

1           **The ageing body: contributing attitudinal factors towards perceptual body size**  
2                                   **estimates in younger and middle-aged women**

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37 **Title:** The ageing body: contributing attitudinal factors towards perceptual body size  
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66 **Declarations**

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68 **Authors' contributions:** VC conceived the study. AB, PC and EM contributed to the concept  
69 and design of the study. AB performed data collection. AB performed the analyses under  
70 supervision of VC and PC. The first draft of the manuscript was written by AB, with input from  
71 VC and PC. All authors approved the manuscript before submission.

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100 **Abstract**

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102 *Objectives:* Over-estimation of body size, a core feature of Eating Disorders (EDs), has been  
103 well-documented both in young healthy and EDs individuals. Yet, evidence that altered body  
104 perception might also affect older women is limited. Here, we examined whether attitudinal  
105 components of body image (i.e., the feelings an individual has about their body size and  
106 shape) might affect perceived actual and ideal body shape self-estimates in midlife, similarly  
107 to younger women.

108

109 *Methods:* Thirty-two younger (mean age: 24.22yrs) and 33 middle-aged (mean age: 53.79yrs)  
110 women took part to a computerised body perception assessment of perceived, actual and ideal  
111 aspects of body image. Body Mass Index (BMI), societal and interpersonal aspects of  
112 appearance ideals, measured by means of Sociocultural Attitudes towards Appearance  
113 Questionnaire (SATAQ-4) and assessment of body uneasiness and concerns for specific body  
114 parts, measured by Body Uneasiness Test (BUT-A/B) scales were also investigated.

115

116 *Results:* Younger and middle-aged women with larger BMI showed greater discrepancy in  
117 perceptual distortions from their perceived actual body size. However, middle-aged women  
118 with greater body-part concerns over-estimated their perceived body size, as opposed to  
119 younger women who were almost accurate. Unlike middle-aged women, younger women  
120 with higher body part concerns desired slimmer ideal body image than their perceived actual.

121

122 *Conclusions:* Results suggest distortions in the perceived actual and ideal body size self-  
123 estimates of younger and middle-aged women are best explained by a combination of BMI,  
124 body parts concerns, and the particular age group to which a participant belonged. In future, a  
125 personalized approach for the assessment of women's perceptions and concerns of specific  
126 body areas during lifespan should be adopted.

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128 **Keywords:** Attitudinal; Perceptual; Body Image; Body size estimates; Middle-aged; BMI;

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134 **Introduction**

135           Body image is a multidimensional construct that represents an individual's conscious  
136 perception of, and attitude towards, their bodily appearance (Arbour & Ginis, 2008;  
137 Reboussin et al., 2000; Tiggemann, 2004). It is strongly associated with an individual's  
138 wellbeing and their satisfaction with life (Donaghue, 2009). According to an influential meta-  
139 analysis by Cash and Deagle (1997), dimensions relevant to the body image construct  
140 substantially include: i) a perceptual component which corresponds to the accuracy with  
141 which an individual can judge the physical dimensions of their own body and ii) an  
142 attitudinal, affective component related to their attitudes and emotions they have about their  
143 body, which may be positive or negative.

144           Excessive concerns about body weight and appearance are common amongst  
145 individuals in western cultures, and presage the development of eating disorders (EDs), such  
146 as anorexia nervosa (AN) and bulimia nervosa (Ricciardelli & McCabe, 2004; Slevec &  
147 Tiggemann, 2011a; Stice, 2002). Typically, individuals with severe body image concerns  
148 focus on the desire to appear thinner (Slevec & Tiggemann, 2011a) and tend to over-estimate  
149 the body size they believe themselves to have (Schuk et al., 2018).

150           Most research into people's body image concerns and eating attitudes has been  
151 conducted in adolescents and young adults, with a particular focus on female university  
152 undergraduates aged 18-24 years (Slevec & Tiggemann, 2011b). This coincides with the  
153 median age of onset for EDs (Hudson et al., 2007; Favaro et al., 2003), with AN being  
154 particularly prevalent in this age group (Smink et al., 2012). Nevertheless, as pointed out by  
155 Saucier (2004) and Tiggemann (2004), comparably high levels of body image concerns may  
156 occur at any age, including women of middle age who represent the focus for the current  
157 study. As with their younger colleagues (Wardle et al., 2006), middle-aged women can  
158 experience negative feelings and attitudes towards their body, such as body dissatisfaction  
159 and drive for thinness (Bane & McAuley, 1998; Longo et al., 2009) along with over-  
160 estimation of their body size (Hayashi et al., 2006, but see Monteath & McCabe, 1997 and  
161 Paul et al., 2015 for opposite results in the general population) leading to an increased risk for  
162 late onset EDs (Marcus et al., 2007; Cumella & Kally, 2008; Hoek, 2006; Slevec &  
163 Tiggemann, 2011a).

164           However, unlike young women, some of the factors giving rise to distorted body  
165 image in middle-age emerge from naturally occurring age-related processes. These include an  
166 increase in body weight/fat distribution due to the menopause and a decrease in muscle mass,  
167 which may also be side effects of different medications (Davis et al., 2012; Genazzani &

168 Gambacciani, 2006; Tchkonina et al., 2010; Vanina et al., 2002). As a result of these natural  
169 occurring age-related changes in their body shape, middle-aged women may exert more of a  
170 need for slimmer weight control to be classed as ‘attractive’, as they still show attentiveness  
171 towards their bodily appearance (Lewis & Cachelin, 2001; McCabe et al., 2007; Pruis &  
172 Janowsky, 2010). Linked to the need to maintain a thinner body size, Marcus and colleagues  
173 (2007) have identified an increase in the number of middle-aged women being diagnosed  
174 with an EDs i.e., 175 out of 589 Middle-aged women of various ethnicities reported having  
175 an ED, predominately AN.

176 Furthermore, although several studies suggest body image in younger women is more  
177 susceptible to societal influence to attain a slim physique than in older women (Lewis &  
178 Cachelin, 2001), others reported that societal influence is also a predictor of body  
179 dissatisfaction, drive for thinness, and body shape concerns in older women (Pruis &  
180 Janowsky, 2010). This suggests that societal influence is an important factor in the  
181 development and maintenance of negative attitudes towards body image of older women, and  
182 that it may be pertinent to understanding body image in this age group.

