN for four years would most likely reduce current behavior. Further evidence against the learning interpretation comes from columns (3) and (4). If learning was important we would expect the coefficients on the stock variables to be negative and statistically significant, but instead they are both positive and insignificant. Thus we conclude that slow learning does not explain state dependence in BN persistence. These findings corroborate our hypothesis that it is tolerance that explains state dependence.

Discussion

In this section we examine the potential addictive nature of BN and discuss robustness checks.

Fit of BN with Addiction Diagnostic Criteria

According to the DSM-IV, a behavior (or use of a substance) is an addiction if it satisfies at least three of seven criteria in a given year: 1) experiencing a persistent desire for or an inability to reduce or control the behavior, 2) the behavior continuing despite known adverse consequences, 3) withdrawal, 4) tolerance (more is needed for the same effect), 5) engaging in the behavior for a longer period than was intended, 6) spending much time seeking or recovering from its effects, and 7) the behavior interfering with important activities. It is straightforward to note that BN fulfils criterion 1 (inability to control its use) as one of the diagnostic criteria for BN involves loss of control over the eating process. Regarding criterion 2, it has been shown that young women persist in BN [5]. Due to data limitations we are not able to determine if the respondents are aware of the negative consequences of their behavior, however a number of the adverse health effects will be readily apparent, such as an irritated esophagus, tooth decay, muscle weakness, gastric rupture, and anemia. In this sense the continued behavior is consistent with addiction criterion 2 (i.e., use continues despite known adverse consequences). There is separate scientific evidence of withdrawal (criterion 3) in laxative use, which is a purging behavior [24]. In the previous subsection, we provided empirical evidence in favor of criterion 4 (tolerance).

In summary we argue that BN fulfills at least three of the DSM-IV criteria necessary to be classified as an addiction, which provides a basis for BN to be classified as an addiction. In line with our argument, two works that studied eating disorders from an ad-

diction perspective, used a structured interview for the assessment of addictive disorder criteria in individuals with anorexia nervosa (AN), BN, or BED.2 They document that the majority of participants (65%) with BN and between 35 and 48% of participants with AN or BED satisfied the criteria for an addictive disorder [31], [32]. Furthermore, [25] note that other diagnostic criteria for bingeing related disorders approximate the DSM-IV criteria for addiction. These include binge-type consumption, (i.e., criterion 5); bingeing is followed by inappropriate compensatory behavior (i.e., criterion 2); bingeing occurs at least twice a week for 3 months (i.e., criterion 5). Their argument is not based on an empirical analysis, but rather on the relation between the DSM-IV addiction and BN criteria. Note that the use of the DSM-IV criteria might have the drawback of being overly cautious, and may underestimate the actual prevalence of BN when compared with the DSM-V classification, whose primary objective is to reduce the fraction of the DSM-IV residual cat- egory diagnosis Eating disorder not otherwise specified (EDNOS)3. In this respect, a recent study of 2,822 Australian adolescents, whose parents were recruited from prenatal clinics and tracked until age 20, shows that using DSM-V criteria instead of DSM-IV criteria considerably increased the prevalence rates of eating disorders [33]. Similarly, the change in classification from the DSM-IV to DSM-V led to an increase in the proportion of BN of 4.5 percentage points of all eating disorders in a sample of young Americans aged 8 to 21 who were newly diagnosed with eating disorders [34].4 As the criteria for BN have been expanded in the DSM-V, all the discussion above readily follows for this classification.

More specifically, when they consider a model where the only explanatory variable is the (assumed to be exogenous) lagged dependent variable; its coefficient is estimated at 0.44 and, not surprisingly, it is very statistically significant. Regarding the effect of past ED-BN experience on current behavior, this coefficient can be interpreted as an elasticity since we would expect the mean of a variable and its lag to be equal, so they obtain a relatively large estimate of the elasticity of 0.44. After they add the controls, Xit, and Di, and treat the lagged dependent variable as endogenous (employing the instrumental variable approach outlined above), the estimated elasticity is 0.149, which indicates that up to two-thirds of the variation in the persistence can be attributed to state dependence. See Goodman [30] for a description of the addiction criteria used in these studies.

