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A taxonomy of groups at risk based on reported and desired body mass index and its relationships with health

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ABSTRACT

This study aimed to identify groups at risk based on reported and desired Body Mass Index (BMI) and their relationships with weight satisfaction, food intake and perceived health, and to analyze gender differences. A pre-experimental observational study was conducted. 3380 individuals (mean age 20.16; 64.4% females) participated in a survey in the context of a healthy university project. Participants anonymously completed the SF-12, reported height, weight, desired weight, satisfaction and quality of intake. Reported BMI (BMI-r) and Desired BMI (BMI-d) were calculated following WHO standards. Combining BMI-r and BMI-d four groups emerged: Favorable Concordance, FC (67.40% normal weight wanting to maintain it), Unfavorable Concordance, UC (9.19% non-normal weight wanting such unhealthy condition), Favorable Discrepancy, FD (13.92% unhealthy weight wanting to move in a healthy direction), and Unfavorable Discrepancy, UD (9.49% normal or non-normal weight desiring an unhealthy condition). FD individuals showed lower levels of self-perceived physical health, poorer perception of the quality of their intake, and less satisfaction with weight. Both UD and UC groups are at risk, showing the UD group the lowest scores in mental health and healthy food intake. Higher proportions of females were found in the UD group, and wanting to lose weight. These findings suggest that health treatment, prevention and promotion programs can benefit from a taxonomy that identifies not only people at risk but the direction and adjustment (i.e. healthy vs non healthy) of their intention to change. Programs could be targeted at different groups, with specific goals and interventions, and avoid the 'one-fits-all' to foster a healthy weight in the young adult university population.

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Reported body mass index; desired weight; groups at risk; health; satisfaction with weight; young adults

Healthy weight has been defined by the World Health Organization (2000) using the Body Mass Index (BMI). It has become, in the past two decades, a major concern for international (WHO (Ed), 2004, WHO (Ed), 2013), regional (OECD/EU (Ed), 2016), national (see Spain, MSSSI (Ed), 2013) and local (see Basque Country; Gobierno Vasco (Ed), 2014) organizations and governments, given its well-documented association with mortality, chronic diseases (Global BMI Mortality Collaboration, 2016; Guh et al., 2009) and mental health disorders (Luppino et al., 2010; Scott et al., 2008; Simon et al., 2006; De

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Wit et al., 2009). Programs for all age groups (WHO (Ed), 2004), and for particular groups such as college students (Plotnikoff et al., 2015) have been established to promote healthy food intake, and to reduce rates of malnutrition, overweight, obesity and eating disorders.

Youth, and more specifically university students in western societies, have been identified as an especially vulnerable group given their tendency to skip meals, snack, and consume fast-food and alcohol (Costa et al., 2010; Hernández et al., 2012; Huang et al., 2010; Lowry et al., 2000). Studies have shown that their food intake is not healthy and that they follow inadequate diets (Satalic et al., 2007; Vargas-Zárate et al., 2010). Such eating styles are largely influenced by societal models and ideal body types, for both men and women, the association of thinness with beauty, and the stigmatization of obesity (Cohane & Pope, 2001; R.M. Puhl & Heuer, 2009). Similar patterns of overweight perceptions have been found in university students from 22 countries (Wardle et al., 2006) and thus speak of the importance of addressing the issue with this population (Deforche et al., 2015).

The relationship between mental health, mental disorders and weight status has been subject to scientific debate in the past decade. Some authors have found a positive relationship between non-normal weight and mental health problems (Faith et al., 2002; Hu et al., 2012; Mannan et al., 2016; Mond et al., 2011; Rawana, 2013; Simon et al., 2006; Subramanian et al., 2013). On the other hand, Atlantis and Baker (2008) reported a weak relationship between obesity and depression after conducting a systematic review of epidemiological studies. In a similar Roberts and Duong (2015), Roberts & Duong (2013) found no association between BMI and depression and Sand et al. (2017) also found no association between desired weight and perceived health. Other authors (Kelly et al., 2011) have clarified this relationship proposing (and presenting epidemiological evidence of) a non-linear relationship between BMI and mental health.