183 Put together, findings like these suggest the need for further research specifically  
184 targeting middle-aged women. By shedding light on the perceptual mechanisms and women’s  
185 attitudes and feelings towards their body shape, it might be possible to provide further insight  
186 into the predictive factors that may trigger, maintain and exacerbate symptoms in those  
187 psychiatric conditions characterised by body image disturbances (e.g., EDs and Body  
188 Dysmorphic Disorders) and hopefully contribute to the development of novel individualised  
189 body image treatments in lifespan.

190

## 191 **The Current Study**

192

193 In this study, we aimed at investigating whether performance in tasks that measure  
194 perceptual (i.e., participants’ estimates of their own body shape) and attitudinal aspects (i.e.,  
195 feelings and attitudes towards body shape and size) of body image, that are relevant to the  
196 development of EDs symptomatology, are essentially the same or different in younger  
197 compared to middle-aged women. With this aim, in separate samples of younger and middle-  
198 aged women, we assessed perceptual self-estimates of perceived current (i.e., ‘How do you  
199 think you look like?’) and ideal (i.e., ‘How would you like to appear?’) body shapes, by  
200 means of a unique 2D digital computer-based distortion optical method, the Body Image  
201 Revealer (BIR, Mian & Gerbino, 2009). In addition, we obtained measures of women’s

202 attitudinal body image, by means of a battery of standard self-report scales to index women's  
203 feelings and attitudes towards their body shape and beauty ideals. With these regards, we felt  
204 it was important to have a wider range of self-report scales than has often been the case in  
205 similar studies of younger women. For example, in three such studies, Cornelissen and  
206 colleagues used the Beck Depression Inventory, the Rosenberg Self Esteem scale, the Body  
207 Shape Questionnaire, and the Eating Disorder Examination Questionnaire to measure  
208 participants' attitudes to body shape, weight, eating, self-esteem and depressive  
209 symptomatology (Cornelissen et al., 2015, 2017; Irvine et al., 2018). In each study, a  
210 principal component analysis (PCA) of the psychometric responses showed that the data  
211 could be compressed onto a *single* principal component, or dimension, suggesting a rather  
212 restricted view of participants' attitudinal body image. Therefore, here we chose a wider  
213 spectrum of measurement including a measure of the cultural and interpersonal risk factors,  
214 such as internalization of appearance ideals and appearance-related pressures which have  
215 been implicated in the aetiology of negative body image and eating pathology (Cafri et al.,  
216 2005; Stice, 2002), here assessed by means of the Sociocultural Attitudes Towards  
217 Appearance Questionnaire-4 (SATAQ-4, Schaefer et al., 2015). Furthermore, given that  
218 healthy and clinical populations often report great dissatisfaction with body areas like weight  
219 and torso (lower, mid and upper) (see Rosen & Ramirez, 1998; Hrabosky et al., 2009), but  
220 also buttocks/hips/thighs, stomach and waist regions (Toh et al., 2019; Ralph-Nearman et al.,  
221 2019), we administered a measure of body uneasiness and dissatisfaction for the whole body  
222 and for specific body parts, by means of the Body Uneasiness Test (BUT, Cuzzolaro et al.,  
223 1999). Anthropometric measures of Body Mass Index (BMI) were also measured. Finally, we  
224 applied a multivariate analysis to investigate how similar was the pattern of responses across  
225 the two age groups.

226 Consistent with the view of a multidimensional model of body image (Cash & Deagle,  
227 1987), we expected that perceptual self-estimates of perceived current and ideal body shape  
228 should best be predicted by a combination of participants own' BMI and their attitudes and  
229 feelings towards their body shape/body parts, as well as internalization of beauty ideals. In  
230 agreement with Pruis and Janowsky' results (2010) which provided evidence that ratings of  
231 body image do not differ in normal, healthy younger and older women when personalized  
232 measures of body shape assessment (in their study women's responses to line drawings of  
233 bodies in the Figure Ratings Scale), are used, we also expected that BMI and body shape  
234 concerns would be predictive of women's perceptual body size estimates in a way that should  
235 be similar in both age groups. However, consistent with studies suggesting stronger societal

236 influence on body image in younger than older women, particularly pressure to conform to  
237 the media ideal of women's bodies (Bedford & Johnson, 2006; Lewis & Cachelin, 2001), we  
238 expected younger women's perceptual body size estimates to be more influenced by their  
239 levels of societal influence and pressures to attain a slim physique, compared to older women.

240

## 241 **Materials and Methods**

242

### 243 **Participants**

244 Sample size calculation was based on the data from Irvine et al. (2019). In this study, 100  
245 healthy adult women carried out a number of tasks including a psychophysical procedure for  
246 self-estimation of body size, they had their BMI measured and they carried out the body  
247 shape questionnaire (BSQ; Evans & Dolan, 1993). First, we calculated multiple regression  
248 analyses in which body size self-estimation was predicted from a combination of BMI and  
249 BSQ. Then, we used PROC POWER in SAS v9.4 (SAS Institute, North Carolina, USA) to  
250 calculate sample sizes appropriate to estimate the effects of BMI and separately, BSQ, at an  
251 alpha value = 0.01, and a power = 0.8. This rendered integer sample sizes for BMI and BSQ  
252 of 23 and 59 respectively. To offset attrition in participant numbers and/or unexpected  
253 sources of variability, we therefore recruited a total of 65 females (as assigned at birth) to the  
254 study who gave their written consent to take part.

