

1 Perceived weight discrimination mediates the prospective relation
2 between obesity and depressive symptoms in US and UK adults

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Abstract

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Objective: Obesity has been shown to increase risk of depression. **Persons with obesity** experience discrimination because of their body weight. Across three studies we tested for the first time whether experiencing (perceived) weight based discrimination explains why obesity is prospectively associated with increases in depressive symptoms.

Methods: Data from three studies: the English Longitudinal Study of Ageing (ELSA) (2008/2009 – 2012/2013), the Health and Retirement Study (HRS) (2006/2008 – 2010/2012), and Midlife in the United States (MIDUS) (1995/1996 – 2004/2005), were used to examine associations between obesity, **perceived weight discrimination and depressive symptoms** among 20,286 US and UK adults.

Results: Across all three studies, class II and III obesity were reliably associated with increases in depressive symptoms from baseline to follow-up. Perceived weight-based discrimination predicted increases in depressive symptoms over time and mediated the prospective association between obesity and depressive **symptoms** in all three studies.

Persons with class II and III obesity were more likely to report experiencing weight based discrimination and this explained approximately 31% of the obesity-related increase in depressive symptoms on average across the three studies.

Conclusions: In US and UK samples, the prospective association between obesity (**defined using BMI**) and increases in depressive symptoms in adulthood may in part be explained by perceived weight discrimination.

Key words: obesity; depression; obesity stigma; discrimination; weight stigma;

Introduction

51
52 There is convincing evidence for a bi-directional link between obesity and depression (de Wit
53 et al., 2010; Luppino et al., 2010): depression is associated with future weight gain (Grundy,
54 Cotterchio, Kirsh, & Kreiger, 2014; Luppino, et al., 2010) and persons with obesity are at
55 greater risk of developing depressive symptoms than their ‘normal’ weight counterparts
56 (Faith et al., 2011; Herva et al., 2006; Roberts, Deleger, Strawbridge, & Kaplan, 2003). There
57 is evidence that the severity of obesity predicts the strength of the association between
58 obesity and depression, whereby persons with class II obesity and above are most likely to
59 suffer from depressive symptoms (Onyike, Crum, Lee, Lyketsos, & Eaton, 2003; Preiss,
60 Brennan, & Clarke, 2013; Vogelzangs et al., 2010). Although the prospective relation
61 between obesity and depression has now been confirmed, the mechanisms explaining why
62 persons with obesity are at an increased risk of developing depressive symptoms remain
63 unclear (Luppino, et al., 2010; Preiss, et al., 2013). Moreover, the majority of studies that
64 have examined potential mechanisms linking obesity to depression have relied on cross-
65 sectional designs and/or non-representative samples (Preiss, et al., 2013).

66 A number of studies have shown that obesity is stigmatised and a substantial portion
67 of persons with obesity report being treated unfairly because of their weight, otherwise
68 known as perceived weight discrimination (Jackson, Steptoe, Beeken, Croker, & Wardle,
69 2015; Puhl & Heuer, 2009; Sutin & Terracciano, 2013). Recent findings have linked
70 experiencing weight-based discrimination with a variety of adverse health outcomes. For
71 example, individuals who report experiencing discrimination because of their weight are
72 more likely to suffer ill health as indexed by both self-report and physiological measures
73 (Chen et al., 2007; Fettich & Chen, 2012; Sutin, Stephan, Carretta, & Terracciano, 2015;
74 Sutin, Stephan, Luchetti, & Terracciano, 2014). Moreover, perceived weight discrimination is
75 most common among persons with class II obesity and above, in which risk of future

76 depression is highest (Dutton et al., 2014; Jackson, Steptoe, et al., 2015; Spahlholz, Baer,
77 Konig, Riedel-Heller, & Luck-Sikorski, 2016). For example, recent data from a
78 representative survey of German participants indicate that one in three participants with class
79 III obesity report experiencing weight based discrimination (Sikorski, Spahlholz, Hartlev, &
80 Riedel-Heller, 2016). In addition, a number of theoretical models suggest that experiencing
81 weight discrimination is likely to act as a form of psychological stressor (Major, Eliezer, &
82 Rieck, 2012; Tomiyama, 2014), which could reduce self-worth and increase negative affect
83 among **persons with obesity** (Crocker, Cornwell, & Major, 1993; Sikorski, Luppá, Luck, &
84 Riedel-Heller, 2015). Thus, the experience of weight based stigma may be an important
85 factor explaining why obesity is associated with increased depressive symptoms.

86 A recent cross-sectional study of English older adults showed that perceived weight
87 discrimination is associated with lower quality of life and more depressive symptoms
88 (Jackson et al., 2015a). Although cross-sectional studies that link weight based discrimination
89 to adverse psychological outcomes are informative, they are also limited as it is plausible that
90 reverse causality may explain these associations; those suffering from depression may be
91 particularly likely to perceive weight based discrimination (Jackson, Beeken, & Wardle,
92 2015) which has been shown to further propagate weight gain (Sutin & Terracciano, 2013).
93 To date, there have been no examinations of the prospective association between obesity,
94 perceived weight discrimination and depression. The aim of the current research was to
95 examine whether experiencing (perceived) weight based discrimination mediates the
96 prospective association between obesity and subsequent changes in depressive symptoms in
97 **three large cohort studies of US and UK adults**. We predicted that experiencing weight
98 discrimination would in part explain **why persons with obesity** show increases in depressive
99 symptoms over time. **A further aim of the current research was to examine whether gender**
100 **moderated this effect. We reasoned that women may be more likely to experience increases**

101 in depressive symptoms as a result of experiencing weight-based discrimination because of
102 the importance attached to female thinness in our current social climate (Thompson & Stice,
103 2001).

