Running head: PERCEIVED WEIGHT AND HEALTH

Does Knowing Hurt? Self-Perceived Overweight Predicts Future Physical Health and Well-Being

Michael Daly[1,2], Eric Robinson[3], and Angelina R. Sutin[4]

[1] Behavioural Science Centre, University of Stirling

[2] UCD Geary Institute, University College Dublin

[3] Institute of Psychology, Health & Society, University of Liverpool

[4] College of Medicine, Florida State University

Word Count Introduction/Discussion: 2,000

Conflict of interest: The authors declare no conflict of interest.

Address correspondence to:

Michael Daly Ph.D.

Stirling University Management School

3A35 Cottrell Building

Stirling FK94LA

+44 (0) 1786 467417

Fax: +44 (0) 1786 467400

michael.daly@stir.ac.uk

Abstract

Self-identification as being 'overweight' may be associated with adverse health outcomes, yet prospective evidence examining this possibility is lacking. Over 7-years, we examined associations between perceived overweight and subsequent health in a sample of 3,582 US adults. Perceived overweight predicted longitudinal declines in subjective health ($d = .22$, p <.001), increases in depressive symptoms ($d = .09$, p < .05), and raised levels of physiological dysregulation ($d = .24$, p <.001) as gauged by clinical indicators of cardiovascular, inflammatory and metabolic functioning. These associations remained after controlling for a range of potential confounders and were observed irrespective of whether self-perceptions of overweight were accurate or inaccurate. The present research highlights the possibility that self-identification as overweight may act independently of body mass index to contribute to unhealthy profiles of physiological functioning and impaired health over time. These findings underscore the importance of evaluating whether weight feedback interventions may have unforeseen adverse consequences.

Does Knowing Hurt? Self-Perceived Overweight Predicts Future Physical Health and Well-
Being

People who are objectively overweight (body mass index (BMI) $\geq 25 kg/m^2$) often do not identify themselves as such, but instead view their bodies as normal weight (Chang & Christakis, 2001; Johnson, Beeken, Croker, & Wardle, 2014; Robinson & Oldham, 2016). Traditionally, this has been considered a cause for concern because self-identification as overweight has been presumed to be a necessary prerequisite to healthy behavior change; if individuals identify themselves as overweight they should be more motivated to seek treatment, initiate lifestyle changes, or attempt weight loss (Duncan et al., 2011; Johnson et al., 2014). Following this rationale, large scale personalized weight feedback programmes have been designed to increase awareness of one's overweight status and prompt weight loss (Ikeda, Crawford, & Woodward-Lopez, 2006).

However, adiposity is stigmatised and derogated in modern society where overweight individuals face negative stereotypes from the general public and healthcare professionals, negative media portrayals and prejudice across a range of life domains (Heuer, McClure, Puhl, 2011; Puhl & Heuer, 2009; Teachman, & Brownell, 2001). Because the stigmatisation of adiposity is widely recognised, individuals who identify as being 'overweight' may fear negative evaluation from others, which is likely to be stressful and damaging to psychological well-being (Blodorn, Major, Hunger, & Miller, 2016; Hunger, Major, Blodorn, & Miller, 2015). Longitudinal studies have shown that those who experience weight discrimination show declines in self-worth, impaired well-being and increased weight gain over time (Robinson, Sutin, & Daly, in press; Sutin & Terracciano, 2013). This evidence suggests that the personal identification of being 'overweight' may be detrimental rather than beneficial to health.

Indeed, self-identification as overweight has been shown to prospectively predict greater weight gain over time in US and UK adults, a finding that was in part explained by the stress associated with personal identification of being 'overweight' (Robinson, Hunger, & Daly, 2015). This weight gain could not be attributed to differences in initial BMI and the consequences of perceived overweight for weight gain were observed irrespective of whether this perception was accurate or inaccurate. Furthermore, recent evidence from a quasi-experimental evaluation of a large-scale weight feedback programme suggests that informing teenage girls that they are overweight may produce unintended weight gain (Almond, Lee, & Schwartz, 2016).

The weight gain associated with personally identifying as being overweight is likely to have implications for psychological health and physiological functioning. Obesity is a well-established risk factor for depression (Faith et al., 2011) and weight changes are known to produce corresponding changes in blood pressure, inflammation, glucose tolerance, and lipids such as cholesterol and triglycerides (e.g. Dattilo & Kris-Etherton, 1992; Neter, Stam, Kok, Grobbee, & Geleijnse, 2003;Tuomilehto et al., 2001). Further, we anticipate that the psychosocial experience attached to identifying as an overweight person may have mental and physical health consequences that occur independently of weight gain.

For example, a series of cross-sectional studies have shown that those who identify themselves as 'overweight' are more likely to suffer from depression and impaired well-being and have an increased risk of suicidal behavior irrespective of their current weight (Atlantis & Ball, 2008; Hayward, Millar, Petersen, Swinburn, & Lewis, 2014; Swahn et al., 2009). Weight-based discrimination has been conceptualized as a 'social-evaluative' threat with likely downstream physiological as well as psychological effects (Dickerson & Kemeny, 2004;Tomiyama, 2014). Prior research on racial and health inequalities, for example, has documented the physiological impact of social denigration; such stress can activate the

sympathetic nervous system and induce sustained neuroendorcrine responses with potential deleterious health consequences (Daly, Boyce, & Wood, 2015;Williams & Mohammed, 2009). Similarly, weight discrimination could mobilize the fight-or-flight response that is adaptive in times of acute physical threat but maladaptive if chronically activated in response to social threat. This could lead to cortisol secretion and stress-induced eating thus detrimentally affecting metabolic and cardiovascular system functioning (Epel, Lapidus, McEwen, & Brownell, 2001;Tomiyama, 2014).

Recent, well-designed experimental studies support this notion. They show that experimental manipulations that aim to induce experiences of weight stigma lead to behavioral and physiological changes, including increased unhealthy eating (Incollingo Rodriguez, Heldreth, & Tomiyama, 2016) and cortisol secretion (Himmelstein, Incollingo, & Tomiyama, 2015), which in the long-term could promote physiological dysregulation. Importantly, the stress-induced physiological consequences of weight stigma are most pronounced among those who perceive themselves as heavy (Himmelstein et al., 2015). Taken together, this emerging evidence suggests that the psychosocial experience attached to self-identifying as 'overweight' may be stressful, leading to weight gain and potentially broader more far reaching health consequences, such as physiological dysfunction (Sutin, Stephan, Carretta, & Terracciano, 2015).

The current study examines whether perceived overweight predicts subsequent impairments to health status 7 years later. It was hypothesized that self-identification as overweight in early adulthood would be associated with greater physiological dysregulation, declines in subjective health, and increased depression levels, after controlling for baseline BMI and a range of sociodemographic characteristics. It was further hypothesized that weight gain would act as a key pathway between perceived overweight and subsequent health impairments.