255 Participants, who self-identified as Caucasian, were preselected and assigned to two  
256 groups based upon age: 32 participants were recruited to the younger women's group (age  $M$   
257 = 24.22 yrs,  $SD$  = 4.51 yrs, range: 18-37yrs) and 33 participants were recruited to the middle-  
258 aged women's group (age  $M$  = 53.79 yrs,  $SD$  = 3.72 yrs, range: 47-65 yrs, see Table 2). All  
259 participants were recruited externally through poster advertisements situated in public  
260 locations, social media and through individuals known to the researcher. Younger women  
261 were also recruited internally through the \*\*\* Psychology SONA participation scheme for  
262 undergraduate Psychology students. Middle-aged women were also recruited internally  
263 through members of staff at \*\*\*. Furthermore, some middle-aged women that had been in  
264 prior lab studies (unrelated to body image) were contacted from our database of previous  
265 study participants (Psychology Research Participants Panel). All participants were provided  
266 with an information sheet prior to investigation, in order to check for eligibility based on the  
267 study inclusion criteria, which was also confirmed on the day of the experiment. Participants  
268 were only eligible to take part if they (self)reported not to have any history of neurological or  
269 psychiatric disorders, including EDs, had normal or corrected visual acuity, and were not



270 pregnant. As an incentive, participants either received SONA (participation point scheme)  
271 points (if undergraduate students) and/or £10 in shopping vouchers. Younger women's BMIs  
272 ranged between 17.73 and 33.18 ( $M = 22.74$ ,  $SD = 4.36$ ) and fell into the following WHO  
273 categories: 4 underweight, 20 normal, 5 overweight and 3 obese. Middle-aged women's  
274 BMIs ranged between 18.93 and 38.83 ( $M = 27.16$ ,  $SD = 5.13$ ) and fell into the following  
275 WHO categories: 15 normal, 7 overweight, 7 obese and 4 severely obese. The study's  
276 experimental procedures and methods were fully approved by \*\*\* Research Ethics Board and  
277 complied with the ethical standards of the 1964 Declaration of Helsinki.

278

### 279 **Assessment of body image**

280

#### 281 **Sociocultural Attitudes towards Appearance Questionnaire**

282 The Sociocultural Attitudes towards Appearance Questionnaire-4 (SATAQ-4,  
283 Thompson et al., 2004) measures a woman's drive to attain attractiveness ideals dictated by  
284 societal influence (Schaefer et al., 2015). For SATAQ-4, participants evaluated each of the 22  
285 items on a 5-point scale (from 1 = definitely disagree to 5 = definitely agree). The  
286 questionnaire comprises of 4 subscales: internalization athletic, internalization body fat,  
287 pressures from family, pressures from peers, and pressures from the media (Thompson et al.,  
288 2004). This questionnaire had good internal consistency with Cronbach's alpha 0.81.

289

#### 290 **Body Uneasiness Test**

291 The Body Uneasiness Test (Cuzzolaro et al., 2006) is considered a valuable tool for  
292 the screening and for the clinical assessment of abnormal body image attitudes and EDs.  
293 Particularly, it assesses body uneasiness and dissatisfaction with the whole body, as well as  
294 specific body parts. It comprises of 34 questions about body experiences (BUT-A) and 37  
295 questions about an individual's dislike of particular body parts (BUT-B). BUT-A is divided  
296 into 5 sub-scales: weight phobia (BUT-WP), dissatisfaction regarding the body and its  
297 weight, body image concerns (BUT-BIC), avoiding and compulsive self-monitoring  
298 behaviour (BUT-AV, BUT-CSM) and experience of depersonalization, defined as separation  
299 and foreignness regarding the body (BUT-D). These scores can be combined into a Global  
300 Severity Index (GSI, the average rating of all 34 items constituting the BUT-A), which  
301 indicates severity of abnormal body image concerns and eating behaviours. Each question is  
302 indexed by a 6-point Likert scale, from 0 representing 'never' to 5 representing 'always'.  
303 Higher scores indicate greater body uneasiness.

304 BUT-B measures specific worries about particular body parts, shapes or functions  
305 (e.g., mouth or skin). These scores are arranged into a Positive Symptom Total (PST, the  
306 number of symptoms rated higher than zero) and a Positive Distress Symptom Index (PDSI,  
307 the average rating of those items constituting the PST). A 6-point Likert scale, which ranges  
308 from 0 (never) to 5 (always) indicating how often participants happen to dislike each  
309 experience or part of their body, is used. The Body Uneasiness Test showed good internal  
310 consistency with Cronbach's alpha 0.90.

311

### 312 **Body Mass Index**

313 Each participant's actual body mass index (BMI) was physically measured and  
314 calculated from their weight and height by using a calibrated bioimpedance digital scale  
315 (OMRON BF511) for weight and a stadiometer for height.

316

### 317 **Body Image Revealer**

318 Perceived actual and ideal body size estimates were obtained by means of a computer-  
319 based method, which mimics changes in adiposity by simulating an optical distortion of the  
320 body. Known as the 'Body Image Revealer' (BIR; Mian & Gerbino, 2009; Cazzato et al.,  
321 2015, 2016; Zamariola et al., 2017), this technique provides a measure of the discrepancy  
322 between the dimensions of the real image and the sizes attributed by the participant during  
323 the task. The BIR has good ecological validity because it gives participants the experience  
324 equivalent to looking at their whole body in a mirror.

325 To generate the experimental stimuli, a frontal picture of each participant, standing in  
326 a T-pose, was taken with a Panasonic TZ5 Lumix digital camera from a distance of 2 metres.  
327 Participants wore skin-tight clothing to ensure that their body outline was clearly visible. The  
328 image of a participant's was then extracted from the background in the raw image, using  
329 Photoshop v7.0, and replaced on a standard white background for further image manipulation  
330 in BIR. Once modified, the image was opened in the software and the experimenter selected  
331 the parts that would be modified, that is from the neck to the feet (but excluding the face and  
332 the arms). Importantly, whilst the experimenter was modifying the real picture, participants  
333 were instructed to look away from the PC monitor, so they were not aware of the body  
334 alteration. Importantly, the ecological validity of the test was increased by keeping the  
335 participants' face in the final images. This way, the procedure was giving the sense that  
336 participants were looking at themselves in the mirror (see Fig. 1 and Online Resource 1 for  
337 more details).

338

339 -----Please insert Figure 1 here -----

340

341 **Procedure**

342 During the experimental session, consenting participants' height and weight was  
343 physically measured by using a calibrated bioimpedance digital scale and a stadiometer and  
344 then their portrait taken. While this image was being edited, participants completed the  
345 demographic questionnaires. Once completed, participants were sat 55 cm in front of the  
346 display monitor and were asked to adjust their image according to two tasks read out to them:  
347 Perceived Actual body image ('How do you think you look like?') and Ideal body image  
348 ('How would you like to appear?'). By pressing the plus (+) or minus (-) key on the  
349 keyboard, participants were able to increase or decrease the apparent adiposity of the image  
350 within a possible range of  $\pm 50\%$  in 1% increments/decrements (see Online Resource 1).  
351 Participants could adjust the degree of distortion of the picture as much as they wanted. After  
352 completion of the two self-body distortion tasks, participants were instructed to fill out the  
353 BUT-A/B and SATAQ-4 questionnaires. Overall, testing lasted 45 minutes.

