Eat Weight Disord
DOI 10.1007/s40519-016-0338-9

ORIGINAL ARTICLE

Self-regulation of eating and physical activity is lower in obese female college students as compared to their normal weight counterparts

Yolanda Campos-Uscanga[1] · Gabriel Gutiérrez-Ospina[2] · Jaime Morales-Romero[1] · Tania Romo-González[3]

Received: 27 June 2016 / Accepted: 20 October 2016

Abstract
Objective Obesity is characterized, among other features, by overeating, reduced physical activity and an abnormal accumulation of body fat. These features are thought to result, at least in part, from the individual's inability to self-regulate their eating and physical activity behaviors (E&PaB). Self-regulation of the E&PaB is a three-step sequential process: self-observation, self-evaluation and self-reaction. However, it is yet unclear whether deficient self-regulation of E&PaB could predispose, facilitate and/or consolidate obesity. Unraveling this issue is fundamental in order to more precisely define the role of self-regulation of E&PaB in the management of obesity.

Methods This research was focused on the question of whether or not self-regulation of E&PaB is related to obesity in female undergraduate students. This population segment seems especially vulnerable to developing obesity since they undergo a significant shift of their E&PaB upon their university enrollment. To address this question, a cross-sectional study with 108 female undergraduate students with normal weight ($n = 80$) or obesity ($n = 28$) was performed, in which self-regulation of eating habits and physical activity was measured by two validated scales and a personal data questionnaire.
Results Female undergraduate students displaying lower E&PaB self-reactions were consistently overweight or obese. In addition, a multivariate analysis identified high levels of self-reaction towards eating habits related to a minor presence of overweight issues or obesity.
Conclusion Self-regulation should be an essential component in the strategies for obesity prevention as an integral approach that must include orientation about healthy eating and physical activity behaviors. In addition, further studies on the effect of self-regulation in the treatment of the obesity are needed.

Keywords Weight control · Adolescent women · Self-regulation · Eating behavior · Physical activity behavior

✉ Tania Romo-González
tromogonzalez@uv.mx

Yolanda Campos-Uscanga
ycampos@uv.mx

Gabriel Gutiérrez-Ospina
gabo@biomedicas.unam.mx

Jaime Morales-Romero
jamorales@uv.mx

[1] Instituto de Salud Pública, Universidad Veracruzana, Luis Castelazo Ayala s/n, Col. Industrial Ánimas, 91190 Xalapa, Veracruz, Mexico

[2] Departamento de Biología Celular y Fisiología, Instituto de Investigaciones Biomédicas; Coordinación de Psicobiología, Facultad de Psicología, Universidad Nacional Autónoma de México, Avenida Universidad # 3000, Distrito Federal 04510, Mexico

[3] Área de Biología y Salud Integral, Instituto de Investigaciones Biológicas, Universidad Veracruzana, Luis Castelazo Ayala s/n, Col. Industrial Ánimas, 91190 Xalapa, Veracruz, Mexico

Introduction

Obesity is a non-transmissible disease characterized, among other features, by overeating, low levels of physical activity and supra-normal body fat storage [1]. Obesity is often related to other non-transmissible diseases (i.e., type 2 diabetes, cardiovascular disease, dyslipidemia, osteoarthritis, hypertension, stroke, and some cancers),

Published online: 31 October 2016

which are lead causes of mortality among the population [2–5].

Obesity is difficult to address because of its multifactorial origins. However, it has been shown that both physical activity and eating behaviors play a substantial role in subjects becoming overweight and developing obesity [6–8] and that these are the most modifiable factors [7]. There are several models and theories that have been used to change behaviors; however those, which include the reasoned action approach, have been the most commonly used [9].

In this regard, self-regulation has gained greater importance in the processes of behavioral change in recent years. Especially since the identification of adequate levels of self-regulation predicts the long-term success of reaching the plans [10], particularly on those interventions of healthy eating and physical activity [11].