Method

Participants

This study uses data from Waves 3 (2001/2002) and 4 (2008/2009) of the National

Longitudinal Study of Adolescent Health (Add Health). We used the public-use Add Health

dataset comprised of a randomly selected sample of half of the core study sample and half of

the African-American oversample. The Add Health sample was drawn from a nationally

representative sample of 144 schools selected using stratified random sampling. Add Health

obtained informed consent at each study wave in accordance with guidelines set out by the

University of North Carolina, School of Public Health Institutional Review Board. The

current study includes participants who completed the Wave 3/baseline and 4/follow-up in-

home interview and provided data on all key variables: perceived weight, BMI, self-rated

health, depressive symptoms, and physiological dysregulation.

Of the 4,882 participants who completed the baseline/Wave 3 assessment, 3,582

provided sufficient follow-up data to be included in the analyses reported here (see Table 1

for sample characteristics). Those included in the analyses were more likely to be female (p <

.001), white (p < .001), and to have a limiting chronic condition (p < .05) than those

excluded. Weighting the analyses to account for selective attrition did not produce different

results, we therefore report unweighted regression results here. Participants included in the

analysis were on average, 21.80 years old (*SD* = 1.81) at baseline and 28.80 years old (*SD* =

1.78) at follow-up.

Measures

Perceived weight. Self-perceived weight was assessed at baseline using the item

"How do you think of yourself in terms of weight?" Participants rated their perceived weight

on a scale from 1 *(very underweight)* to 5 *(very overweight),* with a mid-point of 3 (*about the

right weight*). Participants were classified as having the self-perception of being overweight if

Table 1

Participants' Characteristics

Characteristic	Statistic
Perceived overweight (%)	41.82
Age (years)	
Baseline	$M = 21.80$ ($SD = 1.81$)
Follow-up	$M = 28.80$ ($SD = 1.78$)
Sex (% female)	56.31
White (%)	72.30
Education[a]	$M = 13.23$ ($SD = 1.98$)
Income (USD)	$M = 12,949.39$ ($SD = 11,817.93$)
Limiting condition (%)[b]	18.29
Body Mass Index (kg/m^2)	
Baseline	$M = 26.62$ ($SD = 6.24$)
Follow-up	$M = 29.17$ ($SD = 7.33$)
Self-rated health[c]	
Baseline	$M = 4.00$ ($SD = 0.87$)
Follow-up	$M = 3.64$ ($SD = 0.92$)
Depressive symptoms[d]	
Baseline	$M = 4.51$ ($SD = 4.07$)
Follow-up	$M = 5.17$ ($SD = 4.09$)

Note. There were 3,582 participants, 2,017 women and 1,565 men.

[a] Education was scored on a scale from 6 = *6th grade* to 22 = *5 or more years of graduate school*. This score indicates the highest level of education achieved at the Wave 3/baseline assessment. [b] Presence of a physical condition that limits activities and has lasted for more than 1 year. [c] Self-rated health was scored on a scale from 1 = *Poor* to 5 = *Excellent*. [d] Depressive symptoms were measured using 9 items from the CES-D and ranged from 0-27.

they scored 4-5 (*slightly overweight/very overweight*). This group was contrasted with the remainder of the sample who scored 1-3 on this measure (*very underweight/slightly underweight/about the right weight*).

Body mass index. Height and weight measurements were taken by trained interviewers at baseline and follow-up assessments according to a standardized protocol (see Entzel et al., 2009). Standing height was measured to the nearest 0.5cm against a smooth wall without shoes/hats using a steel tape measure. Weight was measured to the nearest 0.1kg using a high-capacity digital bathroom scale. These readings were used to estimate BMI in kg/m^2. A quality control study where participants were tested and then retested $1 - 2$ weeks later, showed that the assessment methods used produced highly reliable height, weight, and BMI measures (intra-class correlation coefficients from $0.98 - 1.00$; Hussey et al., 2015).

Physiological dysregulation. As part of the Add Health Wave 4 follow-up, participants were examined by qualified staff who collected measures of cardiovascular, inflammatory, and metabolic health. Interviewers followed standardized step-by-step procedures to measure participants' resting, seated blood pressure from the right arm using an electronic oscillometric blood pressure monitor (Entzel et al., 2009). Three assessments were taken at 30 second intervals; measures of systolic and diastolic blood pressure were constructed as the average of the second and third readings. A measure of waist circumference was taken at the superior border of the iliac crest using a tape measure (Entzel et al., 2009). Interviewers also used a finger prick test to collect whole blood spots which were dried and sent to the lab for analysis.

Drawing on these measures we followed prior studies (e.g. Hampson, Edmonds, Goldberg, Dubanoski, & Hillier, 2013) to produce a composite indicator of physiological dysregulation comprised of biomarkers of cardiovascular, inflammatory and metabolic system functioning considered to capture cumulative biological risk (Seeman, McEwen,

Rowe, & Singer, 2001). Specifically, systolic and diastolic blood pressure provided an index of cardiovascular functioning. Inflammation was assessed using high sensitivity C-reactive protein levels. Waist circumference provided an index of body fat. Metabolic risk factors were assessed using the ratio of total blood cholesterol to high-density lipoprotein cholesterol, total triglycerides, glucose, and glycated hemoglobin (HbA1c) levels. Each measure was converted to deciles and summed to produce a normally distributed overall physiological dysregulation score. This composite measure was then standardized to have a mean of 0 and standard deviation of 1.

Self-rated health. General self-rated health was assessed at baseline and follow-up using the item "In general, how is your health?" Participants' health status was scored on a scale from 1 (*poor*) to 5 (*excellent*), with a mid-point of 3 (*good*). This single-item measure summarizes global health information and has been shown to be a stronger predictor of all-cause mortality than individual health markers derived from blood assays, physical measurements, or medical histories (Ganna & Ingelsson, 2015). This measure has also been shown to be predictive of hospitalizations, healthcare use, and mortality that are comparable to those identified using multi-item self-reported health measures (DeSalvo, Fan, McDonnell, & Fihn, 2005).

Depressive symptoms. Depressive symptoms experienced over the previous week were assessed at baseline and follow-up using nine items from the Center for Epidemiological Studies – Depression Scale (CES-D) (Radloff, 1977). The items assessed a range of depressive symptoms including depressed affect (feeling blue, sad, depressed), positive affect (feeling as good as others, enjoying life), somatic symptoms (bothered by things, tired, trouble concentrating), and interpersonal symptoms (feeling disliked by others). The frequency of depressive symptoms in the past week was rated on a scale from 0 (*never/rarely*) to 3 (*most of the time/all of the time*) and the nine items were summed so that

higher scores indicated greater depressive symptomatology (range $0 - 27$; Cronbach's $\alpha = .81$ in both waves).