354

355 **Statistical Analyses**

356 All statistical analyses were conducted using SAS v9.4 (SAS Institute, North  
357 Carolina, USA). In keeping with previous studies (Cazzato et al., 2014, 2016), the average  
358 percentage body percentage distortion (%BDS) was calculated across all trials, separately for  
359 each individual and the two tasks (i.e., perceived actual body size, ideal body size).

360 We wanted to model the relationships between participants' estimates of their  
361 perceived actual and ideal body size predicted from participants' AGE. In addition, we  
362 wanted to control for any influence of BMI and the psychometric variables (BUT-A/B and  
363 SATAQ-4). In order to avoid the possibility of introducing substantial variance inflation into  
364 the models, we first checked for evidence of co-linearity amongst the psychometric variables.

365 We used PROC CORR in SAS v9.4 to compute Pearson's correlations between all  
366 self-report psychometric task subscales, to look for potential association within and between  
367 the responses to the BUT-A, BUT-B, and SATAQ-4. Given that this analysis demonstrated  
368 substantial correlations amongst these variables (see Table 1), we then used PROC FACTOR  
369 in SAS v9.4 to carry out a PCA on this correlation matrix, to identify the smallest number of  
370 statistically independent dimensions in the psychometric tasks that we could use as covariates  
371 in our multivariate analysis, and avoid variance inflation due to multicollinearity amongst

372 explanatory variables. We found four components, corresponding to: i) the body part  
373 responses in the BUT (referred to henceforth as BUT-Parts); ii) attitudinal responses in the  
374 BUT (referred to henceforth as BUT-Att); iii) responses related to social pressure from the  
375 SATAQ-4 (referred to henceforth as SATAQ-Press); iv) responses related to internalization  
376 from the SATAQ-4 (referred to henceforth as SATAQ-Int) (see Online Resource 2).

377 In the last step, we used PROC MIXED in SAS v9.4 to build separate linear mixed  
378 effects models of percentage distortion for perceived actual and ideal body size judgements.  
379 For each model we included as putative fixed effects: age, BMI, BUT-Parts, BUT-Att,  
380 SATAQ-Press, and SATAQ-Int, all of which were continuous explanatory variables.  
381 Critically, we also tested all possible two-way interaction terms. Note that for the sake of  
382 easy visualisation, instead of illustrating the response surface from the statistical models as  
383 continuous 3D surface plots, consistent with the data, we plotted 2D slices through these  
384 response surfaces which show the data separated into two age groups (see Fig. 2a and 2b).

385

386 -----Please insert Table 1 here-----

387

## 388 **Results**

389

### 390 **Univariate Statistics**

391

392 Table 2 shows means and standard deviations for the demographic and psychometric  
393 questionnaire subscale scores, separately for younger and middle-aged women. The right-  
394 hand column of Table 2 shows the output of pairwise comparisons between these two groups,  
395 adjusted for multiple comparisons, using the permutation method in PROC MULTEST (SAS  
396 262 v9.4). Middle-aged women were indeed significantly older, had higher BMIs, and  
397 reported greater concerns on the thighs sub-scale of the BUT-B (this includes questions  
398 about: stomach, abdomen, hips, thighs, and knees) than younger women.

399 Additional demographic characteristics (ethnicity, handedness, and regular menstrual  
400 cycle) are reported in Table 3. We conducted a Chi-Square analysis between young and  
401 middle-aged women to investigate whether there were any differences in characteristics  
402 between these two groups. There were no significant differences for ethnicity ( $\chi^2_1 = 2.00$ ;  $p =$   
403  $.157$ ) and handedness ( $\chi^2_1 = 2.60$ ;  $p = .107$ ) between groups. As expected, there was a  
404 significant difference for regular menstrual cycle ( $\chi^2_1 = 32.32$ ;  $p < .001$ ) between groups.

405

406 -----Please insert Table 2 here-----

407 -----Please insert Table 3 here-----

408

### 409 **Perceived Actual Body Size**

410

411 Table 4 shows the correlation matrices between the four principal components (BUT-  
412 Parts, BUT-Att, SATAQ-Press, SATAQ-Int), age, BMI, and percentage distortion for  
413 participants' estimates of their perceived actual body size (%BDS), calculated separately for  
414 younger and middle-aged women.

415 For middle-aged women, percentage distortion for their perceived actual body size  
416 was significantly, positively correlated with BMI, BUT-Parts and BUT-Att, but not with  
417 SATAQ-Press or SATAQ-Int. BMI was significantly, positively correlated with BUT-Att and  
418 SATAQ-Press but not with BUT-Parts or SATAQ-Int. For the younger women, percentage  
419 distortion (%BDS) for the perceived actual body size was significantly, positively correlated  
420 with BMI and SATAQ-Press, but not with any other component. BMI was significantly,  
421 positively correlated with BUT-Parts, BUT-Att, and SATAQ-Press, but not SATAQ-Int (see  
422 Table 4).

423

424 -----Please insert Table 4 here-----

425

426 We used PROC MIXED (SAS v9.4) to model percentage distortion for perceived  
427 actual body size. We found statistically significant main effects of BMI,  $F(1,60) = 17.19$ ,  
428  $p < .001$ , and BUT-Parts,  $F(1,60) = 7.31$ ,  $p = .01$ . Critically, however, the effect of BUT-  
429 Parts was age dependent, because we found a significant interaction between age and  
430 BUT-Parts,  $F(1,60) = 12.13$ ,  $p < .001$ .

431 Figure 2a shows clearly that over-estimation of perceived actual body size increases  
432 as a function of increasing concerns about body parts in middle-aged women. Statistically,  
433 however, there is no relationship between percentage distortion and BUT-Parts for  
434 younger women,  $F(1, 28) = 3.14$ ,  $p = .087$ . Moreover, since the 95% CI for their regression  
435 line includes 0% body distortion, we conclude that these groups were mostly accurate in their  
436 judgments.