Several studies have shown that obese patients display difficulties in self-regulating their eating and physical activity behaviors (E&PaB) [12, 13]. In fact, according to Fagundo et al., overeating is a sign of disparity among circuits related to motivation and behaviors (involving reward) and those implicated in inhibition response, such as reward-saliency, motivation-drive, learning-conditioning and inhibitory control-emotional regulation-executive function [14]. This is why it is believed that impaired E&PaB self-regulation is at the core of the etiology of obesity and that training of E&PaB must be at the center of obesity prevention and/or treatment measures.

Self-regulation makes reference to internal processes that occur in the subject, either in an automatized or deliberate way [15]. These processes are focused on the behavioral management through time and in dynamic contexts for the achievement of goals [15]. As a process, self-regulation occurs through the implementation of three interdependent sub-functions: self-observation, self-evaluation and self-reaction. The starting point is the self-observation of behaviors, the social and cognitive conditions where these behaviors exist, and the subject's self-efficacy perception [16]. The next step consists of a self-evaluation that the subject must make of his/her behaviors and their measure against the established goals and ideal standards [16]. Finally, through self-reaction, motivational strategies are applied in order to achieve the objectives [17].

Most of the evidence of the process of weight self-regulation comes from weight loss interventions, meaning that it comes from studies that implement a treatment in an overweight or obese sample [11]. Only recently did our research group observe that low levels of self-evaluation of physical activity were associated with excess weight in indigenous college women [18]. Thus, there is no solid evidence that a self-regulatory condition developed by the subject (without training) could explain weight gain or an unhealthy life style. Moreover, it is important to study the association of self-regulation and obesity since there is evidence that identifies some phenotypic features in obese people (i.e., recurrent overeating episodes, commonly of highly palatable food in relation to negative emotions and/or dietary restriction) which can be the consequence of an addiction to food and to an alteration on the inhibitory control emotional regulation-executive function circuit [14]. Additionally, since women show higher rates of obesity compared to men [19], and disordered eating associated with obesity is also especially prevalent in women [20], it would be interesting to study E&PaB self-regulation in women.

In Mexico, the prevalence of obesity increased from 9.5% in 1988 to 32.4% in the year 2012 [21]. Interestingly, throughout the population, adult women are the most highly affected, since 73% of them are overweight or obese [22]. This condition is preoccupying because obese pregnant mothers could epigenetically inherit a pro-obesogenic phenotype to their children [23, 24], thus favoring the propagation of this phenotype in the population, generation after generation.

Having this background in mind, we researched whether E&PaB self-regulation was already deficient by the time of obesity diagnosis in female undergraduate students of the Universidad Veracruzana (Mexico). This population segment is especially vulnerable to developing or consolidating obesity since they undergo significant shifts of their E&PaB upon their university enrollment [25]. In addition, students entering college are still exploring their identity, reaffirming their self-image and assessing their social role [26], conditions that make them prone to develop psychological states that predispose them to cultivate either pro- or anti-obesogenic E&PaB.

Therefore, the purpose of this study is to determine whether self-regulation of E&PaB could be associated with obesity in female college students.

Materials and methods

Study design and sample

A quantitative cross-sectional study was performed. The size of the sample was estimated considering a statistical power of 80%, with a confidence level of 95% and a correlation coefficient to detect 0.29 between BMI and self-regulation, based on the results of a previous research [27]. Initially, 143 women were included. According to their nutritional status they were classified as underweight (9), normal weight (80), overweight (26) and obese (28). To avoid biased results, students with underweight and overweight status were discarded from the study, since students

with low weight have a pathological condition, whereas the overweight group represented an intermediate stage between normal weight and obesity that could bias the associations. Our final sample was made up of 108 female undergraduate students with normal weight ($n = 80$) or obesity ($n = 28$).

All women were randomly recruited at the Nursing School of the Universidad Veracruzana (Mexico) after signing an informed consent. The rate of response was 92%. Women that were physically disabled, pregnant or that did not attend either the interview, the physical exploration and/or test sessions were excluded from the study. The College of Researchers at the Institute of Public Health of the Universidad Veracruzana reviewed and approved the protocols used to gather the data.