Gender differences are another important topic in BMI and weight research. Overall, there is greater prevalence of obesity in females (Kanter & Caballero, 2012), with evidence showing that young adult females are the gaining weight faster than other age groups (Cheng et al., 2016). At the same time, mental disorders associated with underweight are more prevalent in women (Galmiche et al., 2019).

An area of interest has been the differences between desired weight and reported BMI. Epidemiological data (Maynard et al., 2006) showed an increase of 2.3 kg in desired weight between 1994 and 2003 in the US, as reported weight also increased. Along the same lines, the Tromsø study in Norway, showed that discrepancies were common and considerable (Sand et al., 2017), and were reduced over time (Aars & Jacobsen, 2016). Muening et al. (2008) added that discrepancies were a strong predictor of mental and physical health. Duong and Roberts (2016) also found high prevalences of discordances in a sample of adolescents in the US, and Ramirez Molina et al. (Ramírez-Molina et al., 2015) explored discrepancies in a Spanish sample. Finally, clinical studies (Tasca et al., 2006) have also pointed out discrepancies as a vulnerability factor for eating disorders in women.

However, most studies focused on the discrepancy or concordance of actual and desired weight, regardless of the valence of such phenomena. It can be argued that discrepancies or concordances should be analyzed with reference to objective standards of healthy weight, to be able to capture the favorable or unfavorable nature of both concordances and

discrepancies and to identify groups at risk. Therefore, the main goal of this study was to propose a taxonomy of groups at risk in terms of discrepancies or concordances between reported and desired BMI, taking into account objective criteria of healthy and unhealthy weight. Two other objectives were formulated: to explore its relationships with weight satisfaction, food intake and perceived health, and to analyze gender differences.

Method

Participants

In the context of a healthy university project at a middle-sized social sciences private university in Northern Spain, undergraduate students from all degrees and schools were invited to complete a comprehensive assessment of health and well-being using a self-report questionnaire. Student population was 5380 from which, 3555 participants completed the instruments (1.26% sample error, with a confidence level of 99%). Inclusion criteria was being between 18 and 25 (n = 3380). 18 participants did not report height or weight. Thus, the final sample consisted of 3362 individuals (1.35% sample error with a CL of 99%), representative of the university population. Average age was 20.16 (SD = 1.45) with a 64.6% of women, and a small difference in age for gender $F_{(1,\ 3369)} = 5.87$, p = .015) with a minimal effect (Cohen's d = .09).

Instruments

Based on similar projects conducted in Spanish and international universities, a group of experts selected the instruments. The variables and instruments utilized were: age and sex, reported height and weight, and reported desired weight. Reported Body Mass Index (BMI-r) and Desired Body Mass Index (BMI-d) were calculated using the Quetelet index, applying the algorithm BMI = kg * $m^{-2.}$ Two new variables were then calculated using the standard cutoff points defined by WHO (WHO (Ed), 2000) for adults: reported and desired BMI (reported BMI = reported weight * m2; desired BMI = desired weight * m2), and identifying underweight (BMI below 18.5); normal weight (between 18.5 and 24.9) and overweight (above 25) individuals.

An item about satisfaction with current weight, with a 3 option response format (*satisfied, lose and gain weight*), and an item regarding their agreement, on a 5-point Likert scale, with the statement '*My food intake is healthy and balanced*' were also included.

To assess perceived health, the SF-12 (Ware et al., 1996) was used. It is an abbreviated version of the SF-36 (Ware & Sherbourne, 1992) two component summary scores (physical and mental health) based on authors' algorithms (Ware et al., 1996) and adapted for the Spanish population (Vilagut et al., 2005). They are expressed using a standardized T scale with an average normative score of M = 50 and a SD = 10. A higher score indicated better health and scores below 30 (2 SD below the mean) would be indicative of a health risk condition. In this sample, overall internal consistency was .82 being higher in the mental score (.80) than in the physical one (.64).