104 **Study 1: English Longitudinal Study of Ageing (ELSA)**

105 Our first aim was to make use of data from the ELSA to examine whether there is evidence
106 that perceived weight discrimination mediates the prospective association between obesity
107 and depressive symptoms among older UK adults.

108 *Sample.* Participants were drawn from the English Longitudinal Study of Ageing (ELSA), an
109 ongoing prospective cohort study established in 2002 to study the health and ageing of
110 community dwelling older adults (≥ 50 years). The initial ELSA sample was recruited from
111 three waves of the Health Survey for England (1998, 1999, 2001), an annual cross-sectional
112 survey based on a stratified random sample of English households. Interview data is collected
113 every two years and a clinical assessment conducted every four years. In the current analyses,
114 we calculate body mass index from height and weight measurements collected as part of the
115 wave 4 (2008-2009) health assessment and examine longitudinal change in depressive
116 symptoms over the four year period from wave 4 to wave 6 (2012-2013). Participants
117 completed a measure of discrimination as part of the wave 5 (2010-2011) interview. To be
118 included in the current analyses, participants needed to have provided complete demographic,
119 BMI, and depressive symptom data as well as the perceived weight discrimination measure
120 (N = 6,000). Sample characteristics are detailed in Table 1. Participants in all three studies
121 provided informed consent and ethical approval was obtained for each study.

122 *Measures*

123 *BMI.* As part of the wave 4 health assessment, trained nurses weighed participants to the
124 nearest 0.1 kg using the Tanita THD-305 portable electronic scales. Standing height was
125 measured to the nearest millimetre using a portable stadiometer. Participants stood on the

126 centre of a baseplate looking straight ahead in order to gauge height accurately and
127 consistently. BMI was derived as kg/m^2 and defined as normal weight (BMI < 25),
128 overweight (BMI 25-29.9), class I (BMI 30-34.9), class II (BMI 35-39.9) and class III obesity
129 (BMI 40 and above).

130 *Perceived Weight Discrimination.* In all three studies participants completed an adapted
131 version of the perceived everyday experiences with discrimination scale (Williams, Yan,
132 Jackson, & Anderson, 1997). Participants firstly reported how frequently they perceived a set
133 of discriminatory experiences to occur in their day-to-day life. During wave 5 of ELSA, the
134 frequency of five forms of unfair treatment was assessed (“you are treated with less respect or
135 courtesy”, “you are threatened or harassed”, “you receive poorer service than other people in
136 restaurants and stores”, “people act as if they think you are not clever”, “you receive poorer
137 service or treatment than other people from doctors or hospitals”) on a 6 point scale from
138 ‘Never; to ‘Almost every day’. Next, participants who reported having experienced
139 discrimination in daily life were asked to select the reason(s) they believed they were
140 discriminated against from a list that included weight. Participants could choose as many or
141 as few attributions for the unfair treatment as necessary. In fitting with other studies which
142 have examined the association between perceived weight discrimination and health outcomes
143 (Jackson, Beeken, et al., 2015; Sutin, et al., 2015), perceived weight discrimination
144 (dichotomous variable) was defined as those who reported experiencing discrimination and
145 indicated they believed that weight was a reason for this discrimination. Rates of perceived
146 weight discrimination across body weight categories are detailed in Table 2.

147 *Depressive symptoms.* A validated eight-item version of the Center for Epidemiology
148 Depression Scale (CES-D) was administered to assess depressive symptoms at baseline and
149 at follow-up (Radloff, 1977; Turvey, Wallace, & Herzog, 1999) . The short form CES-D uses
150 a yes/no response format to assess feelings over the last week including sadness, lethargy,

151 loneliness, as well as happiness and enjoyment of life. Positively worded items were reverse
152 scored and a total sum score was generated ranging from 0 to 8, with higher scores indicating
153 greater depressive symptoms. The CES-D demonstrated sufficiently high levels of reliability
154 (Cronbach $\alpha = .79$ in both waves) and a moderate degree of stability across study waves ($r =$
155 $.50, p < .001$).

156 *Covariates.* We based our choice of covariates on recorded variables likely to be associated
157 with depression and/or obesity (Preiss et al., 2013, Luppino et al., 2010). Participants
158 reported demographic information at baseline (wave 4, 2008-2009) including their age,
159 gender, ethnicity (white vs. non-white), education level (from 1 = no qualifications, to 7 =
160 degree level qualification or above), marital status (married, cohabiting, neither), and
161 employment status (retired, employed/self-employed, unemployed, permanently
162 sick/disabled, looking after home/family). Participants also reported details relating to their
163 health and health behavior. Specifically, participants indicated whether they had a long-
164 standing illness, whether they were a current smoker, the frequency of their alcohol
165 consumption in the past week (scored from 0 = drank on none of the last seven days, to 7 =
166 drank on all days in the past week), and the frequency they engage in moderate and vigorous
167 physical activity (each item rated from 1 = “more than once a week”, to 4 = “hardly ever, or
168 never”).