437 Figure 2b shows plots of percentage distortion for perceived actual body size as a  
438 function of participants' BMI, with the same colour scheme for younger and middle-aged  
439 women. Statistically, the two groups were indistinguishable, and showed a significant

440 tendency to over-estimate their perceived actual body size with increasing BMI. These  
441 results suggest that distortions in perceived actual body size estimation of younger and  
442 middle-aged women are best explained by a combination of BMI, concern for body parts,  
443 and the particular age group to which a participant belonged.

444

### 445 **Ideal Body Size**

446

447 Table 5 shows the correlation matrices between the four principal components (BUT-  
448 Parts, BUT-Att, SATAQ-Press, SATAQ-Int), age, BMI, and percentage distortion for  
449 participants' estimates of their ideal body size, calculated separately for younger and middle-  
450 aged women.

451 For middle-aged women, percentage distortion for their ideal body size was not  
452 significantly correlated with BMI or any principal component. BMI was significantly,  
453 positively correlated with BUT-Att and SATAQ-Press, but not with BUT-Parts or SATAQ-  
454 Int. For the younger women, percentage distortion was significantly, negatively correlated  
455 with BUT-Parts, but neither with BMI nor any other component. BMI was significantly,  
456 positively correlated with BUT-Parts, BUT-Att and SATAQ-Press, but not with SATAQ-Int  
457 (see Table 5).

458

459 -----Please insert Table 5 here-----

460

461 We used PROC MIXED (SAS v9.4) to model percentage distortion for ideal body  
462 size. We found significant main effects of BUT-Parts,  $F(1,61) = 8.82, p = .004$ , and Age,  
463  $F(1,61) = 4.83, p = .03$ , as well as a significant interaction between Age and BUT-Parts,  
464  $F(1,61) = 6.85, p = .01$ . Figure 2c clearly shows that as younger women's body part  
465 concerns increase, their ideal body size becomes progressively slimmer. By contrast,  
466 middle-aged women selected a slimmer ideal, irrespective of their body concerns, since  
467 the regression of percentage distortion on BUT-Parts has a substantially negative intercept,  
468 together with a regression slope no different from zero,  $F(1, 30) = 0.06, p = 0.816$ .

469

470 -----Please insert Figure 2 here -----

471

### 472 **Discussion**

473

474 To our knowledge, this is the first study to use a personalised assessment, 2D optical  
475 distortion method, to compare young and middle-aged women's perceptual performance of  
476 their perceived actual and ideal body image. Our analyses included also anthropometric  
477 covariates, such as BMI, body dissatisfaction and sociocultural influences, which are all  
478 factors that are well-known contributors to the aetiology and development of EDs (Culbert et  
479 al.,2015; Pedersen et al., 2018) during lifespan. Ultimately, we investigated if specific  
480 differences in negative attitudinal components of body image, i.e., beauty ideals/pressures  
481 and body-related concerns, may interact with women' age and may affect body image  
482 perceptual self-estimates in a way which is substantially different in younger and middle-  
483 aged women. In line with a multidimensional model of body image according to which the  
484 size someone believes themselves to be is a combination of attitudinal and perceptual factors  
485 (Cash & Deagle, 1997), our results suggest that the accuracy of women's judgments of their  
486 perceived current and ideal body shape is modulated by the age group they belong to and  
487 negative attitudes towards their bodies, particularly their concerns for body parts.

488

### 489 **Perceived Actual Body Image**

490 In agreement with studies reporting that women in the general population may  
491 overestimate their body size (Johnson et al., 2008), but in disagreement with other findings  
492 that instead suggest that women tend to underestimate their body size in the general  
493 population (Monteath & McCabe, 1997; Robinson, 2017), we found that middle-aged women  
494 with greater body parts concerns reported greater over-estimations in the perception of their  
495 perceived actual body image. We did not observe the same outcome in younger women, who  
496 were almost accurate. Similar results were also obtained by Deeks and McCabe (2001) who  
497 reported that when middle-aged women were asked to pick a 'silhouette' which best  
498 corresponded to their perceived actual body size, they chose a larger figure than was  
499 objectively true. Critically and consistent with our findings, in Deeks and McCabe (2001)'  
500 study, it was middle-aged women who displayed higher dissatisfaction with specific body  
501 parts (lower and mid torso). As these regions are typically judged as larger than their actual  
502 size (Smeets et al., 2009) possibly due to these areas being more prone to the effects of aging  
503 (Genazzani & Gambacciani, 2006; Vanina et al., 2002), it may be plausible that  
504 overestimation of body size for middle-aged women may have occurred if focus was placed  
505 on those body parts of greater concern, when making their judgements (Kittler et al., 2007).

506 Both younger and middle-aged women over-estimate their perceived current body  
507 size with increasing BMI, thus suggesting that as BMI increases over the lifetime, this factor

508 continues to influence body image perceptions similarly (Holsen et al., 2012). This finding is  
509 in line with research by Wardle et al. (2006), who found that even young women with healthy  
510 BMI inaccurately overestimated their body size. Likewise, as found in Thaler et al. (2018),  
511 Toveé et al. (2003) and Zamariola et al. (2017), estimation of perceived actual body size was  
512 predicted by BMI, so that women with higher BMI's demonstrated an overestimated  
513 perception of their perceived actual body image.

514 A possible explanation for this finding is that body size distortion could occur as a  
515 result of an individual's real body weight, as well as societal pressures to obtain a thin body  
516 size. Particularly women with higher BMI's may have had greater discrepancies in their  
517 ability to estimate their own body size, as they may perceive their body to be significantly  
518 larger than what society classes as thin, which as a result may distort their own mental image  
519 of the self (Arciszewski et al., 2012; Zamariola et al., 2017). Societal stigmatisation of greater  
520 weight may have also fed into body image concerns for these women, which has been  
521 previously associated with overestimations of body size (Thaler et al., 2018).

522 An additional explanation could be that as larger body sizes are more typical in  
523 middle-aged women of Western societies (Sowers et al., 2007), this may have impacted and  
524 altered perceptions of a body silhouette classed as the 'norm', compared to a body size  
525 classed as being overweight (Robinson, 2007; Robinson & Kirkham, 2014).