Procedure and statistical analyses

Data were gathered using a voluntary and anonymous questionnaire (see instruments) in the beginning of the second semester. Students were recruited in class, with the authorization of the lecturer and the Dean's office. Trained psychologists administered the instruments and were present to answer questions. Average duration was 50 minutes including instructions. The project secured the approval of the University Research Ethics Committee. It is a pre-experimental observational study.

Means and standard deviations have been used to present results when data were expressed in an interval scale; frequencies and percentages were calculated for ordinal and/or nominal data. In order to compare group means of reported or desired BMI according to gender, variance analyses have been used. If homoscedasticity (Levene test) was not fulfilled, Brown–Forsythe robust test was calculated. If the intergroup homogeneity null hypothesis was rejected, post-hoc testing based on the Scheffe statistic was utilized to identify differences between groups. Effect sizes for between-group mean differences were estimated using Cohen's *d* coefficient.

In order to explore differences of proportions of the categories of reported vs desired BMI and/or gender, Chi square tests were calculated for the homogeneity test, and standardized residuals (SR) were calculated to estimate statistically significant differences. SRs below −1.96 or above +1.96 identified categories in which either, infra or over representation of observed frequencies as compared with expected, were found for the sample distribution (p. ≤ .05).

Results

Average height of participants was 169.7 cm (SD = 9.1), reported weight average was 63.4 kl (SD = 13.1), and desired weight average was 61 kl (SD = 10.8). Average reported BMI for women was 21.25 (SD = 3.56) and for men 23.17 (SD = 3.41) while desired BMI was 20.23 (SD = 2.24) for women and 22.63 (SD = 2.33) for men.

The combination of BMI-r and BMI-d (Table 1) yields a taxonomy as a function of the concordance/discrepancy of categories and of the criterion of normal weight, considered as the adjusted reference standard: low weight and overweight, are regarded as risky or unfavorable health conditions. Therefore, four distinctive groups resulted as shown in

Table 1. Contingency percentages between reported and desired BMI: A taxonomy.

	Reported BMI						
Desired BMI	Underweight		Normal Weight		Overweight		Prevalence
Underweight	UC	5.88	**UD**	6.72	**UD**	0.50	441 (13.1%)
Normal Weight	*FD*	5.08	FC	67.40	*FD*	8.83	2734 (81.3%)
Overweight	**UD**	0.29	**UD**	1.96	UC	3.30	187 (5.6%)
Prevalence	379 (11.3%)		2558 (76.1%)		425 (12.6%)		N = 3362

Numbers express percentages with respect to total.
IMC →Underweight: <18.5; Normal Weight: 18.5 to 24.99; Overweight: >25
FC: Favorable Concordance→ Contingency between reported and desired BMI in normal weight (n = 2266; 67.40%).
FD: Favorable Discrepancy→ Contingency between reported and desired BMI with favorable desire towards normal weight (n = 468; 13.92%).
UC: Unfavorable Concordance → Contingency between reported and desired BMI with unfavorable desire of non-normal weight (n = 309; 9.19%).
UD: Unfavorable Discrepancy → Contingency between reported and desired BMI with unfavorable desire of non-normal weight (n = 319; 9.49%).

(Table 1). Favorable Concordance (FC): normative reported and desired BMI; Unfavorable Concordance (UC): under or overweight and desired to continue in the same weight; Favorable Discrepancy (FD): under or overweight and desired to move towards normal weight, therefore in a favorable direction; and finally, Unfavorable Discrepancy (UD): four possible combinations of individuals in any reported condition expressing a desire to move in an unhealthy direction. An example would be a contingency of normal BMI wanting an underweight condition.

Table 1 presents prevalence of the categories. Three out of four individuals had a normal weight (76.1%) and, approximately, one out of every 10 presented underweight (11.3%) or overweight (12.6%). In terms of desired BMI, there was an increase in the prevalence of normal weight (81.3%) and underweight (13.1%), and a decrement in the percentages of overweight.