Analytical Strategy

We first predicted self-rated health and depressive symptoms at follow-up (T) controlling for these variables at baseline (T - 1) to capture residualized changes in health and avoid issues associated with regression toward the mean (e.g. Linn & Slinde, 1977). The main explanatory variable was whether the participant self-identified as overweight at baseline (T - 1), as shown in Model 1. We controlled for potential confounds, including baseline BMI and age, sex, race, education, income, and the presence of a limiting health condition. We then tested the relation between perceived overweight at baseline (T − 1) and physiological dysregulation assessed 7 years later (T).

$$
\begin{aligned}
\text{Health}_T = \beta_0 + \; & \beta_1 Health_{T-1} + \beta_2 Perceived\ overweight_{T-1} \\
& + \beta_3 Baseline\ characeristics\ (BMI, demographic, socioeconomic)_{T-1} \\
& + \varepsilon
\end{aligned}
$$

Next, we conducted two robustness tests. First we tested whether each predicted association was also observed using a continuous measure of perceived weight rather than our main dichotomous perceived overweight indicator. We then tested whether the anticipated links between perceived overweight and the health outcomes examined were moderated by overweight status or gender. We anticipated that perceived overweight would predict worse subsequent health irrespective of whether these perceptions were accurate or inaccurate or whether participants were male or female.

Finally, we tested whether weight gain attributable to perceived overweight (path-a in Figure 1) predicted subsequent health (path-b) and mediated the associations between perceived overweight and physiological dysregulation and changes in self-rated health and

depressive symptoms (a×b effect is statistically significant). To test this hypothesis we used the SPSS PROCESS macro (Hayes, 2013) and created 10,000 bootstrap samples to estimate 95% bias-corrected and accelerated confidence intervals (BCa CI) and establish the significance levels of the indirect effects.

Because physiological dysregulation was available at follow-up only in Add Health it was not possible to rule out the possibility that unobserved baseline dysregulation may act as a 'third variable' (see dashed lines in Figure 1) influencing baseline weight perceptions and subsequent physiological dysregulation and explaining why these variables are linked. However, using additional datasets (see Supplementary Materials, Section 2 for details) it was possible to estimate the impact of including/excluding a control for baseline physiological dysregulation on the portion of the link between perceived overweight and follow-up dysregulation that is due to weight gain over time (i.e. the indirect effect a×b). We first tested whether controlling for baseline dysregulation influenced the strength of path-a (perceived overweight => weight gain) over an 11-year period. Next, we tested whether including a control for baseline physiological dysregulation affected the association between weight gain (over 4 years) and follow-up dysregulation (path-b).

Results

Of the 3,582 participants, at baseline 41.82% self-identified as overweight, whilst the remaining 58.18% did not perceive their weight as being overweight, as shown in Table 1. The correlation between perceived overweight (dichotomous) and overweight (BMI $\geq$ 25 kg/m^2) was .57 (p < .001) confirming the substantial discrepancy between being 'objective' and perceived overweight (Duncan et al., 2011; Johnson et al., 2014). Self-rated health decreased over the course of the study (from M = 4.00 (SD = 0.87) to M = 3.64 (SD = 0.92); t = -21.46, p < .001) and depressive symptoms increased (from M = 4.51 (SD = 4.07) to M =

5.17 (SD = 4.09); t = 9.24, p < .001). Participants also gained 2.55 BMI points (t = 36.30, p < .001) over the 7 year period between baseline and follow-up assessments.

Health outcomes at 7-year follow-up

The results of the regression analyses examining are summarized in Table 2. Those who perceived themselves to be overweight showed a decline in self-rated health from baseline to follow-up of .22 standard deviations (p < .001). Perceiving oneself as overweight (vs. not) also predicted a small increase in depressive symptoms over the study period (d = .09, p < .05). In addition to these changes in self-rated health and depressive symptoms, perceived overweight predicted physiological dysregulation 7 years later. Those who self-identified as overweight had dysregulation scores that were .24 standard deviations (p < .001) higher than those who did not. These associations were independent of baseline BMI and the potential confounding sociodemographic factors measured, including age, gender, ethnicity, education, income, and the presence of a limiting condition. Further, we observed a very similar pattern of results when a continuous measure of perceived weight was utilized as shown in Supplementary Materials Section 1.

We also investigated whether the link between self-identified overweight and the health outcomes examined was dependent on whether participants accurately perceived themselves as overweight (BMI ≥ 25.0 at baseline) or overestimated their weight status (BMI < 25 at baseline). When included in the fully adjusted model, the interaction term between perceived overweight and the accuracy of overweight perception (i.e. whether the participant was objectively overweight vs. not overweight at baseline) was non-significant for changes in self-rated health (b = .02, SE = .08; t = .24, p = .81) and depressive symptoms (b = .24, SE = .32; t = .74, p = .46). Further, the inclusion of the interaction term did not produce any increase in model fit, confirming the effect that perceived overweight had on self-rated health and depression was not dependent on the accuracy of weight perceptions.

There was a significant negative interaction between perceived overweight and the accuracy of overweight perception in predicting physiological dysregulation (b = -.17, SE = .07; t = -2.29, p < .05), indicating that identifying as overweight was more strongly associated with dysregulation when this perception was inaccurate (BMI < 25 at baseline). However, perceiving oneself as being overweight was predictive of future physiological dysregulation both amongst those who were overweight at baseline (b = .15, SE = .05; t = 3.00, p < .005) and those of with BMI levels < 25 who overestimated their weight at baseline (b = .26, SE = .06; t = 4.36, p < .001). Taken together these findings suggest that perceived overweight is an important predictor of subsequent health irrespective of the accuracy of weight perceptions.

Finally, we tested whether the association between perceived overweight and health was moderated by gender. Across the three outcomes there was no evidence that gender interacted with baseline perceptions of overweight vs. not overweight (all p-values > .05), which indicated the effect of perceived overweight on future health was similar in both male and female adults.

Weight gain mediation

There was substantial evidence that weight gain may explain why self-identifying as overweight is predictive of subsequent health ratings and physiological dysregulation. Perceived overweight predicted increased weight gain between baseline and follow-up (b = 1.08, SE = .19; t = 5.79, p < .001), as shown previously (Robinson et al., 2015). Weight gain was unrelated to changes in depressive symptoms and formal mediation analysis confirmed there was no evidence of an indirect effect of perceived overweight on depressive symptoms through weight gain (b = .00, 95% BCa CI: -.01, .01). However, weight gain was associated with a decline in self-rated health (b = -.04, SE = .00; t = -11.75, p < .001) and higher levels of physiological dysregulation at follow-up (b = .10, SE = .00; t = 33.59, p < .001) in a model adjusted for baseline BMI and covariates.