169 *Mediation Analyses.* Across all three studies mediation analysis was used to identify whether
170 weight status at baseline (i.e. overweight, obesity class I, II, and III relative to normal weight)
171 had an indirect effect on depressive symptoms (standardized to have a mean of 0 and a
172 standard deviation of 1) at follow-up through perceived weight discrimination. All mediation
173 analyses were adjusted for initial depressive symptoms and covariates that may confound the
174 relationship between obesity and depression: age, age-squared (to account for a potential non-
175 linear relationship), gender, education, marital status, and employment status. We firstly

176 established the preconditions necessary for successful mediation (Baron & Kenny, 1986).
177 This involved establishing an association between: (i) **weight status categories** and depressive
178 symptoms (total effect, path *c*), (ii) weight status categories and perceived weight
179 discrimination (path *a*), and (iii) perceived weight discrimination and depressive symptoms
180 (path *b*) in a model which included baseline weight status. Where the conditions for
181 mediation were met we conducted further analyses of the potential indirect effects (path $a \times$
182 *b*) identified using the ‘*khb*’ command in Stata (version 13)(Karlson, Holm, & Breen, 2012;
183 Kohler, Karlson, & Holm, 2011). We employed this method because our perceived weight
184 discrimination mediator variable was dichotomous and ‘path *a*’ coefficients (independent
185 variable to dichotomous mediator) derived from logistic regression cannot be multiplied
186 directly with the ordinary least squares ‘path *b*’ coefficients (dichotomous mediator to
187 continuous dependent variable, path *b*) using the standard product of coefficients approach
188 (Preacher & Hayes, 2008). The *khb* method decomposes the total effect of obesity on
189 depression into a direct effect and an indirect effect through perceived weight discrimination.
190 It also provides estimates of the magnitude and statistical significance level of the indirect
191 effect and proportion of the total association accounted for by this pathway.

192 *Robustness tests.* We conducted supplementary mediation analyses where each model was
193 adjusted for health behavior and health status. We considered this an additional stringent test
194 of the study hypotheses given that health-related variables may act as either confounding
195 factors and/or additional pathways from perceived discrimination to depressive symptoms. If
196 including these variables in our regressions did not notably change the indirect association
197 between obesity and depressive symptoms through perceived discrimination we considered
198 the relationship to be unlikely to be affected by health-related variables. **We also tested**
199 **whether the mediation results were notably different if a continuous measure of body weight**
200 **(i.e. BMI) was used as the predictor variable or if a dichotomous indicator of clinically**

201 significant depression was used as the outcome measure. Specifically, we tested whether
202 weight discrimination mediated the longitudinal association between BMI (treated
203 continuously) and changes in depressive symptoms and whether weight discrimination
204 explained the link between weight categories and changes in the presence of clinically
205 significant depression levels over time. For the latter analyses we used scale specific cut-off
206 scores for clinically significant depression scores to identify those meeting the criteria for
207 depression (see Table S1 for scale cut off scores in each study and depression rates).

208 *Results and Conclusion*

209 Participants in the class II and III obesity categories were at an increased risk of developing
210 more depressive symptoms from baseline to follow up ($p < .01$), as shown in Table 3. As
211 expected, the proportion of participants experiencing weight discrimination increased
212 markedly across weight categories (i.e. overweight, obesity classes I, II, III) (see Table 2).
213 For example, amongst normal weight and overweight participants less than 1 % reported
214 weight discrimination, while $> 20\%$ of class II and III obese participants reported
215 experiencing weight discrimination. Perceived weight discrimination was found to be a
216 significant predictor of increased depressive symptoms from baseline to follow up ($\beta = .188$,
217 $p < .001$) in models adjusting for weight status at baseline, as outlined in Table 3.

218 We found a significant indirect effect between class II ($\beta = .036$, $SE = .012$, $p < .01$,
219 $95\% CI = .013 - .059$) and class III obesity ($\beta = .057$, $SE = .019$, $p < .01$, $95\% CI = .020 -$
220 $.095$) and longitudinal change in depressive symptoms through perceived weight
221 discrimination, as shown in Table 3. In total, 18.1% of the total effect of class II obesity and
222 20.6% of the effect of class III obesity on depressive symptoms was mediated through
223 perceived weight discrimination. Our robustness tests indicated that perceived weight
224 discrimination explained approximately 28% of the association between class II/III obesity
225 and depressive symptoms in models adjusting for the presence of a long-standing limiting

226 illness, whether the participant smoked, and the frequency with which the participant drank
227 and exercised (see Table S2 of the online supplemental materials). We interpret this as
228 evidence that the contribution of perceived weight discrimination to explaining the obesity-
229 depression link is unlikely to be due to confounding by health or health behavior in this
230 study.

231 In addition, we found that 22.9% of the total effect of BMI (continuous variable) on
232 increases in depressive symptoms ($B = .011$, $SE = .002$, $p < .01$) was mediated by weight
233 discrimination ($B = .002$, $SE = .0001$, $p < .01$), as shown in Table S3. Weight discrimination
234 predicted increases in clinically significant depression levels over time ($OR = 1.51$, $p < .05$,
235 $95\% CI = 1.04-2.19$) and mediated 22.3% of the link between class II and class III obesity
236 and clinically significant depression on average, as shown in Tables S4 and S5. These
237 supplementary analyses show that the role of perceived weight discrimination in mediating
238 the link between body weight and depression is not markedly different to our main analyses
239 when either a continuous BMI measure or a dichotomous measure of clinically significant
240 depression is employed.