526 Indeed, according to the 'Social Comparison Theory' individuals make constantly  
527 evaluations about physical characteristics, such as body size by looking at the appearance of  
528 those around us, which in turn may provide an internal standard (norm) or internal  
529 representation of what is normal (Festinger, 1954; Mussweiler, 2003). With these regards, the  
530 on-going obesity epidemic in both non-developing and developing countries, might have led  
531 to a recalibration of body shape and particular to a perception that larger body sizes are  
532 considered as 'normal'. If this was the case, then this altered shift in standard models of  
533 different BMI classifications may have caused an overestimated shift in perceived actual  
534 body size estimations, if middle-aged women used these standard models to base their  
535 judgements on their own body.

536 Nevertheless, for younger women only, we found a positive association with  
537 sociocultural influences i.e. pressures from the media, family and peers (SATAQ-Press) with  
538 an increase in perceived actual body image distortions. This is in line with previous research  
539 reporting that although middle-aged women still care for their bodily appearance, they are  
540 less influenced from societal pressures compared to younger women, who are more  
541 influenced by these pressures (Pruis & Janowsky, 2010; Lewis & Cachelin, 2001). This could



542 be due to differences concerning traditional (television) and Social Media exposure  
543 (Facebook, Instagram), with younger women having more exposure than middle-aged women  
544 (Baugh, 2009; Wadsworth & Johnson, 2008).

545

### 546 **Ideal Body Image**

547 In the present study, both younger and middle-aged women consistently preferred a  
548 slimmer body size when asked to judge how they would like to appear, a result which is  
549 largely in agreement with the current literature (Baugh, 2009; Lewis & Cachelin, 2001;  
550 McCabe et al., 2007; Pruis & Janowsky, 2010). Interestingly, as younger women's body part  
551 concerns increase, their ideal body becomes progressively slimmer. By contrast, middle-aged  
552 women selected a slimmer ideal, irrespective of their body concerns.

553 One possible explanation for this finding is that younger women may have placed a  
554 greater importance for attractiveness on specific body parts, which prior research has found to  
555 be in the lower region of the body, i.e. stomach and thighs (Irvine et al., 2019; Stanford &  
556 McCabe, 2002; Ralph-Nearman et al., 2019). If young women believe their body parts are not  
557 similar to what they perceive to be attractive in terms of size, then their desire to be thinner  
558 will be greater (Stanford & McCabe, 2002). Furthermore, 'Thinspiration', a class of body-  
559 idealising content that currently has emerged on social media, seems to be more important for  
560 younger females, leading to young women to generally compare various body parts of the  
561 'ideal model' to their own (Griffiths et al., 2018).

562 For both younger and middle-aged women, there was no effect of BMI on their ideal  
563 body image perceptual self-estimates. This is somehow surprising since it was expected,  
564 particularly for the middle-aged women, a relationship with higher BMI and ideal body  
565 image distortions, as middle-aged women were also those women who showed greater  
566 distortion in their perceived actual body size. Also, previous research has emphasised how  
567 BMI can account for body dissatisfaction in middle-aged women (Algars et al., 2009; Dunkel  
568 et al., 2010; McKinley & Lyon, 2008) which results in a greater drive for thinness (Keski-  
569 Rahkonen et al., 2005; Lewis & Cachelin, 2001). Instead, our findings are in line with Pruis  
570 and Janowsky (2010) in that BMI was not a predictor of ideal body image in older women. In  
571 addition, it offers support for findings of Cheung et al. (2011), in that majority of women  
572 with healthy BMI still have a desire for a slimmer body physique. Therefore, it is not just  
573 women with higher BMIs who have a greater desire for a slimmer ideal body, but also  
574 females with normal range BMIs. Moreover, as suggested by Cheung et al. (2011), it could  
575 be plausible that ideal body image is more influenced by factors such as body self-esteem,

576 which contribute towards body dissatisfaction and that BMI is less important in influencing  
577 an individual's ideal body image.

578

### 579 **Limitations**

580 Certain limitations of the present study should also be acknowledged.

581 First, although the BIR software has been proved to be successful in investigating  
582 perceptual body image in healthy and EDs populations (see Cazzato et al., 2014, 2016;  
583 Zamariola et al., 2017), and is ecologically valid in the sense that it resembles a person's  
584 mirror image, nevertheless the program does not adjust an individual's arms or face.  
585 Therefore, particularly at the extremes of thinness and fatness, there may be image distortions  
586 – i.e. departures from an ecologically valid image - which may cause participants to adopt a  
587 compensatory strategy, whereby participants' judgements of the apparent body size of the  
588 person in the stimulus might be based on the computation of surface area, or perhaps  
589 perimeter-area ratio. Yet, we believe it is unlikely that the BIR inability of altering the face  
590 and/or the arms of participants might have affected differently the two samples of women,  
591 given that both groups displayed (low) similar levels of concerns for such body parts (as  
592 measured by the BUT-B). Nevertheless, we believe that keeping participants' face during the  
593 perceptual tasks might have added strength to the individualised assessment procedure, as it  
594 might have improved the ecological validity of the test and reinforced women's self-body  
595 identification during task performance.

596 Yet, it would be beneficial in future studies to investigate body image perception  
597 using stimulus images that do not have the limitations listed above. For example, in previous  
598 research of Cornelissen et al. (2017), different 3D avatars were generated depicting realistic  
599 BMI physiques. As well as more realistic 3D representations (see Keizer et al., 2016, for a  
600 clinical application of full body VR in EDs), this software should enable all body parts to be  
601 adjusted so as to represent a more accurate reflection of varying body sizes and that  
602 individuals can view more than just a frontal perspective. This is especially important  
603 considering the natural occurring age-related changes in older women which result in  
604 different body composition and fat distribution than younger women (Genazzani &  
605 Gambacciani, 2006; Hughes et al., 2004).

606 With these regards, a recent study from Ralph-Nearman and colleagues (2019) has  
607 tested the feasibility of a novel mobile tool, the so called 'Somatomap' that allows  
608 individuals to visually represent their perception of body-part sizes and shapes, as well as  
609 areas of body concerns and record the emotional valence of concerns. In light of the results of

610 our current study which highlight the importance of addressing specific body parts concerns  
611 in women and related visual size (mis)perceptions, it would be extremely useful to adopt a  
612 tool with such properties when assessing multiple components of body image across life span  
613 in future.