Robustness Checks

One concern is that any observed changes in personality traits may be the result of measurement error rather than actual changes in traits. In particular, suppose Xit and yit (and by extension Xit-1 and yit-1) are each a function of some variable plus random noise. In that case a first stage regression of yit-1 on Xit-1 and Xit can generate significant coefficients on both regressors in the presence of measurement error in Xit. To address this concern, we exploit the longitudinal nature of our data to investigate the single factor hypothesis. We decisively reject the null hypothesis that changes in our variables over time are simply due to measurement error5. Our results are in line with recent articles surveyed in a review [22] on individual differences in changes of personality traits, which used the reliable change index, and conclude that reliable differences in changes of personality traits during childhood and adolescence exist and are not attributable to measurement error.

We also consider whether our results are robust to not using the interpolated data. Recall, the estimates in Table 4 have been obtained using interpolated values of personality traits in wave 7. Table 6 presents results for column (1) of Table (4) without using the interpolated values in wave 7. A comparison of the 2SLS estimates, with and without interpolated indices, suggests that the use of imputed values does not invalidate the main results. Further, both the diagnostics still show that our instruments are not weak, and the over identifying restrictions are not rejected. In particular, we obtain i) a test statistics of 143.20 and ii) the over identification test statistic is 1.796 (p-value 0.407) when not using the imputed values in wave 7. Table 6: Two-Stage Least Squares Estimates Interpolation Robustness Finally, note that the distrust index is the only IV that is not significant in the first stage results (see Table 5).

Table6: 2SLS Estimates with and without interpolated Indices

Variables	(1)	(2)
Lagged ED•BN Index	0.190***	0.149***
	(0.048)	(0.035)
European American	• 0.105	•0.134*
	(0.12)	(0.069)
Age	• 0.021	•0.065***
	(0.025)	(0.016)
Parents Some College	0.017	•0.066
	(0.144)	(0.081)
Parents Bachelor Degree or More	• 0.009	•0.035
	(0.164)	(0.092)
Income in [$20000, $40000]	•0.524***	•0.240***
	(0.147)	(0.083)
Income more than $40,000	•0.463***	•0.288***
	(0.158)	(0.089)
Distrust Index	• 0.040**	•0.002
	(0.017)	(0.01)
Ineffectiveness Index	0.258***	0.230***
	(0.017)	(0.012)
Perfectionism Index	0.129***	0.096***
	(0.016)	(0.01)
Constant	0.515	1.138***
	(0.414)	(0.285)
Interpolated Indices	No	Yes
Weak IV Test	143.2	221.89
Over identification Test	1.796	2.736
	(0.407)	(0.213)
Sample Size	2285	5426

Notes: Standard errors robust to heteroskedasticity and intra•group correlation are reported in parenthesis. * indicates significant at 10%; ** significant at 5%; *** significant at 1%. The excluded case is parents without tertiary education, African American, income less than $20,000.

We then consider only the perfectionism and ineffectiveness indices as IV, and we obtain an estimate for the lagged coefficient of the ED-BN index of 0.163 when we estimate the specification of column (1) in Table 4, suggesting that the results are robust to the exclusion of the distrust index. Partial forms of AN, BN, purging disorder, and BED were all under this general heading ”ED-NOS.´´ In order to accomplish the targeted decrease of this residual category - labeled ”other specified feeding and eating disorder´´ (OSFED) in the DSM-V, the criteria for AN and BN have been widened, and BED has been included as a defined eating disorder. As a result, OSFED only includes atypical forms of AN, BN, and BED of low frequency or limited duration, as well as purg-

ing disorder and night eating syndrome. For a detailed comparison between DSM-IV and DSM-V classification for bulimia nervosa see [35]. More details of the test and the test results are available on request.

Conclusions

This study presents evidence that suggest BN fulfills at least three of the DSM-IV criteria for an addiction. Our case can be made even stronger by noting that BN presents important similarities to drug and alcohol abuse. First, individuals suffering from ED report requiring more of the behavior to produce the same effect, parallel to the behavior associated with drug or alcohol addictions. Medical research has found that the auto-addiction-opioid theory posits that ED is an addiction to the body's production of opioids [26]. Starving, bingeing, purging, and exercise increase the body's β-endorphin levels resulting in the same chemical effect as that delivered by exogenous opiates. Medical research provides further support of this hypothesis. For instance, opioid receptor binding in the area of the brain involving the anticipation and reward of eating in bulimic women is lower than in healthy women [27] and this reaction has been found in other studies of addictive behavioral disorders, including drug addiction and gambling. Second, patients with BN seem to respond to treatment initially aimed at combatting drug and alcohol abuse. For example, Naltrexone, an anti-addiction opioid antagonist normally used in the treatment of alcohol dependence, has shown signs of success in normalizing eating patterns in those suffering from anorexia and bulimia [28].