241 **Study 2: Health and Retirement Study (HRS)**

242 In Study 1 we found evidence that the relation between obesity and depressive symptoms is
243 mediated by perceived weight discrimination among older English adults. A potential
244 limitation of Study 1 was that the mediator variable (perceived weight discrimination) was
245 measured after the baseline measures of BMI and depression. We were able to address this in
246 Study 2. Moreover, given that the relation between obesity and depression has been
247 suggested to be particularly strong among Americans (Luppino, et al., 2010), in Study 2 we
248 aimed to replicate the findings of Study 1 in a large sample of older US adults.
249 *Sample.* A total of 9,908 participants were drawn from the Health and Retirement Study, a
250 longitudinal study of Americans over the age of 50 and their spouses. In 2006, HRS

251 implemented an enhanced face-to-face interview that included a standardized measurement of
252 weight and height and a psychosocial questionnaire that participants completed at home and
253 mailed back to the University of Michigan. Half of the HRS sample participated in the
254 enhanced interview in 2006; the other half participated in 2008. These two samples were
255 combined as baseline. Participants completed the same assessment again four years later, in
256 2010 and 2012, respectively. These assessments were combined as the follow-up to give each
257 participant a four-year follow-up interval. See Table 1 for sample demographic information.

258 *Measures*

259 *BMI.* As part of the enhanced face-to-face interview, trained staff measured and weighed
260 participants. BMI was derived as kg/m^2 and categorized into categories as in Study 1.

261 *Perceived weight discrimination.* Participants completed the perceived everyday experiences
262 with discrimination scale as described in Study 1 (Williams, et al., 1997) at baseline.

263 *Depressive symptoms.* At baseline and follow-up, participants completed a short version of
264 the Center for Epidemiological Studies Depression (CES-D) scale (Turvey, et al., 1999).

265 **Participants rated nine items (yes/no) that measured depressive symptoms during the last**
266 **week (e.g. I felt depressed), which were summed for a total depressive symptoms score.**

267 *Covariates.* Demographic information was provided at baseline (2006/2008) and included
268 age, age-squared, gender, ethnicity (white vs. other), years of education, marital status
269 (married, separated/divorced, widowed, never married) and employment categories
270 (employed, unemployed, homemaker, retired, temporary leave, disabled). Health and health
271 behavior were assessed using a measure of disease burden at baseline (a sum of eight
272 diagnosed chronic conditions), history of ever smoking, frequency of vigorous physical
273 activity, and average alcohol consumption in a week over the last three months.

274 *Results and Conclusion*

275 We used the same analysis strategy as in Study 1. In an initial model unadjusted for perceived
276 weight discrimination, individuals of class I, II and III obesity were at an elevated risk of
277 increased depressive symptoms from baseline to follow up, as detailed in Table 4. The
278 numbers of participants experiencing weight discrimination increased as BMI increased. For
279 example, amongst normal weight and overweight participants around 2% reported
280 experiencing weight discrimination, while > 20% of class II and III obese participants
281 reported weight discrimination (see Table 2). Those who reported perceived weight
282 discrimination showed a significant increase in depressive symptoms over the four year
283 period from baseline to follow up ($\beta = .141, p < .001$), as shown in Table 4. We observed
284 significant indirect effects of obesity classes I ($\beta = .011, SE = .003, 95\% CI = .005 - .016, p$
285 $< .01$), II ($\beta = .026, SE = .006, 95\% CI = .013 - .038, p < .01$) and III ($\beta = .046, SE = .011,$
286 $95\% CI = .024 - .069, p < .01$) on depressive symptoms through perceived weight
287 discrimination. Effect ratios showed that perceived weight discrimination explained
288 approximately 34% of the effect of classes I, II, and III obesity on longitudinal changes in
289 depressive symptoms, as shown in Table 4.

290 *Robustness tests.* As in Study 1, we also tested the effect of perceived weight discrimination
291 on the relation between obesity and change in depressive symptoms while controlling for
292 other health and health behavior variables (i.e. disease burden, physical activity, smoking and
293 alcohol consumption). This analysis confirmed that perceived weight discrimination
294 significantly mediated the relation between obesity (classes I/II/III) and change in depressive
295 symptoms whilst controlling for a range of potential confounding variables, explaining
296 approximately 35% of this association (see Table S2). **As in Study 1, we found that weight**
297 **discrimination explained a substantial portion (38.6%) of the longitudinal link between BMI**
298 **(continuous variable) and increases in depressive symptoms (total effect: $B = .005, SE =$**
299 **$.001, p < .01$; indirect effect: $B = .002, SE = .0004, p < .01$), as shown in Table S6. Once**

300 again, weight discrimination predicted increases in the presence of clinically significant
301 depression from baseline to follow-up (OR = 1.50, $p < .01$, 95% CI = 1.22-1.84) and partially
302 mediated of the link between class I, II, and III obesity and clinically significant depression
303 (26.4% explained on average), as shown in Tables S4 and S7.

304 **Study 3: Midlife in the United States (MIDUS)**

305 In the third study we sought to replicate the findings of Study 1 and Study 2 in a sample with
306 a more diverse age range.

307 *Sample.* Data were drawn from the Midlife in the United States (MIDUS) study, a national
308 longitudinal study of the psychosocial factors that influence the health and well-being of
309 Americans from midlife to old age (for comprehensive sample information see (Brim et al.,
310 2004). The main sample was recruited via random digit dialling and the total sample includes
311 siblings within recruited households and a sample of twin pairs. In total 7,108 non-
312 institutionalized adults aged 25 to 74 were first interviewed in 1995/1996. Those included in
313 the current analyses needed to have provided complete demographic information and to have
314 completed both the baseline discrimination measure and a measure of depression at baseline
315 (1995/1995) and follow-up ten years later (2004/2005). 4,283 individuals met these criteria
316 and the demographic information for this sample are outlined in Table 1.