The contrast of proportions between BMI-r and BMI-d was statistically significant ($\chi^2_{(12)} = 1000.1$, $p < .001$), with a prevalence of 67.40% of FC ($n\text{-}_{FC} = 2266$), 9.19% of UC ($n\text{-}_{UC} = 309$), 13.92% FD ($n\text{-}_{FD} = 468$), and 9.49% of UD ($n\text{-}_{UD} = 319$).

With regard to our second goal, perceived health, quality of food intake and satisfaction with weight were analyzed as a function of the taxonomy developed. Descriptive statistics for these variables were as follows: SF-12 Physical Component (M = 53.74; SD = 5.96), SF Mental Component (M = 43.53; SD = 9.22) and quality of food intake with a scale from 0 to 4, had a mean of 2.96 (SD = 0.94). 42.7% of the sample was satisfied with weight, 48.2% wanted to lose weight and 8.8% desired to gain. Table 2 presents means, standard deviations and proportions contrast in the perception of health, food intake and satisfaction with weight as a function of the taxonomy developed, which have all showed to be statistically significant ($p < .001$). In terms of the physical health, all groups had means above 50, indicating a good perception of health, showing the FC (M = 54.06) and FD (M = 52.72) groups a statistically significant difference ($d = .23$). All groups obtained scores below 50 in mental health indicating a perception of problems. The lowest values were seen in the UD group (M = 41.45), with statistically significant differences with the other three groups ($M_{FC} = 43.77$, $d = .25$; $M_{FD} = 43.56$, $d = .22$; $M_{UC} = 43.69$, $d = .23$). Differences were also found in terms of their degree of agreement with the quality of their intake where the FC and UC groups have higher scores than FD and UD groups ($d_{FC\text{-}FD} = .18$;
$d_{FC\text{-}UD} = .19$; $d_{FD\text{-}UC} = .20$; $d_{FD\text{-}UD} = .21$; with all effect sizes significant at $p < .05$.

Concerning weight satisfaction, significant differences were also found as shown in the standardized residuals (SR) in Table 2. Amongst the FC group, there was a positive and higher than 1.96 SR in the 'satisfied with weight' response, indicating that observed cases (46.0%) as compared to expected (42.8%) are higher ($p < .001$). The FD group yielded SRs higher than 1.96, in absolute terms, being positive for 'desire to lose weight' (SR = 4.2) and 'desire to gain weight' (SR = 3.0), and negative for 'satisfied with weight' (SR = −5.8); therefore, the proportion of cases satisfied with their weight in the FD group (25.7%) is below expected values (42.8%). In the UC group, there was a negative SR for the desire to lose weight (a 37.4% of observed cases as compared with a 48.4% expected) and positive for satisfaction with weight. Finally, there are no significant SRs in the UD group.

In terms of gender differences, results are shown in Table 3. SRs were positive for men in the FC group and negative in the UD group, whereas in women, higher proportions of observed cases are found in the UD group. Women had positive SRs in the 'desire to lose

Table 2. Contrast of means and proportions in perception of health, intake assessment and weight satisfaction as a function of BMI convergence taxonomy (n = 3362).

	FC (a) (n = 2266)		FD (b) (n = 468)		UC (c) (n = 309)		UD (d) (n = 319)		Contrast Test			
SF-12	M	SD	M	SD	M	SD	M	SD	F	p	Post-hoc	
Physical Health	54.06	5.71	52.72	6.39	53.06	6.53	53.78	6.35	8.22	.001	ab	
Mental Health	43.77	9.10	43.55	9.34	43.68	9.67	41.45	9.22	5.40	.001	ad, bd, cd	
Healthy Intake	3.00	0.93	2.83	0.97	3.04	0.96	2.82	0.96	7.09	.001	ab, ad, bc, cd	
Satisfaction with weight	FC (n = 2262)		FD (n = 468)		UC (n = 309)		UD (n = 289)		Contrast Test			
	n	%	SR	n	%	SR	n	%	SR	χ^2	p	
Wants to lose weight	1044	46.2	−1.5	287	61.4	4.2	116	37.4	−2.8	158	54.7	1.6	91.75	.001
Satisfied	1041	46.0	2.3	120	25.7	−5.8	164	53.2	2.8	103	35.6	−1.9		
Wants to gain weight	177	7.8	−1.7	61	12.9	3.0	29	19.4	0.3	28	9.7	0.5		