Table 2

Self-Perceived Overweight Predicting Subsequent Physiological Dysregulation and Changes in Self-rated Health and Depressive Symptoms.

	Physiological Dysregulation (z-score)		Self-rated health (z-score)		Depressive symptoms (z-score)	
		+ Weight gain		+ Weight gain		+ Weight gain
Perceived overweight	.24***	.13***	-.22***	-.18***	.09*	.09*
	(.04)	(.03)	(.04)	(.04)	(.04)	(.04)
Age	.03***	.04***	-.02*	-.02**	.03***	.03**
	(.01)	(.01)	(.01)	(.01)	(.01)	(.01)
Sex (female)	-.52***	-.49***	-.06	-.07*	.16***	.16***
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
White	.01	.06*	.18***	.16***	-.12***	-.12***
	(.03)	(.03)	(.03)	(.03)	(.04)	(.04)
Education	-.04***	-.03***	.07***	.07***	-.07***	-.07***
	(.01)	(.01)	(.01)	(.01)	(.01)	(.01)
Income	-.00	.00	-.00	-.00	-.00	-.00
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
Limiting condition	.07*	.09**	-.05	-.06	.07	.06
	(.04)	(.03)	(.04)	(.04)	(.04)	(.04)
BMI baseline	.07***	.07***	-.01***	-.02***	-.00	-.00
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
Weight gain[a]	–	.10***	–	-.04***	–	-.00
		(.00)		(.00)		(.00)
Self-rated health	–	–	.39***	.38***	–	–
			(.02)	(.02)		
Depressive symptoms	–	–	–	–	.10***	.10***
					(.00)	(.00)

Note. There were 3,582 participants, 2,017 women & 1,565 men. Standard errors are included in parentheses. [a] Weight gain is BMI at baseline subtracted from BMI at follow-up.

* p < .05. ** p < 0.01. *** p < .001.

Importantly, including weight gain in our main regression model diminished the strength of the associations between perceived overweight and self-rated health ($b = -.22$, $SE = .04$, p < .001, reduced to $b = -.18$, $SE = .04$, p < .001) and physiological dysregulation ($b = .24$, $SE = .04$, p < .001, reduced to $b = .13$, $SE = .03$, p < .001), as shown in Table 2. Formal mediation analyses confirmed that weight gain mediated the association between perceived overweight and declines in self-rated health ($b = -.04$, 95% BCa CI: -.06, -.03) and increased physiological dysregulation ($b = .11$, 95% BCa CI: .07, .14). Finally, our additional analyses of two separate datasets indicated that the latter mediation channel may not be markedly affected by the absence of a control for baseline physiological dysregulation (which was not observed in Add Health).

Specifically, this additional data showed that adjusting for initial dysregulation did not diminish the association between current perceptions of overweight and subsequent weight gain (path-a: $b = .67$, $SE = .12$, p < .001 reduced to $b = .66$, $SE = .12$, p < .001) or the association between weight gain and dysregulation at follow-up (path-b: $b = .10$, $SE = .01$, p < .001 increased to $b = .11$, $SE = .01$, p < .001) (see Supplementary Materials, Section 2). In the context of the current study these analyses provide indirect evidence that the portion of the link between perceived overweight and follow-up dysregulation that is due to weight gain (i.e. the mediation channel a×b) is unlikely to be attributable to unobserved variation in baseline physiological dysregulation.

In summary, the mediation analyses demonstrated the association between perceived overweight and physiological dysregulation was partially indirect, with 46% of this relation mediated by weight gain. A similar pattern emerged for self-rated health, with a smaller portion (18%) of the role of perceived overweight explained by weight gain. Weight gain did not explain why perceived overweight was linked to increased depressive symptoms.

Discussion

There is now evidence linking perceptions of weight to weight gain throughout life. Children viewed as "overweight" by their parents tend to gain more weight across childhood irrespective of their initial BMI (Robinson & Sutin, 2016). In the teenage years, normal weight adolescents who perceive themselves as overweight appear to be at increased risk of unhealthy eating, weight gain and obesity (Cuypers et al., 2012; Martin et al., 2014; Sutin & Terracciano, 2015). Further, BMI report cards labelling adolescent girls as "outside a healthy weight" have been shown to inadvertently promote weight gain (Almond et al. 2016). In adulthood, self-identifying as overweight has been found to have the unanticipated downside of promoting stress-related eating and weight gain (Robinson et al., 2015). Together these findings suggest that psychologically identifying as a member of the socially stigmatized 'overweight' group is likely associated with weight gain and eating patterns conducive to obesity.

The current study aimed to test whether there may be other consequential downstream health and well-being effects of weight perceptions. We capitalized on the natural differentiation between medically defined adiposity and personal identification of being 'overweight' to show that self-identifying as overweight predicted poor health in a large sample of US adults. Specifically, self-perceived overweight was prospectively associated with less healthy physiological functioning, declines in subjective health and increases in depressive symptoms over a 7-year follow-up period. These associations were independent of initial BMI levels and sociodemographic characteristics, were not significantly different for males and females, and were meaningful in magnitude. For example, the longitudinal link between perceived overweight and decreased subjective health ($d = .22$) was equivalent in magnitude to an additional 3-years of education, a key predictor of self-rated health (e.g. Kunst et al., 2005) and the link to physiological dysregulation corresponded to an increase in

BMI of over 3-points (d =.24). These findings are compatible with the idea that self-identifying as overweight is likely to be stressful and as a result may have adverse health effects (Sutin & Terracciano, 2015).

Indeed, there is rapidly growing evidence that weight-based social stigmatization is linked to daily stress, negative feelings, unhealthy eating, weight gain and declines in physical and mental health (Robinson et al., in press; Sutin et al., 2015; Sutin, Robinson, Daly, & Terracciano, 2016; Sutin et al., 2016). These findings suggests that weight stigma may trigger a cycle of stress, maladaptive coping responses, further weight gain, and poor health (Blodorn et al., 2016; Brewis, 2014; Hunger et al., 2015; Sikorski, Luppa, Luck, & Riedel- Heller, 2015;Tomiyama, 2014). However, it has not been clear whether simply recognizing oneself as being overweight in our current social climate may set in motion this negative cycle leading to weight gain and poor health.

Our mediation analyses provided some initial evidence that this may be the case. Weight gain mediated a large portion of the long-term prospective association between self-identification as overweight and health status as gauged by multiple biomarkers of cardiovascular, metabolic and immune system functioning and participant perceptions of physical health. In contrast, whilst the psychological experience attached to being 'overweight' was predictive of increased depressive symptoms over time, this could not be explained by changes in body weight over time. It may be that mechanisms such as reduced self-esteem or negative body image explained this association.