317 *Measures*

318 *BMI.* Participants reported their height and weight as part of the MIDUS baseline survey. As
319 in Study 1 and Study 2 BMI was derived as kg/m^2 and divided into overweight, obesity class
320 I, class II, and class III categories. Self-reported BMI and objectively verified BMI recorded
321 during a physical exam were available for a subset of 900 MIDUS participants and found to
322 be highly correlated in this sample ($r = .92$, $p < .001$) (Robinson, Hunger, & Daly, 2015).

323 *Perceived weight discrimination.* Weight discrimination was derived from the measure of
324 everyday discrimination as in Study 1 and Study 2 (Williams, et al., 1997). At baseline and

325 follow-up participants were asked to indicate how frequently they experienced nine forms of
326 discriminatory treatment which included similar items to those used in Study 1 and Study 2
327 ('you are treated with.... less courtesy than other people', '...less respect than other people',
328 'you receive poorer service than other people', 'people act as if they... think you are not
329 smart' '... are afraid of you', '... think you are dishonest', '...think you are not as good as
330 they are', 'you are... called names or insulted', '...threatened or harassed'). After making
331 these ratings, participants were asked to select the reason(s) for this discrimination from a list,
332 including 'weight or height'. Perceived weight discrimination (dichotomous variable) was
333 defined as those who identified weight or height as a reason for having experienced
334 discrimination.

335 *Depressive symptoms.* The World Health Organization Composite International Diagnostic
336 Interview-Short Form (CITI-SD (Kessler, Andrews, Mroczek, Ustun, & Wittchen, 1998) was
337 used to gauge the presence of depressive symptoms at baseline and follow-up. Participants
338 firstly indicated if they "felt sad, blue, or depressed" or "lost interest in most things" for two
339 weeks in the past 12 months. Those who endorsed either of these items then responded to
340 seven (yes/no) follow-up questions assessing depressive symptoms relating to how they felt
341 during this period (e.g. "feel down in yourself, no good, or worthless"). A rating was derived
342 from the two measures ranging from 0 to 7 (0 = no two week period of depressed affect or
343 anhedonia in the past year, 7 = highest depressive symptom score).

344 *Covariates.* Additional covariates included age, age-squared, gender, ethnicity (white vs.
345 other), educational level (from 1 = No school/some grade school, to 12 = PhD/MD level),
346 marital status and (married, separated, divorced, widowed, never married) and employment
347 status (employed, self-employed, unemployed, laid off, homemaker, student, retired, on
348 leave, permanently disabled, other). Health and health behavior were gauged by the presence
349 of a chronic health condition at baseline, current regular smoking, and the frequency of

350 moderate and vigorous physical activity in the past month, and alcohol consumption in the
351 past month.

352 *Results and Conclusion*

353 We used the same analysis strategy as in Studies 1 and 2. In the first model unadjusted for
354 perceived weight discrimination, depressive symptoms among individuals of class II and III
355 obesity increased from baseline to follow up ten years later (see Table 5). Once again
356 perceived weight discrimination increased markedly in line with weight status, as shown in
357 Tables 2 and 5. Perceived weight discrimination was a significant predictor of increased
358 depressive symptoms from baseline to follow up ($\beta = .152, p < .001$) and the inclusion of
359 perceived weight discrimination reduced the strength of the associations between classes II
360 and III obesity and depressive symptoms at follow up (see Table 5). Mediation analyses
361 confirmed significant indirect effects of class II ($\beta = .052, SE = .017, 95\% CI = .018 - .086, p$
362 $< .01$) and III ($\beta = .081, SE = .026, 95\% CI = .028 - .132, p < .01$) obesity on depressive
363 symptoms through perceived weight discrimination. An examination of the effect ratios
364 indicated that perceived weight discrimination explained over 31% of the total effect of
365 obesity (classes II/III) on depressive symptoms.

366 *Robustness tests.* As in Studies 1 and 2, we tested the indirect effect of perceived weight
367 discrimination on the relation between obesity and change in depressive symptoms while
368 controlling for health and health behavior variables. Once again these analyses confirmed that
369 perceived weight discrimination significantly mediated the relation between obesity and
370 change in depressive symptoms, explaining approximately 30% of this association (see Table
371 S1). **Similarly, our supplementary analyses again confirmed that weight discrimination**
372 **mediated the association between continuous BMI and depressive symptoms (explaining**
373 **54.2% of this link) and mediated the link between class II and class III obesity and clinically**
374 **significant depression (explaining 38.3% of the association), as shown in Tables S8 and S9.**

375 *Additional mediation analysis.* In our main analyses for Study 3 we combined perceived
376 weight discrimination scores measured at baseline and follow-up. However, further analyses
377 also showed that obesity at baseline predicted increases in weight discrimination from
378 baseline to follow up and this increase explained changes in depressive symptoms over time.
379 More specifically, in unadjusted analyses obesity classes I, II, and III showed a strong graded
380 associated with increases in weight discrimination from baseline to follow-up (Class I: OR =
381 5.39, 95% CI = 3.60 - 8.07; Class II: OR = 8.07, 95% CI = 4.92 - 13.23; Class III: OR =
382 24.47, 95% CI = 13.06 - 45.84). In analyses adjusting for baseline weight discrimination and
383 covariates we found that only obesity class III predicted longitudinal increases in depressive
384 symptoms (total effect: $\beta = .220$, $p < .05$). Including changes in weight discrimination
385 between baseline and follow-up in this model explained 25.5% of the longitudinal association
386 between obesity class III and subsequent changes in depressive symptoms (indirect effect: β
387 = .056, $p < .05$). Thus, the association between obesity and longitudinal change in depressive
388 symptoms is in part explained by experiencing weight discrimination when changes in
389 perceived weight discrimination over time are examined as a mediator.