614 Second, although previous studies of Cornelissen and co-authors (Cornelissen et al.,  
615 2015, 2017; Irvine et al., 2018) demonstrated that attitudinal components of body image can  
616 be compressed into a *single* principal component reflecting variation in attitudes to body  
617 shape, weight and eating, self-esteem, and tendency to depression, yet in this study we did  
618 not include a measure of self-esteem and depression which could have mediated the need to  
619 appear thinner. With these regards, albeit no evidence for a specific role of self-esteem has  
620 been reported when investigating specific age-related differences in perceptual body image in  
621 previous investigations, yet it would be interesting to investigate in the future the link  
622 between self-esteem and body image concerns (Stapleton et al., 2017), as well as repeated  
623 dieting behaviours in older women.

624

## 625 **Conclusions**

626 Despite the limitations discussed, the present study provided, for the first time,  
627 evidence that performance at tasks that measure perceptual and attitudinal components of  
628 body image are essentially different in young and middle-aged women. Most importantly, we  
629 have demonstrated that distortions in perceived actual and ideal body size estimation of  
630 younger and middle-aged women are best explained by a combination of BMI, concern for  
631 body parts, and the particular age group to which a participant belonged.

632 Overall, these results suggest that women regardless of age, show perceptual and  
633 attitudinal body image distortions, yet it is important to focus on specific concerns towards  
634 body parts, which accounts for perceived actual body image perceptions for middle-aged  
635 women and a desire to appear slimmer for young women. Thus, this study highlights the need  
636 for a multidimensional and personalized computerised approach for studies of body image in  
637 women across lifespan, which includes women of a variety of ages and a multitude of  
638 potential attitudinal factors of body image, as well as women's perceptions and concerns of  
639 specific body areas.

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643

644 **Compliance with Ethical Standards**

645

646 **Conflict of interests:** The authors declare no conflict of interest.

647

648 **Ethical approval:** All procedures performed in studies involving human participants were in  
649 accordance with the ethical standards of the institutional research committee and with the 1964  
650 Helsinki declaration and its later amendments or comparable ethical standards.

651

652 **Informed consent:** Informed consent was obtained from all individual participants included  
653 in the study.

654

655 **Data availability:** The datasets analysed during the current study are not publicly available  
656 due lacking participant consent for data-sharing with third parties (according to our current  
657 General Data Protection Regulation, GDPR), but are available from the corresponding author  
658 on reasonable request.

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**Table 1.** Pearson's correlation coefficients for the inter-correlations for BMI and the 18 subscales of the self-report questionnaires for both young and middle-aged women combined.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 BMI	-																	
2 SATAQ_INTT	0.14	-																
3 SATAQ_INTM	-0.14	0.54***	-															
4 SATAQ_FP	0.50***	0.32**	0.05	-														
5 SATAQ_PP	0.36**	0.45**	0.37**	0.63***	-													
6 SATAQ_PM	0.40**	0.24*	0.09	0.33**	0.31*	-												
7 BUT_BIC	0.67***	0.40**	0.11	0.40**	0.39**	0.50***	-											
8 BUT_A	0.59***	0.32**	0.06	0.35**	0.38**	0.33**	0.84***	-										
9 BUT_CSM	0.28*	0.52***	0.38**	0.24	0.45**	0.39**	0.70***	0.61***	-									
10 BUT_D	0.27*	0.41**	0.31*	0.11	0.29*	0.18	0.58***	0.64***	0.76***	-								
11 BUT_WP	0.54***	0.41**	0.10	0.25*	0.36**	0.51***	0.88***	0.76***	0.81***	0.71***	-							
12 BUT_M	0.22	0.42**	0.35**	0.20	0.31*	0.28*	0.52***	0.43**	0.58***	0.47***	0.54***	-						
13 BUT_FS	0.35**	0.37**	0.16	0.30*	0.31**	0.29*	0.58***	0.51***	0.62***	0.56***	0.65***	0.66***	-					
14 BUT_TH	0.67***	0.24	-0.04	0.41**	0.32*	0.44**	0.69***	0.58***	0.52***	0.37**	0.67***	0.52***	0.62***	-				
15 BUT_L	0.40**	0.40**	0.18	0.21	0.27*	0.41**	0.61***	0.47***	0.62***	0.50***	0.69***	0.70***	0.70***	0.71***	-			
16 BUT_H	0.34**	0.33**	0.04	0.25*	0.25	0.37**	0.62***	0.55***	0.59***	0.44**	0.69***	0.73***	0.80***	0.66***	0.78***	-		
17 BUT_MOU	0.23	0.23	0.07	0.08	0.15	0.15	0.41**	0.30*	0.49***	0.36**	0.45**	0.38**	0.52***	0.35**	0.44**	0.43**	-	
18 BUT_SK	0.16	0.35**	0.26*	0.15	0.39**	0.25*	0.50***	0.41**	0.66***	0.56***	0.56***	0.57***	0.63***	0.47***	0.55***	0.57***	0.37**	-
19 BUT_BLU	0.31*	0.30*	0.22	0.31*	0.33**	0.27*	0.45**	0.40**	0.56***	0.50***	0.52***	0.52***	0.72***	0.52***	0.58***	0.64***	0.51***	0.52***

\*= p<.05, \*\*= p<.01, \*\*\*= p<.0001

Note: BMI= Body Mass Index; SATAQ= Sociocultural Attitudes Towards Appearance Questionnaire; BUT= Body Uneasiness Test;

INTT= Internalisation-Thin/low body fat; INTM= Internalisation-Muscular/athletic; FP=Family Pressures; PP= Peer Pressures; PM= Pressures Media; BIC= Body Image Concerns; A= Avoidance; CSM= Compulsive Self-Monitoring; D= Depolarisation; WP= Weight Phobia; M= Mouth; FS= Face Shape; TH= Thighs; L= Legs; H= Harms; MOU= Moustache; SK= Skin; BLU= Blushing.