M: Means, SD: Standard Deviations. Post-hoc contrast: letters identify statistically different groups. SR: Standardized residuals (values ≤ −1.96 and/or ≥ 1.96 are statistically significant for a p value p ≤ .05)

Table 3. Gender differences in BMI contingencies and satisfaction with weight. (n = 3353*).

	Males (n = 1191)			Females (n = 2162)			Contrast Test	
BMI Contingencies	n	%	SR	n	%	SR	χ^2	p
FC – Favorable Concordance	870	73.0	2.4	1390	64.3	−1.8	29.94	<.001
FD – Favorable Discrepancy	156	13.1	−1.4	336	15.5	1.1		
UC – Unfavorable Concordance	91	7.6	−1.8	219	10.1	1.4		
UD – Unfavorable Discrepancy	74	6.2	−2.9	217	10.0	2.1		
Satisfaction with weight								
Wants to lose weight	328	27.6	−10.3	1293	59.8	7.6	372.16	<.001
Satisfied	658	55.4	6.6	776	35.9	−4.9		
Wants to gain weight	202	17.0	9.5	93	4.3	−7.0		

SR: Standardized residuals (values ≤ −1.96 and/or ≥ 1.96 are statistically significant for a p value p ≤ .05); * – Nine participants did not provide information on their gender (3362–9 = 3353).

weight' option (SR = 7.6; 59.8%) while men had them in the 'satisfied with weight' (SR = 6.6; 55.4%) and 'desire to gain weight' (SR = 9.5; 17%) options. Women showed similar SR of opposite valence in the categories of wanting to lose and gain weight. The highest negative SR value is for males wanting to lose weight. Finally, men (M = 3.02; SD = 0.96) more than women (M = 2.93; SD = 0.93; $F_{(1,\ 3274)} = 7.04$, p = .008, d = .10)) considered their food intake as healthy and balanced.

Discussion

The majority (76.1%) of the sample reports a healthy BMI, a percentage in accordance with local (79.7%, Gobierno Vasco (Ed), 2014), national (71.6%, ENSE, 2011/12) and European epidemiological data (73.2% Eurostats, 2015) and reports of other Spanish universities (Bennassar, 2013). However, underweight rates (11.3%) were higher, and overweight prevalence was lower (12.6%) than in the aforementioned reports and other regional studies with college students (Arroyo-Izaga et al. 2006). Furthermore, the percentage of women wanting to lose weight (59.8%) was far higher than the 36.4% obtained for Basque women (ESCAV, 2013). SF-12 scores on the mental component where more than half a SD below the mean. This result is in accordance with previous international data on the mental health status of college students (Auerbach et al., 2018).

As it relates to our first objective, the taxonomy of favorable vs unfavorable concordances and discrepancies between reported and desired BMI offers an interesting tool for the identification of subsamples at risk, identifying the direction (favorable vs. unfavorable) of the concordances or discrepancies. It as a taxonomy that combines risk assessment, in terms of current reported condition (i.e. under or overweight), and risk associated with personal aspirations, which could be an indirect index of goal oriented future behavior. Following the transtheoretical model of change (Prochaska & DiClemente, 1983), the former have already achieved a contemplative stage whereas the later have not. It is also interesting to identify those resistant to change (UCs), both in the underweight and overweight conditions, in order to stress motivational and cognitive changes before other strategies are implemented. Equally enlightening, is the identification of unfavorable concordances in underweighted and overweighed individuals and

their differentiation from, for instance, their FD counterparts who expressed a desired to change in a healthy direction. Two out of four groups in the UD category could be the most challenging individuals for intervention programs, given their unhealthy condition aggravated by the fact they would like to move to another unhealthy situation (i.e. over weighted wanting to be underweighted). The UC group also poses a challenge for intervention since their unhealthy condition is aggravated by the fact that they do not show intention to change.