390 **Additional Analyses**

391 *Gender.* Because women may be judged more critically because of their weight than men, we
392 examined gender differences in each of the key study variables (i.e. obesity, weight
393 discrimination, depressive symptoms) and tested whether gender moderated the relation
394 between perceived weight discrimination and depressive symptoms. We did this by including
395 a gender by perceived weight discrimination interactions in the earlier reported regression
396 models for studies 1-3 and examined whether this explained further variance in depressive
397 symptoms.

398 Across the three studies we found little evidence that rates of obesity differed between
399 men and women. However, women showed larger increases in depressive symptoms than

400 men in all studies, as show in Table S10. Women were also more likely than men to
401 experience weight-based discrimination in studies 2 and 3. In Study 3 (MIDUS), women
402 experienced a particularly increased risk of weight discrimination (OR = 2.207, 95% CI =
403 1.750-2.784, $p < .01$) and depressive symptoms ($\beta = .167$, SE = .031, $p < .01$) potentially
404 pointing to a gender difference in the mediating role of weight discrimination in that study.

405 There was no evidence that gender moderated the prospective association between
406 perceived weight discrimination and depressive symptoms in studies 1 and 2 ($ps > .05$). In
407 Study 3 we identified a significant interaction that indicated perceived weight discrimination
408 was more closely linked to change in depression amongst women. Supplementary mediation
409 analyses showed that whilst obesity (classes I/II/II) was linked to higher rates of perceived
410 weight discrimination in both men and women, discrimination only acted as a pathway from
411 obesity (classes II/II) to depressive symptoms for women in Study 3 (explaining 43% of this
412 association, see Table S11).

413 General Discussion

414 We used three large samples of predominantly white US and UK adults to test the hypothesis
415 that experiencing weight based discrimination mediates the prospective effect of obesity on
416 depressive symptoms. In line with previous research (Preiss, et al., 2013; Vogelzangs, et al.,
417 2010), we found consistent evidence that obesity (class II and III) was associated with
418 increases in depressive symptoms over several years. Moreover, across all three samples the
419 prospective association between obesity and depressive symptoms was in part explained by
420 perceived weight discrimination; adults with obesity were more likely to report experiencing
421 weight based discrimination, which in turn predicted increases in depressive symptoms over
422 time. On average perceived weight discrimination was linked to a .16 SD increase in
423 depressive symptoms and on average explained 31% of the total effect of obesity class II and
424 class III on depressive symptoms.

425 The results of the present research are consistent with previous cross-sectional
426 findings linking the experience of weight based discrimination with impaired well-being and
427 depressive symptoms (Chen, et al., 2007; Jackson, Beeken, et al., 2015). However, the
428 present work is the first to show that there is a prospective association between perceived
429 weight based discrimination and increased depressive symptoms. To date, there has also been
430 little research explaining potential mechanisms linking heavier body weight to longitudinal
431 increases in depressive symptoms (Preiss, et al., 2013; Remigio-Baker et al., 2014); our
432 findings suggest that among US and UK adults, perceived weight based discrimination may
433 be an important factor explaining this link. **In Study 3 we observed that the effects on**
434 **depressive symptoms of experiencing weight-based discrimination were more detrimental to**
435 **women than men, but this finding was not observed in either Study 1 or 2, so the replicability**
436 **of this gender effect is unclear and warrants further attention.**

437 Due to the observational nature of the present work we cannot make strong claims
438 about the causal influence that perceived weight discrimination has on the development of
439 depressive symptoms. However, experimental work suggests that experiencing weight based
440 stigma increases negative affect (Himmelstein, Incollingo Belsky, & Tomiyama, 2015;
441 Schvey, Puhl, & Brownell, 2011) and the present work adds to this emerging literature.
442 Moreover, a number of theoretical models suggest that experiencing weight discrimination is
443 likely to be stressful and may reduce self-worth (Crocker, et al., 1993; Sikorski, et al., 2015;
444 Tomiyama, 2014) , both of which are likely to increase depressive symptoms. Obesity is
445 viewed negatively by large proportions of society and realising that one is part of a
446 stigmatised social group is likely to be psychologically distressing (**Hunger & Major, 2015;**
447 **Hunger, Major, Blodorn, & Miller, 2015**). Experiencing weight discrimination may therefore
448 reinforce negative beliefs about how **a person with obesity** believes they are viewed by
449 others. Understanding the pathways by which experiencing weight based discrimination is

450 associated with increased depressive symptoms will now be important. Experiencing weight
451 based discrimination could also contribute to depressive symptoms **by limiting employment**
452 **opportunities**, increasing body dissatisfaction (Wardle, Waller, & Rapoport, 2001),
453 **internalisation of weight stigma (Durso & Latner, 2008)**, damaging self-esteem (Myers &
454 Rosen, 1999) and/or by increasing feelings of loneliness (Lewis et al., 2011). **Regardless of**
455 **the pathways by which experiencing weight based discrimination is associated with**
456 **depressive symptoms, challenging discrimination based on weight will now be important and**
457 **policies which challenge the derogation of persons with obesity or outline the damaging**
458 **effects of weight stigma may be ways of achieving this.**