This research points to the need for further examination of the assumption that a failure of individuals who measure as overweight to accurately identify their weight status may be a major public health concern (Duncan et al., 2011;Johnson et al., 2014). Rather than increasing the likelihood individuals will effectively manage their body weight, the stress and stigma associated with adiposity may render self-identification of being 'overweight' more

detrimental than beneficial to health. Most worryingly, if this is the case well-intended attempts by healthcare professionals and public health officials to ensure people in the medically defined overweight category identify as such could lead to long-run unforeseen consequences. Our findings provide initial evidence that such consequences could include physiological dysregulation, depressive symptoms and poor health. This possibility now warrants close examination using multi-wave observational studies along with experimental and quasi-experimental designs with large samples and lengthy periods of follow-up (e.g. Almond et al., 2016).

This further work is necessary because our observational findings are limited in two key respects. First, while we could show that perceived overweight preceded declines in subjective health and increases in depressive symptoms, our measure of physiological dysregulation was available at follow-up only. We therefore cannot rule out the possibility of reverse causality whereby the link between self-identifying as overweight and subsequent dysregulation reflects the unobserved influence of baseline physiological dysregulation (see Figure 1). Our mediation analyses partially mitigate this possibility as we show that weight gain over 7-years explains a large portion of the link between self-identification as being 'overweight' and subsequent dysregulation. Further, our additional analyses drawing on two further datasets found little evidence that controlling for initial dysregulation was likely to alter this mediation effect. This noted, additional waves of data are needed to definitively test whether perceived overweight prospectively predicts physiological dysfunction.

A second form of reverse causality that our data cannot directly address is the possibility that current weight perceptions partially reflect the human capacity to imagine future outcomes and anticipate weight gain and health changes. In this scenario, perceived overweight may not influence health, rather such perceptions may simply reflect self-knowledge of the eventual effects of one's diet/exercise patterns or of a family/genetic

propensity for weight gain. To overcome this potential limitation future studies should control for the perceived probability of future weight gain. Further, an examination of the mediating pathways from perceived overweight to the emergence of poor health (e.g. through discrimination experiences, stigma concerns, perceived stress, eating behavior) would help articulate the mechanisms underlying these links. Finally, employing long form measures of reported health coupled with latent change models would help ensure effect size estimates are not attenuated by measurement error.

This study also has several important strengths. Using longitudinal analyses allowed us to examine how self-perceptions of overweight predict changes in health and well-being over time. Further, by examining physiological dysregulation, a measure comprised of objectively assessed clinical indicators, we could rule out the possibility that the link between perceived overweight and future health was due to differences in answering style (e.g. where people who tend to say negative things about their weight also do so about their health). Finally, we could show that weight gain explained a large portion of the link between perceived overweight and physiological dysregulation. This finding is notable because it supports a cyclical model whereby identifying with a stigmatised group may have a range of deleterious social-psychological consequences that perpetuate weight gain and lead to poor health (Tomiyama, 2014). Further, this finding also suggests that psychosocial and psychobiological pathways unrelated to weight gain must be examined to fully explain how self-identification as overweight may "get under the skin".

In conclusion, the current research provides initial evidence that perceived overweight may contribute to future health and sets the scene for studies exploring the psychosocial processes linking self-identification as overweight and subsequent ill health.

References

Almond, D., Lee, A., & Schwartz, A. E. (2016). Impacts of classifying New York City

students as overweight. *Proceedings of the National Academy of Sciences USA*, *113*,

3488-3491.

Atlantis, E., & Baker, M. (2008). Obesity effects on depression: systematic review of

epidemiological studies. *International Journal of Obesity*, *32*, 881-891.

Blodorn, A., Major, B., Hunger, J.M., & Miller, C. (2016). Unpacking the psychological

weight of weight stigma: A rejection-expectation pathway. *Journal of Experimental

Social Psychology, 63,* 69-76.

Brewis, A. A. (2014). Stigma and the perpetuation of obesity. *Social Science & Medicine,

118,* 152-158.

Chang, V. W., & Christakis, N. A. (2001). Extent and determinants of discrepancy between

self-evaluations of weight status and clinical standards. *Journal of General Internal

Medicine, 16,* 538-543.

Cuypers, K., Kvaløy, K., Bratberg, G., Midthjell, K., Holmen, J., & Holmen, T. L. (2012).

Being normal weight but feeling overweight in adolescence may affect weight

development into young adulthood—an 11-year followup: the HUNT study, Norway.

Journal of Obesity, *2012*, doi:10.1155/2012/601872

Daly, M., Boyce, C.J., & Wood, A.M. (2015). A social rank explanation of how money

influences health. *Health Psychology, 34,* 222-230.

Dattilo, A. M., & Kris-Etherton, P. M. (1992). Effects of weight reduction on blood lipids

and lipoproteins: a meta-analysis. *The American Journal of Clinical Nutrition, 56,*

320-328.

DeSalvo, K. B., Fan, V. S., McDonell, M. B., & Fihn, S. D. (2005). Predicting mortality and

    healthcare utilization with a single question. *Health Services Research, 40*, 1234-

    1246.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses. A

    theoretical integration and synthesis of laboratory research. *Psychological Bulletin,*

    130, 355-391.

Duncan, D. T., Wolin, K. Y., Scharoun-Lee, M., Ding, E. L., Warner, E. T., & Bennett, G. G.

    (2011). Does perception equal reality? Weight misperception in relation to weight-

    related attitudes and behaviors among overweight and obese US adults. *International*

    Journal of Behavioral Nutrition and Physical Activity, *8*, 20. doi 10.1186/1479-5868-

    8-20.

Entzel, P., Whitsel, E.A., Richardson, A., Tabor, J., Hallquist, S., Hussey, J.M., Halpern,

    C.T., and Harris, K.M. (2009). *Add Health Wave IV Documentation. Cardiovascular*

    and Anthropometric Measures [electronic resource]. Chapel Hill, NC: Carolina

    Population Center. [http://www.cpc.unc.edu/projects/addhealth/data/guides/Wave IV

    cardiovascular and anthropometric documentation 110209.pdf

Epel, E. S., Lapidus, R., McEwen, B., & Brownell, K. (2001). Stress may add bite to appetite

    in women: A laboratory study of stress-induced cortisol and eating behavior.

    Psychoneuroendocrinology, 26, 37-49.

Faith, M. S., Butryn, M., Wadden, T. A., Fabricatore, A., Nguyen, A. M., & Heymsfield, S.

    B. (2011). Evidence for prospective associations among depression and obesity in

    population-based studies. *Obesity Reviews, 12*, e438-e453. doi: 10.1111/j.1467-

    789X.2010.00843.x

Ganna, A., & Ingelsson, E. (2015). 5 year mortality predictors in 498 103 UK Biobank participants: a prospective population-based study. *Lancet, 6736,* 1-8.