**Table 2.** Demographic and psychometric responses from middle-aged (n= 33) women and younger women (n= 33).

	Middle-aged (n= 33) <i>M (SD)</i>	Younger (n= 32) <i>M (SD)</i>	Middle-aged vs. younger <i>p</i>
Age (years)	53.79 (3.72)	24.22 (4.51)	<.001
BMI (kg/m <sup>2</sup> )	27.16 (5.13)	22.74 (4.36)	<.005
<b>SATAQ-4</b>			
Internalization- Thin/Low body fat (max 5)	2.62 (1.03)	2.89 (0.68)	ns
Internalization- Muscular/ Athletic (max 5)	2.16 (0.98)	2.56 (1.07)	ns
Pressures-Family (max 5)	2.08 (1.22)	1.80 (1.04)	ns
Pressures-Peers (max 5)	1.98 (1.20)	1.76 (1.02)	ns
Pressures-Media (max 5)	3.44 (1.39)	3.16 (1.33)	ns
<b>BUT-A</b>			
Body Image Concern (max 5)	1.90 (0.93)	1.45 (1.07)	ns
Avoidance (max 5)	0.87 (0.75)	0.51 (0.74)	ns
Compulsive Self-Monitoring (max 5)	1.36 (0.86)	1.26 (0.90)	ns
Depersonalization (max 5)	0.76 (0.75)	0.65 (0.64)	ns
Weight Phobia (max 5)	2.00 (1.01)	1.55 (1.08)	ns
Global Severity Index (max 5)	1.46 (0.78)	1.13 (0.85)	ns
<b>BUT- B</b>			
Mouth (max 5)	1.56 (0.92)	1.26 (0.90)	ns
Face Shape (max 5)	1.22 (0.82)	1.04 (0.97)	ns
Thighs (max 5)	2.79 (1.19)	1.65 (1.13)	<.005
Legs (max 5)	1.72 (1.21)	1.23 (1.02)	ns
Harms (max 5)	1.53 (1.08)	1.17 (0.99)	ns
Moustache (max 5)	0.86 (1.12)	0.89 (1.02)	ns
Skin (max 5)	2.02 (1.23)	1.72 (1.15)	ns
Blushing (max 5)	1.47 (1.07)	1.22 (1.00)	ns
Positive Symptom Total (max 37)	26.85 (10.56)	23.84 (12.27)	ns
Positive Symptom Distress Index (max 5)	2.29 (.75)	1.94 (.72)	ns

*Note: BMI= Body Mass Index; SATAQ-4= Sociocultural Attitudes Towards Appearance Questionnaire; BUT= Body Uneasiness Test.*

**Table 3.** Demographic characteristics of middle-aged (n= 33) women and younger women (n= 32), analysed by Chi-square.

<b>Characteristic</b>	<b>Group</b>		<b>Total n (%)</b>
	<b>Middle-aged n (%)</b>	<b>Young n (%)</b>	
<b>Ethnicity</b>			
Caucasian	31 (93.9)	32 (100)	63 (96.9)
Mixed Race	2 (6.1)	0 (0)	2 (3.1)
<b>Handedness</b>			
Right	29 (87.9)	23 (71.9)	52 (80)
Left	4 (12.1)	9 (28.1)	13 (20)
<b>Menstrual Cycle</b>			
Yes	8 (24.2)	30 (93.8)	38 (58.5)
No	25 (75.8)	2 (6.2)	27 (41.5)

**Table 4.** Pearson correlations between each of the four principal components (BUT-Parts, BUT-Att, SATAQ-press, SATAQ-Int), age, BMI, and perceived actual body size distortion, presented separately for middle-aged women (n= 33) and younger women (n=32).

		Actual	Age	BMI	BUT-Parts	BUT-Att	SATAQ-Press
Middle-aged women	Age	-.03	-				
	BMI	.37*	-.08	-			
	BUT-Parts	.43*	.16	-.04	-		
	BUT-Att	.39*	-.13	.45*	-.12	-	
	SATAQ-Press	.06	-.02	.47*	-.00	-.11	-
	SATAQ-Int	.10	.14	-.09	.03	.13	.09
Younger women	Age	-.26	-				
	BMI	.41*	-.07	-			
	BUT-Parts	-.10	-.03	.39*	-		
	BUT-Att	.16	-.25	.42*	.08	-	
	SATAQ-Press	.39*	.21	.56**	-.06	.06	-
	SATAQ-Int	.00	-.09	-.18	.06	-.07	-.00

\* $p < .05$ , \*\* $p < .005$ , \*\*\* $p < .001$ .

Note: BMI= Body Mass Index; Att= Attitudinal; Press= Pressures; Int= Internalisation

**Table 5.** Pearson correlations between each of the four principal components (BUT-Parts, BUT-Att, SATAQ-press, SATAQ-Int), age, BMI, and ideal body size distortion, presented separately for middle-aged women (n= 33) and younger women (n=32).

		Ideal	Age	BMI	BUT-Parts	BUT-Att	SATAQ-Press
Middle-aged	Age	.26	-				
Women	BMI	-.11	-.08	-			
	BUT-Parts	.08	.16	-.04	-		
	BUT-Att	-.02	-.13	.45*	-.12	-	
	SATAQ-Press	-.11	-.02	.47*	-.00	-.11	-
	SATAQ-Int	-.06	.14	-.09	.03	.13	.09
Younger	Age	-.19	-				
women	BMI	.00	-.07	-			
	BUT-Parts	-.49**	-.03	.39*	-		
	BUT-Att	-.10	-.25	.42*	.08	-	
	SATAQ-Press	.08	.21	.56**	-.06	.06	-
	SATAQ-Int	.15	-.09	-.18	.06	-.07	-.00

\* $p < .05$ , \*\* $p < .005$ , \*\*\* $p < .001$ .

Note: BMI= Body Mass Index; Att= Attitudinal; Press= Pressures; Int= Internalisation



## Figure Captions:

**Fig. 1.** Visual representation of the body distortion technique, using the Body Image Revealer (BIR); veridical (0 = original, centre), distortion (-50 = slimmer and +50 = fatter) of body size. Images of participants were viewed against a white background.

**Fig. 2.** (a) Significant two-way interaction between BUT-parts and Age for the perceived actual body image subcomponent. (b) Non-significant interaction between BMI and age group for the perceived actual body image. (c) Significant two-way interaction between BUT-parts and Age for the ideal body image subcomponent. For all figures, the shaded regions correspond to the 95% confidence intervals for the regression slopes, which have been computed separately for each group. Blue circles with a blue regression line represent the younger women, red circles with a red regression line, middle-aged women.