These results suggest directions for policy aimed at combating BN. Our results strongly suggest that BN should be treated as an addiction. This is important in the sense that we argue those exhibiting BN should be treated in an analogous way (from a treatment reimbursement perspective) to those individuals abusing drugs or alcohol. In many states this is a policy issue. According to the National Eating Disorders Coalition even among those states that provide some coverage it is often inadequate. Eating disorders (and hence BN) are not included under the Obamacare benefits categories, instead the definition of a required "mental health service" is left to the discretion of the states and insurance companies. In the majority of the states treatment for alcoholism and drug addiction is covered whereas treatment for ED is not covered [29], and when available the coverage can be inadequate. Our study suggests avenues for additional research. First, while one benefit of the data is that it contains information on bulimic behaviors for all girls, a limitation is that it does not contain information on actual BN diagnosis. Thus it would be valuable to consider this study applied to a longitudinal dataset on women who have been diagnosed with BN to determine the extent to which the results are robust to diagnosis. For example, it may be the case that tolerance is even more pronounced among this group of women. Second, it would be valuable to examine more demographic groups as the current study only allows us to consider African Americans and European American girls. It does not let us say anything about other ethnic groups or minorities where the effect of BN may be different due to cultural differences. Third, it would be worthwhile to further understand the mechanisms through which the addictive behavior operates - is it related to social interactions, family influences, media exposure, etc. This current study does not enable us to address these important questions.

References

1. National Eating Disorders Association (2013).

2. NIMH (2002) The National Institute of Mental Health: Eating Disorders: Facts About Eating Disorders and the Search for Solutions. Pub No. 01-4901.

3. Cavanaugh C, Ray L (1999) What we Know about Eating Disorders: Facts and Statistics. In Lemberg, Raymond and Cohn, Leigh (Eds). Eating Disorders: A Reference Sourcebook. Oryx. Press. Phoenix, AZ.

4. Bulik C, Sullivan P, Epstein L, McKee M, Kaye W et al. (1992) Drug use in women with anorexia and bulimia nervosa. Int J Eat Disord 11: 213-25.

5. Ham J, Iorio D, Sovinsky M (2013) Caught in the Bulimic Trap? Persistence and State Dependence of Bulimia Among Young Women," J. of Human Resources 48: 736-67.

6. Garner D, Marion P, Olmstead M, Polivy J (1983) Development and Validation of a Multidimensional Eating Disorder Inventory for Anorexia Nervosa and Bulimia. Int J Eat Disord 2: 15-34.

7. American Psychiatric Association (1994) Diagnostic and statistical manual of mental dis- orders (4th edition) (DSM-IV). Washington, DC: APA.

8. Gearhardt A, Boswell R, White M (2014) The association of "food addiction" with disordered eating and body mass index. Eat Behav 15: 427-33.

9. Gearhardt A, Corbin W, Brownell K (2009) Food addiction: an examination of the diagnostic criteria for dependence. J Addict Med 3: 1-7.

10. Gearhardt A, Davis C, Kuschner R, Brownell K (2011) The addiction potential of hyperpalatable foods. Curr. Drug Abuse Rev 4: 140-5.

11. Gold M, Frost-Pineda K, Jacobs W (2003) Overeating, binge eating, and eating disor- ders as addictions. Psychiat Ann 33: 117-22.

12. Hoek H, van Hoeken D (2003) Review of the prevalence and incidence of eating disorders. Int J Eat Disord 383-96.

13. Robinson G, Connolly J, Whitter M, Magaňa C (2006) State Mandates for Treatment for Mental Illness and Substance Use Disorders (DHHS Pub. No. (SMA) 07-4228). Rockville, MD: Center for Mental Health Services, Substance Abuse and Mental Health Services Administration.

14. Daly R (2008) Few States Act on Parity Improvements This Year. Psychiatr News 43: 2-25.

15. Striegel-Moore R, Schreiber G, Lo A, Crawford P, Obarzanek E et al. (2000) Eating Disorder Symptoms in a Cohort of 11 to 16-Year-Old Black and White Girls: The NHLBI Growth and Health Study. Int J Eat Disord 27: 49-66.