Hampson, S. E., Edmonds, G. W., Goldberg, L. R., Dubanoski, J. P., & Hillier, T. A. (2013). Childhood conscientiousness relates to objectively measured adult physical health four decades later. *Health Psychology, 32*, 925-928.

Hayes, A. F. (2013). *An introduction to mediation, moderation, and conditional process modeling: A regression-based approach.* New York, NY: Guilford Press.

Hayward, J., Millar, L., Petersen, S., Swinburn, B., & Lewis, A. J. (2014). When ignorance is bliss: weight perception, body mass index and quality of life in adolescents. *International Journal of Obesity, 38,* 1328-1334.

Heuer, C. A., McClure, K. J., & Puhl, R. M. (2011). Obesity stigma in online news: a visual content analysis. *Journal of Health Communication*, *16*, 976-987.

Himmelstein, M. S., Incollingo Belsky, A. C., & Tomiyama, A. J. (2015). The weight of stigma: Cortisol reactivity to manipulated weight stigma. *Obesity*, *23*, 368-374.

Hunger, J.M., Major, B., Blodorn, A., & Miller, C. (2015). Weighed down by stigma: How weight-based social identity threat influences weight gain and health. *Social Psychology and Personality Compass, 9,* 255-268.

Hussey, J. M., Nguyen, Q. C., Whitsel, E. A., Richardson, L. J., Halpern, C. T., Gordon-Larsen, P., ... & Harris, K. M. (2015). The reliability of in-home measures of height and weight in large cohort studies: evidence from add health. *Demographic Research, 32,* 1081-1100.

Ikeda, J.P., Crawford, P.B., & Woodward-Lopez, G. (2006). BMI screening in schools: helpful or harmful. *Health Education Research, 21,* 761-769.

Incollingo Rodriguez, A. C., Heldreth, C. M., & Tomiyama, A. J. (2016). Putting on weight

stigma: A randomized study of the effects of wearing a fat suit on eating, well- being,

and cortisol. *Obesity, 24,* 1892-1898.

Johnson, F., Beeken, R. J., Croker, H., & Wardle, J. (2014). Do weight perceptions among

obese adults in Great Britain match clinical definitions? Analysis of cross-sectional

surveys from 2007 and 2012. *BMJ Open, 4,* e005561.

Kunst, A. E., Bos, V., Lahelma, E., Bartley, M., Lissau, I., Regidor, E., ... & Helmert, U.

(2005). Trends in socioeconomic inequalities in self-assessed health in 10 European

countries. *International Journal of Epidemiology, 34,* 295-305.

Linn, R.L., & Slinde, J.A. (1977). The determination of the significance of change

between pre-and posttesting periods. *Review of Educational Research*, *47,* 121-150.

Martin, B. C., Dalton, W. T., Williams, S. L., Slawson, D. L., Dunn, M. S., & Johns-

Wommack, R. (2014). Weight status misperception as related to selected health risk

behaviors among middle school students. *Journal of School Health, 84*, 116-123.

Neter, J. E., Stam, B. E., Kok, F. J., Grobbee, D. E., & Geleijnse, J. M. (2003). Influence of

weight reduction on blood pressure a meta-analysis of randomized controlled trials.

Hypertension, 42, 878-884

Radloff, L. S. (1977). The CES-D scale a self-report depression scale for research in the

general population. *Applied Psychological Measurement, 1*, 385-401.

Robinson, E., Hunger, J. M., & Daly, M. (2015). Perceived weight status and risk of weight

gain across life in US and UK adults. *International Journal of Obesity, 12,* 1721-

1726.

Robinson, E., & Oldham, M. (2016). Weight status misperceptions among UK adults: the

use of self-reported vs. measured BMI. *BMC Obesity*, *3,* doi: 10.1186/s40608-016-

0102-8

Robinson, E., & Sutin, A. (2016). Parental perception of weight status and weight gain across

childhood. *Pediatrics, 137,* doi: 10.1542/peds.2015-3957

Robinson, E., Sutin, A.R., & Daly, M. (in press). Perceived weight discrimination mediates

the longitudinal relation between obesity and depressive symptoms in US and UK

adults. *Health Psychology,* doi.org/10.1037/hea0000426

Seeman, T. E., McEwen, B. S., Rowe, J. W., & Singer, B. H. (2001). Allostatic load as a

marker of cumulative biological risk: MacArthur studies of successful

aging. *Proceedings of the National Academy of Sciences USA*, *98*, 4770-4775.

Sikorski, C., Luppa, M., Luck, T., & Riedel-Heller, S. G. (2015). Weight stigma "gets under

the skin"—evidence for an adapted psychological mediation framework—a

systematic review. *Obesity, 23,* 266-276.

Sutin, A. R., Robinson, E., Daly, M., & Terracciano, A. (2016). Weight discrimination and

unhealthy eating-related behaviors. *Appetite, 102*, 83-90.

Sutin, A. R., Stephan, Y., Carretta, H., & Terracciano, A. (2015). Perceived discrimination

and physical, cognitive, and emotional health in older adulthood. *The American

Journal of Geriatric Psychiatry*, *23*, 171-179.

Sutin, A. R., Stephan, Y., Grzywacz, J.G., Robinson, E., Daly, M., & Terracciano, A. (2016).

Perceived weight discrimination, changes in health, and daily stressors. *Obesity, 24,*

2202-2209.

Sutin, A.R., & Terracciano, A. (2013). Perceived weight discrimination and obesity. *PLoS ONE*, *8,* e70048.

Sutin, A.R., & Terracciano, A. (2015). Body weight misperception in adolescence and incident obesity in young adulthood. *Psychological Science, 26*, 507-511.

Swahn, M. H., Reynolds, M. R., Tice, M., Miranda-Pierangeli, M. C., Jones, C. R., & Jones, I. R. (2009). Perceived overweight, BMI, and risk for suicide attempts: Findings from the 2007 Youth Risk Behavior Survey. *Journal of Adolescent Health*, *45*, 292-295.

Teachman, B. A., & Brownell, K. D. (2001). Implicit anti-fat bias among health professionals: is anyone immune? *International Journal of Obesity & Related Metabolic Disorders*, *25*, 1525-1531.

Tomiyama, A.J. (2014). Weight stigma is stressful: A review of evidence for the Cyclic Obesity/Weight-Based Stigma model. *Appetite, 82,* 8-15.

Tuomilehto, J., Lindström, J., Eriksson, J. G., Valle, T. T., Hämäläinen, H., Ilanne-Parikka, P., ... & Salminen, V. (2001). Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. New England Journal of Medicine, 344(18), 1343-1350.