459 *Limitations and Future Directions*

460 Our focus in the present work was on middle age and older adulthood, so we do not know
461 whether the same pattern of results would be observed among younger adults. Given that
462 experiencing weight based and other forms of discrimination have been associated with
463 adverse health outcomes among younger age groups (Puhl & Heuer, 2009; Schmitt,
464 Branscombe, Postmes, & Garcia, 2014; Wott & Carels, 2010) and obesity may be stigmatised
465 most among younger age groups (Hebl et al., 2008), weight based discrimination may also
466 play a role in explaining the link between obesity and depression in younger age groups.
467 However, further work is now needed to test whether this process holds amongst younger
468 adults. **Further work would also benefit from considering the importance of personality**
469 **variables when considering perceived weight discrimination and depressive symptoms, as it**
470 **is plausible that factors such as neuroticism may increase the likelihood that a person**
471 **perceives an experience as discriminatory and/or exacerbate the damaging psychological**
472 **effects of discrimination. Although it should be noted that associations between experiencing**
473 **discrimination and mental health in other studies tend to be robust, irrespective of adjusting**
474 **for personality characteristics (Lewis, Cogburn & Williams, 2016). A limitation of the**

475 present work was that we did not have very large numbers of participants with class II and III
476 obesity in each study, although we still observed consistent findings across studies and when
477 BMI was used as a predictor rather than weight categories. Our samples also predominantly
478 consisted of white participants and the lack of racial diversity could have influenced our
479 results. It is therefore not clear whether experiencing weight discrimination is prospectively
480 linked to increased depressive symptoms among other ethnic groups. Some final limitations
481 concern Study 3; because of practical constraints only self-reported BMI data was available
482 and the measure of perceived weight discrimination was derived from participants' reports of
483 being discriminated against due to their size more generally (e.g. weight or height), as
484 opposed to only their weight.

485

486 *Conclusions*

487 In US and UK samples, the prospective association between obesity and increases in
488 depressive symptoms in adulthood may in part be explained by perceived weight
489 discrimination.

490

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643 **Table 1.** *Basic Demographic Characteristics and Descriptive Statistics for Participants in*
 644 *Studies 1-3*

	Study 1 / ELSA	Study 2 / HRS	Study 3 / MIDUS
	N = 6,000	N = 9,908	N = 4,378
Variable	M(SD) / %	M(SD) / %	M(SD) / %
Age (years)	64.75 (8.60)	66.97 (9.72)	46.68 (12.45)
Female (%)	55.4	60.1	53.2
White (%)	97.8	85.2	93.8
BMI baseline (kg/m ²)	28.29 (5.17)	29.39 (5.83)	26.62 (5.16)
Weight status (%)			
BMI ≤ 25 kg/m ²	26.60	22.88	41.69
Overweight	42.13	36.97	37.62
Class I obese	21.30	24.60	13.98
Class II obese	7.00	10.40	4.66
Class III obese	2.97	5.15	2.06
Depressive symptoms (t0)	1.21 (1.78) ^a	1.69 (2.09) ^b	.70 (1.83) ^c
Depressive symptoms (t1)	1.21 (1.78) ^a	1.78 (2.13) ^b	.61 (1.72) ^c

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646 ^a score ranging from 0 to 8, with higher scores indicating greater depressive symptoms

647 ^b score ranging from 0 to 9, with higher scores indicating greater depressive symptoms

648 ^c score ranging from 0 to 7, with higher scores indicating greater depressive symptoms

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650 **Table 2.** *Percentage of Participants Reporting Experiencing Weight Based Discrimination by*
 651 *Weight Status in Studies 1-3*
 652

	Study 1/ ELSA ^a	Study 2 / HRS ^b	Study 3 /MIDUS ^c
	N = 6,000	N = 9,908	N = 4,378
	% (N of total)	% (N of total)	% (N of total)
Normal weight (BMI < 25 kg/m ²)	0.9 (14/1596)	1.9 (42/2268)	4.9 (89/1825)
Overweight	0.9 (22/2528)	2.5 (91/3663)	8.4 (138/1647)
Class I obese	5.9 (75/1278)	9.1 (221/2437)	21.2 (130/612)
Class II obese	20.5 (86/420)	20.8 (214/1030)	38.7 (79/204)
Class III obese	32.6 (58/178)	36.5 (186/510)	58.9 (53/90)

653 ^a Perceived weight discrimination: those reporting experiences of discrimination attributable
 654 to weight in the 2008/2009 wave of ELSA.

655 ^b Perceived weight discrimination: those reporting experiences of discrimination attributable
 656 to weight in the 2006/2008 wave of HRS.

657 ^c Perceived weight discrimination: those reporting experiences of discrimination attributable
 658 to weight/height in 1995/1996 or 2004/2005 waves of MIDUS.

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673 **Table 3.** *Mediation Models of the Indirect Effect of Obesity on Changes in Depressive*
 674 *Symptoms through Perceived Weight Discrimination in Study 1 (ELSA; N = 6,000)*
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	Point	SE	95% CI	Effect
	Estimate		Lower ; Upper	ratio
Class III Obesity				
Weight status -> discrimination	3.892**	.320		
<i>(IV to mediator, path a)</i>				
Discrimination -> depression	.188**	.059		
<i>(mediator to DV, path b)</i>				
Weight status -> depression	.278**	.068		
<i>(total effect, path c)</i>				
Weight status -> depression	.220**	.070		
<i>(direct effect, path c')</i>				
Weight status -> depression	.057**	.019	[.020 ; .095]	.206
<i>(indirect effect, path a × b)</i>				
Class II Obesity				
Weight status -> discrimination	3.321**	.298		
<i>(IV to mediator, path a)</i>				
Discrimination -> depression	.188**	.059		
<i>(mediator to DV, path b)</i>				
Weight status -> depression	.197**	.047		
<i>(total effect, path c)</i>				