The analyses of perceived health, quality of intake and satisfaction with weight add further light. FD groups, aware of the fact that their weight is not healthy, tend to assess their physical health worse than those in the FC category do. On the contrary, individuals in the UD and UC groups do not report physical health problems as compared to the FC group, a fact that further hinders movement towards healthy change. In terms of mental health, the UD group had the lowest mean (41.45), speaking of a group who might present other health issues and again emerging as one of the most challenging groups for professional interventions. The fact that the UC group does not differentiate from the FC and FD groups in terms of mental health also speaks of the greater vulnerability of the UD group.

Along the same lines, the FD groups reported their food intake was less healthy and balanced that the FC group, indicating awareness of intake deficiencies. It is also interesting to notice that the UC groups had the highest score on quality of food intake, statistically different from the FD group. Again, a challenge to work on perceived quality of intake from a psychoeducational perspective.

Differences in the desire to loose/gain weight in the four groups offer additional information to tailor interventions. For instance, there are two distinctive groups (as identified in the taxonomy) of FD cases: people wanting to lose or gain weight are statistically higher than expected (as indicated by the standardized residuals). In the UC condition, there is a higher proportion than expected of individuals satisfied with their weight, as opposed to the FD whose proportion of people satisfied with their weight is lower than expected, speaking of people resistant to change, even if in an unhealthy condition. Finally, the percentage of individuals in the UD group wanting to lose weight is lower than expected. In sum, both the UC and UD groups seem to be the most vulnerable individuals requiring in each case different strategies to help them change their situation.

The last goal was to analyze gender differences. We found a higher proportion of men in the FC condition and of women in the UD condition. The latter is a very heterogeneous group that should be approached differently, even though the majority (6.72% out of 9.49%) are people in normal weight wanting to be underweighted. Overall, a very high proportion of women (59.8%) wanted to lose weight, a fact that should guide educational campaigns in universities. As it relates to males, two issues warrant attention: the higher (17%) than expected percentage of men wanting to gain weight deserves a closer look in the light of Muscle Dysmorphia and Body Dismorphic Disorders literature (Cafri et al., 2005; Cohane & Pope, 2001; Grieve, 2007) and the social pressure for a more athletic body shape. Secondly, there are higher proportions than expected of males satisfied with their weight, just the opposite in the case of females.

Several limitations should be mentioned. Research with using reported height and weight has been both questioned (Connor-Gorber et al., 2007; Kuczmarski et al., 2001; Subramanian et al., 2013) and supported (Pursey et al., 2014) and thus some caution is warranted. A more precise estimation of desired BMI could have been obtained if we had also asked for desired height. Furthermore, the cross-sectional nature of the research design does not allow for the determination of the causal relationship between physical and mental health and the taxonomies produced, neither for the study of developmental changes. The interpretation of the results should consider trends of shifts upwards in desired weight in the past decades, concomitantly with increased reported weight (Maynard et al., 2006)

> Results should be replicated in other cultures since findings from western cultures on these topics have not always been replicated in non-western contexts (Atlantis & Baker, 2008; Subramanian et al., 2013). Future work could further explore the categories proposed since it conveys a manageable set of distinctive groups but might also conceal a more detailed and efficient (in terms of interventions) picture of weight related health problems (i.e. the distinction in the FD group of over weighted from the underweighted people wanting to be in the normal group, or the case of underweighted UC individuals further wanting to lose more weight).

In sum, the taxonomy proposed, notwithstanding the limitations mentioned, has yielded an interesting classification of individuals with favorable or unfavorable concordances or discrepancies of reported and desired BMI. Differences in health, weight satisfaction and food intake have been explored along with gender differences. In conclusion, these results can help design programs targeted at different groups, with specific goals and intervention strategies, and avoid the 'one-fits-all' approach to foster a healthy weight in the young adult university population.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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