Williams, D. R., & Mohammed, S. A. (2009). Discrimination and racial disparities in health: Evidence and needed research. *Journal of Behavioral Medicine, 32*, 20-47.
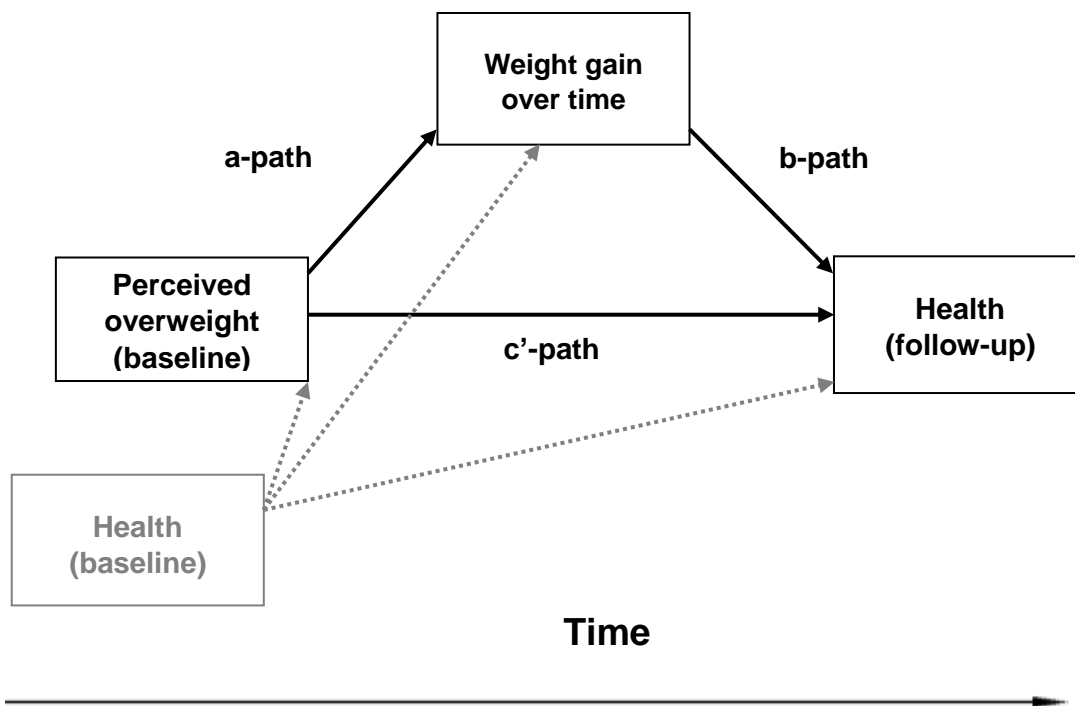
Figure 1. Conceptual Diagram of the Mediation Channel from Self-Perceived Overweight to

Subsequent Health through Weight Gain.

Supplementary Materials for:

Does Knowing Hurt? Self-Perceived Overweight Predicts Future Physical Health and Well-Being

Michael Daly[1,2], Eric Robinson[3], and Angelina R. Sutin[4]

[1] Behavioural Science Centre, University of Stirling

[2] UCD Geary Institute, University College Dublin

[3] Institute of Psychology, Health & Society, University of Liverpool

[4] College of Medicine, Florida State University

To whom correspondence should be addressed. Email: michael.daly@stir.ac.uk

Section 1: Self-perceived weight (continuous) and subsequent health analyses.

Section 2: Additional analyses testing the impact of controlling for baseline physiological dysregulation on the mediation pathway from perceived overweight to dysregulation through weigh gain.

Section 1: Self-perceived weight (continuous) and subsequent health analyses.

We examined whether the same pattern of associations between perceived overweight (dichotomous indicator) and health outcomes were observed when a continuous measure of perceived weight was utilized. Self-perceived weight was assessed at baseline where participants rated their perceived weight on the following scale: 1 = *very underweight,* 2 = *slightly underweight,* 3 = *about the right weight*, 4 = *slightly overweight,* and 5 = *very overweight*. Because those who rate their weight as 'very underweight' are likely to experience weight bias (e.g. stereotyped as depressed, undereating, teased about weight: Lundgren, Anderson, Thompson, Shapiro, & Paulosky, 2004; Tantleff-Dunn, Hayes, & Braun, 2009) and health problems we remove this group (1.1% of the sample/39 participants) from the analyses.

The continuous measure of perceived weight (N = 3,543) therefore ranged from 'slightly underweight' to 'very overweight' and was found to predict all health outcomes, as shown in Table S1. Each one-point increase in perceived weight was associated with a .13 *SD* decrease in self-rated health, a .06 *SD* increase in depressive symptoms and raised physiological dysregulation levels (.13 *SD* higher). The decrease in the linkages between perceived weight and the health outcomes attributable to weight gain was of a similar magnitude to that observed using the dichotomous perceived overweight predictor. For example, the same portion (46%) of the association between perceived weight and dysregulation was explained by weight gain when a dichotomous or continuous measure of perceived weight was used.

We therefore conclude that there is little evidence that the pattern of relationships observed between perceived weight and health outcomes differs markedly depending on whether a dichotomous vs. a continuous measure of perceived weight is utilized.

Table S1. *Self-Perceived Weight Predicting Subsequent Physiological Dysregulation and Changes in Self-rated Health and Depressive Symptoms.*

	Physiological Dysregulation (z-score)		Self-rated health (z-score)		Depressive symptoms (z-score)	
		+ Weight gain[a]		+ Weight gain[a]		+ Weight gain[a]
Perceived weight[b]	.13***	.07**	-.13***	-.11***	.06*	.06*
	(.03)	(.02)	(.03)	(.03)	(.03)	(.03)
Self-rated health	–	–	.39***	.38***	–	–
			(.02)	(.02)		
Depressive symptoms	–	–	–	–	.09***	.09***
					(.00)	(.00)

Note. Analyses are adjusted for age, sex (female), ethnicity (white), education, income, the presence of a long-standing illness, and baseline BMI There were 3,543 participants, 2,001 women & 1,542 men. Standard errors are included in parentheses.

[a] Weight gain is BMI at baseline subtracted from BMI at follow-up.

[b] Ranging from 1 = slightly underweight to 4 = very overweight.

* $p < .05$. ** $p < 0.01$. *** $p < .001$.

Section references:

Lundgren, J. D., Anderson, D. A., Thompson, J. K., Shapiro, J. R., & Paulosky, C. A. (2004). Perception of teasing in underweight persons: A modification of the perception of teasing scale. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity, 9*, 139-146.

Tantleff-Dunn, S., Hayes, S., & Braun, C. P. (2009). How did you get so thin? The effect of attribution on perceptions of underweight females. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity, 14,* 38-44.

Section 2: Additional analyses testing the impact of controlling for baseline physiological

dysregulation on the mediation pathway from perceived overweight to dysregulation through

weigh gain.