Weight status -> depression	.161**	.048		
<i>(direct effect, path c')</i>				
Weight status -> depression	.036**	.012	[.013 ; .059]	.181
<i>(indirect effect, path a × b)</i>				

Class I Obesity

Weight status -> discrimination	2.021**	.297		
<i>(IV to mediator, path a)</i>				
Discrimination -> depression	.188**	.059		
<i>(mediator to DV, path b)</i>				
Weight status -> depression	.031	.032		
<i>(total effect, path c)</i>				
Weight status -> depression	.021	.032		
<i>(direct effect, path c')</i>				
Weight status -> depression	–	–	–	–
<i>(indirect effect, path a × b)</i>				

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Note. Models use z-scores for depressive symptoms as the outcome variable. Models are adjusted for baseline depressive symptoms, age, age-squared, gender, ethnicity (white vs. other), educational attainment, marital status (married, cohabiting, other) and employment categories (employed/self-employed, unemployed, homemaker, retired, permanently sick or disabled). * $p < .05$, ** $p < .01$.

692 **Table 4.** *Mediation Models of the Indirect Effect of Obesity on Changes in Depressive*
 693 *Symptoms through Perceived Weight Discrimination in Study 2 (HRS; N = 9,908)*
 694

	Point Estimate	SE	95% CI Lower ; Upper	Effect ratio
Class III Obesity				
Weight status -> discrimination	3.289**	.186		
<i>(IV to mediator, path a)</i>				
Discrimination -> depression	.141**	.033		
<i>(mediator to DV, path b)</i>				
Weight status -> depression	.107**	.040		
<i>(total effect, path c)</i>				
Weight status -> depression	.061	.042		
<i>(direct effect, path c')</i>				
Weight status -> depression	.046**	.011	[.024 ; .069]	.433
<i>(indirect effect, path a × b)</i>				
Class II Obesity				
Weight status -> discrimination	2.612**	.177		
<i>(IV to mediator, path a)</i>				
Discrimination -> depression	.141**	.033		
<i>(mediator to DV, path b)</i>				
Weight status -> depression	.067*	.031		
<i>(total effect, path c)</i>				

Weight status -> depression	.041	.032		
<i>(direct effect, path c')</i>				
Weight status -> depression	.026**	.006	[.013 ; .038]	.389
<i>(indirect effect, path a × b)</i>				

Class I Obesity

Weight status -> discrimination	1.732**	.173		
<i>(IV to mediator, path a)</i>				
Discrimination -> depression	.141**	.033		
<i>(mediator to DV, path b)</i>				
Weight status -> depression	.053*	.024		
<i>(total effect, path c)</i>				
Weight status -> depression	.043	.024		
<i>(direct effect, path c')</i>				
Weight status -> depression	.011**	.003	[.005 ; .016]	.197
<i>(indirect effect, path a × b)</i>				

695 *Note.* Models use z-scores for depressive symptoms outcome variable. Models are adjusted
696 for baseline depressive symptoms, age, age-squared, gender, ethnicity (white vs. other),
697 educational attainment, marital status (married, separated/divorced, widowed, never married)
698 and employment categories (employed, unemployed, homemaker, retired, temporary leave,
699 disabled). * $p < .05$, ** $p < .01$.

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709 **Table 5.** *Mediation Models of the Indirect Effect of Obesity on Changes in Depressive*
 710 *Symptoms through Perceived Weight Discrimination in Study 3 (MIDUS; N = 4,378)*
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	Point Estimate	SE	95% CI Lower ; Upper	Effect ratio
Class III Obesity				
Weight status -> discrimination <i>(IV to mediator, path a)</i>	3.455**	.259		
Discrimination -> depression <i>(mediator to DV, path b)</i>	.152**	.048		
Weight status -> depression <i>(total effect, path c)</i>	.293*	.101		
Weight status -> depression <i>(direct effect, path c')</i>	.212	.104		
Weight status -> depression <i>(indirect effect, path a × b)</i>	.081**	.026	[.028 ; .132]	.273
Class II Obesity				
Weight status -> discrimination <i>(IV to mediator, path a)</i>	2.751**	.193		
Discrimination -> depression <i>(mediator to DV, path b)</i>	.152**	.048		
Weight status -> depression <i>(total effect, path c)</i>	.147*	.069		

Weight status -> depression	.094	.071		
<i>(direct effect, path c')</i>				
Weight status -> depression	.052**	.017	[.018 ; .086]	.356
<i>(indirect effect, path a × b)</i>				

Class I Obesity

Weight status -> discrimination	2.040**	.157		
<i>(IV to mediator, path a)</i>				
Discrimination -> depression	.152**	.048		
<i>(mediator to DV, path b)</i>				
Weight status -> depression	.001	.044		
<i>(total effect, path c)</i>				
Weight status -> depression	-.027	.045		
<i>(direct effect, path c')</i>				
Weight status -> depression	–	–	–	–
<i>(indirect effect, path a × b)</i>				

712 *Note.* Models use z-scores for depressive symptoms outcome variable.
713 Models are adjusted for age, age-squared, gender, ethnicity (white vs. other), educational
714 attainment, marital status (married, separated, divorced, widowed, never married) and
715 employment categories (employed, self-employed, unemployed, laid off, homemaker,
716 student, retired, on leave, permanently disabled, other). * $p < .05$, ** $p < .01$.