16. Rush J, First M, Blacker D (2008) Handbook of Psychiatric Measures (2nd edition). American Psychiatric Publishing: Arlington, VA.

17. Arellano M, Bond S (1991) Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employ-

ment Equations. Rev of Econ Studies 58: 277-97.

18. Bulik C, Devlin B, Bacanu S (2003) Significant Linkage on Chromosome 10p in Families with Bulimia Nervosa. Am J Med Genet 72: 200-7.

19. Lilenfeld L, Kaye W, Greeno C (1998) A Controlled Family Study of Restricting Anorexia and Bulimia Nervosa: Comorbidity in Probands and Disorders in First-Degree Relatives. Arch Gen Psychiatry 55: 603-10.

20. Pearlstein T (2002) Eating disorders and comorbidity. Arch Womens Ment Health 4: 67-78.

21. McCrae R, Costa P, Terracciano A, Parker WD, Mills CJ et al. (2002) Personality trait development from age 12 to age 18: Longitudinal, cross-sectional, and cross-cultural analyses. J. of Personality and Social Psychology 83: 1456-68.

22. Roberts B, Wood D, Caspi A (2008) The development of personality traits in adult- hood. In O.P. John, R.W. Robins, & L. A. Pervin (Eds.), Handbook of personality: theory and research (3rd edition, Ch 14, pp. 375-398). New York, NY: Guilford.

23. Hansen C, Hausman J, Newey W (2008) Estimation with Many Instrumental Variables. J. of Business and Econ Statistics 26: 398-422.

24. Colton P, Woodside D, Kaplan A (1998) Laxative Withdrawal in Eating Disorders: Treatment Protocol and 3 to 20-Month Follow-Up. Int J Eat Disord 25: 311-7.

25. Corwin R, Grigson P (2009) Food Addiction: Fact or Fiction? J Nutr 139: 617-9.

26. Vandereycken W (2006) The Addiction Model in Eating Disorders: Some Critical Remarks and a Selected Bibliography. Int J Eat Disord 9: 95-101.

27. Bencherif B, Guarda A, Colantuoni C, Ravert H, Dannals R, Frost J (2005) Regional Opioid Receptor Binding in Insular Cortex is Decreased in Bulimia Nervosa and Correlates Inversely with Fasting Behavior. The Journal of Nuclear Medicine 46: 1349-51.

28. Marrazzi M, Bacon J, Kinzie J, Luby E (1995) Naltrexone use in the treatment of anorexia nervosa and bulimia nervosa. Int. Clinical Psychopharmacology 10: 163-72.

29. National Heart, Lung, and Blood Institute (NHLBI) Growth and Health Study Research Group (1992) Obesity and cardiovascular disease risk factors in black and white girls: The NHLBI Growth and Health Study. American Journal of of Public Health 82: 1613-21.

30. Goodman A (1990) Addiction: definition and implications. Br J Addict 85: 1403

31. Speranza M, Revah-Levy A, Giquel L, Loas G, Venisse J-L et al. (2012) An investigation of Goodman addictive disorder criteria in eating disorders. Eur Eat Disord Rev 20: 182.

32. Cassin SE, von Ranson KM (2007) Is binge eating experienced as an addiction? Appetite 49: 68-70.

33. Allen KL, Byrne SM, Oddy WH, Crosby RD (2013) DSM-VR and DSM-5 eating disorders in adolescents: Prevalence, stability, and psychosocial correlates in a population-based sample of male and female adolescents. Journal of abnormal psychology 122: 720.

34. Ornstein RM, Rosen DS, Mammel KA, Callahan ST, Forman S et al. (2013) Distribution of eating disorders in children and

adolescents using the pro- posed DSM-5 criteria for feeding and eating disorders. Journal of Adolescent Health 53: 303-5.

35. Smink FR, van Hoeken D, Oldehinkel AJ, Hoek HW (2014) Prevalence and severity of DSM eating disorders in a community cohort of adolescents. International Journal of Eating Disorders 47: 610-9.

36. Cassin SE, von Ranson KM (2005) Personality and eating disorders: a decade in review. Clinical psychology review 25: 895-916.

37. Ham J, D Iorio, M Sovinsky (2021) Health outcomes, personality traits and eating disorders, Economic Policy 36: 51-6.