We identified a close relationship between perceived overweight at baseline and

physiological dysregulation at follow-up (d = .24). Yet it is possible that baseline

dysregulation (which was not assessed in Add Health) led to both initial perceptions of

weight and subsequent dysregulation explaining the association between these two variables.

Unfortunately, we cannot assess this possibility directly in Add Health or other datasets that

we are aware of.

However, our mediation analyses show that self-identifying as overweight at baseline

predicts weight gain over 7-years (path a) and that this in turn predicts physiological

dysregulation (path b), as illustrated in Figure 1. Together these paths produce a mediation

channel which explains 46% of the link between perceived overweight and subsequent

dysregulation (indirect effect, path a×b: B = .11, 95% BCa CI: .07, .14). Using additional data

it is possible to evaluate whether the two path that make up this channel are likely to be

affected by confounding by baseline physiological dysregulation.

The influence of baseline dysregulation on path 'a' can be tested in the British

National Child Development Study (NCDS) where perceived overweight and physiological

dysregulation are measured at baseline (age 42-44) and weight gain is assessed over an 11-

year period (from age 44 to 55). Further, the contribution of initial dysregulation to the

association between weight gain (over 4 years) and follow-up physiological dysregulation

(path b) can be examined in the English Longitudinal Study of Ageing (ELSA).

As shown in Table S2 and Table S3 including initial dysregulation in the regression

models did not markedly diminish the strength of either path 'a' or path 'b' in Figure 1. In

fact, the estimates derived from these analyses suggest that controlling for initial

physiological dysregulation may marginally increase (by approximately 12%) the strength of

the mediation effect observed. These analyses provide indirect evidence to suggest that the

portion of the link between perceived overweight and follow-up dysregulation that is due to

weight gain may not be attributable to unobserved variation in baseline physiological
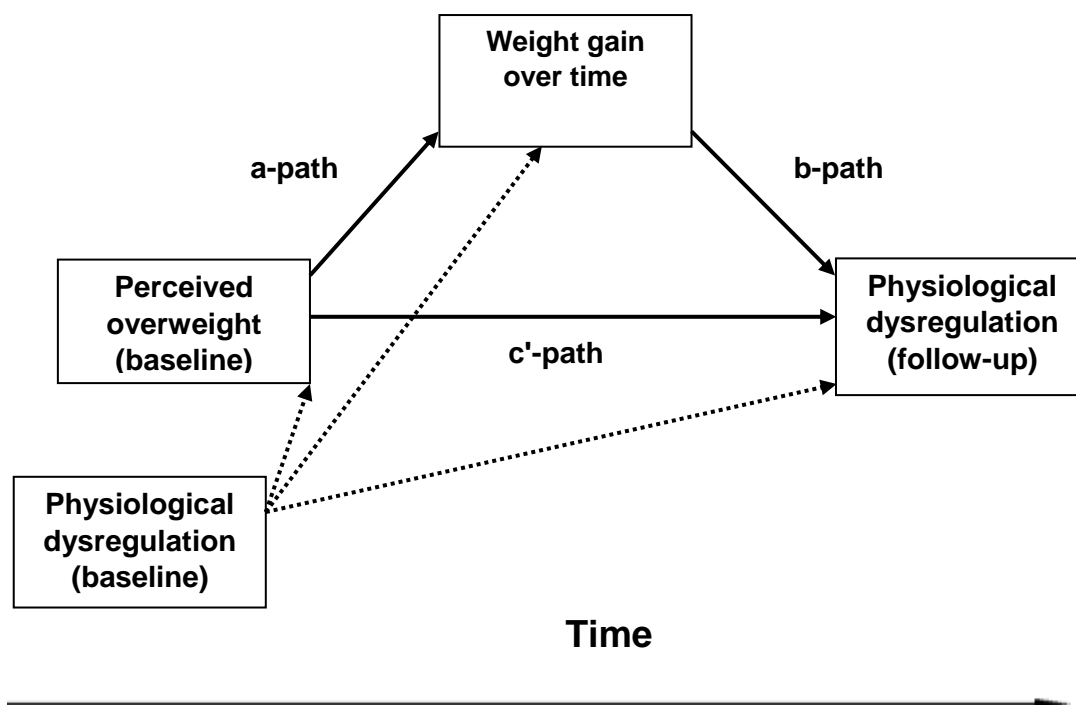
dysregulation.

Figure S1. Conceptual Diagram of the Mediation Channel from Self-Perceived Overweight to

Subsequent Physiological Dysregulation through Weight Gain.

Note: Unobserved baseline dysregulation may act as a 'third variable' (see dashed lines)

influencing weight perceptions, weight gain, and subsequent physiological dysregulation and

explaining why each of these variables are linked.

Table S2. *Impact of Baseline Physiological Dysregulation on the Association between Self-Perceived Overweight and Weight Gain 11 years later in the NCDS (N = 4,924).*

	Weight gain (kg/m^2)	
	B	SE
Model 1		
Perceived overweight	.670***	.120
Model 2 (+ baseline physiological dysregulation)		
Perceived overweight	.662***	.120

Note. All participants were born in the same week in March, 1958. Analyses are adjusted for sex (female), ethnicity (white), and social background (derived from the father's occupation: I = professional occupations, II = managerial or technical occupations, III = skilled workers, IV = semiskilled workers, and V = unskilled) and initial BMI levels (objectively recorded).

[a] Physiological dysregulation was gauged using a composite measure of systolic and diastolic blood pressure, C-reactive protein, waist circumference, total blood cholesterol to high-density lipoprotein cholesterol, total triglycerides, and glycated hemoglobin (HbA1c) levels. As in the main manuscript all biomarkers were converted to deciles then summed and standardized to have a mean of 0 and standard deviation of 1.

* $p < .05$. ** $p < 0.01$. *** $p < .001$.

Table S3. *Impact of Baseline Physiological Dysregulation on the Association between Weight Gain (from 2004/2005 to 2008/2009) and Follow-up Physiological Dysregulation in ELSA (N = 2,468).*

	Physiological dysregulation (follow-up)	
	B	SE
Model 1		
Weight gain (between baseline and follow-up: kg/m^2)	.096***	.007
Model 2 (+ baseline physiological dysregulation)		
Weight gain (between baseline and follow-up: kg/m^2)	109.***	.005

Note. Analyses are adjusted for age, sex (female), educational attainment, and wealth (gauged using an extensive measure of benefit unit non-pension wealth) and initial BMI levels (objectively recorded).

[a] Physiological dysregulation was gauged using a composite measure of systolic and diastolic blood pressure, C-reactive protein, waist circumference, total blood cholesterol to high-density lipoprotein cholesterol, total triglycerides, and glycated hemoglobin (HbA1c) levels. As in the main manuscript all biomarkers were converted to deciles then summed and standardized to have a mean of 0 and standard deviation of 1.

* $p < .05$. ** $p < 0.01$. *** $p < .001$.