Instruments

Assessing self-regulation of eating behaviors

Self-regulation of eating behaviors was estimated by using the *Escala de autorregulación de hábitos alimentarios* (self-regulation of eating habits scale) [28]. This instrument, validated with Mexican college students, consists of 14 questions; each rated from 1 (never) to 5 (always) based upon the Likert's scale. Thus, the rating scale ranges from 14 to 70 points. There are four questions that evaluate self-observation ($\alpha = 0.730$), other four that explore self-evaluation ($\alpha = 0.719$) and six that assess self-reaction ($\alpha = 0.864$), explaining 46.9% of the variance. Under this instrument's design, the higher the scores for each parameter the better the self-regulation levels. The statistical confidence of the whole test was high ($\alpha = 0.874$) [28].

Assessing self-regulation of physical activity behaviors

Self-regulation of physical activity behaviors was estimated by using the *Escala de autorregulación de la actividad física* (Physical activity self-regulation scale) [29]. This instrument, also validated with Mexican college students, consists of 12 questions; each rated from 1 (never) to 5 (always) based upon the Likert's scale. Thus, the rating scale ranges from 12 to 60 points. Five questions evaluate self-observation ($\alpha = 0.744$), two questions explore self-evaluation ($\alpha = 0.686$) and five questions assess self-reaction ($\alpha = 0.824$), explaining 49.4% of the variance. The statistical confidence of the whole test was high ($\alpha = 0.846$) [29].

Gathering personal data, anthropometry and body indexes

Personal information was collected through the use of a general data sheet. This data set included information on age, physical activity and one question in which the subjects answered whether they followed a nutritional plan or not; nevertheless the characteristics of the plans or eating practices were not asked. Body measurement data were collected using standardized examination procedures and calibrated equipment [30]. Anthropometric measurements including weight, height, waist and hip circumference were used to calculate body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) and waist-to-hip ratio (WHR) (calculated by dividing the waist circumference to the hip circumference).

Body mass index was used to diagnose obesity. Normal weight was considered when BMI values ranged between 18.5 and 24.9 kg/m^2. Obesity was diagnosed when BMI values were equal or greater than 30.0 kg/m^2 [31]. Furthermore, obesity was determined in women of low height (height under 1.5 m) when BMI was equal to or greater than 25.0 kg/m^2, according to the setting for the Mexican population [32].

Data analysis

Collected data were analyzed under the platform of the Statistical Package for the Social Sciences version 15 (SPSS for Windows, Version 15.0. Chicago).

Normality of data distribution was analyzed using the Kolmogorov–Smirnov test. The variables with normal distribution were WHR, self-regulation, self-observation and self-evaluation of eating behaviors and self-regulation, self-observation and self-reaction of physical activity behaviors. The mean for these variables were presented alongside the standard deviation, and values were compared using t tests for two-group comparisons.

The variables with a non-normal distribution were BMI, age, waist circumference, self-reaction of eating behaviors and self-evaluation of physical activity behaviors. The median for this set of variables was presented alongside the interquartile range and values were compared using Mann–Whitney U tests.

Along with the above, women's responses about their physical activity and nutritional plans were compared using Chi-square.

The association between variables was studied using Spearman's correlation. Subsequently, the results were plotted with Applied Graph and Network Analysis (Agna) software. Agna is a validated platform-independent application designed for social network analysis, sociometry and sequential analysis [33]. Finally, taking into consideration that it is possible to use a prevalence odds ratio as a measure of the effect size [34], a logistic regression model was used to identify elements (independent variables) that may be associated to obesity (dependent variable).

Results

Self-regulation in obese and normal weight students

Waist circumference and WHR were consistently lower in normal weight students than in obese ones. Both groups had high cardiovascular risk, but in women with obesity the risk was higher, while women with normal weight followed an eating plan more often (Table 1). These results support that obese women sampled are a good representation of this group.

Students with obesity showed significantly lower global scores of self-regulation of eating behavior. Accordingly, the dimensional scores for self-reaction of eating behavior were significantly higher in normal weight students than in obese women (Table 2).

Self-regulation and anthropometric variables in normal weight and obese students

Positive correlations were found among BMI, WHR, WC and age, and between self-evaluation of eating behavior and BMI. Self-reaction of eating behavior was negatively correlated with WC. All dimensions of self- regulation of E&PaB were positively correlated (Table 3).

In addition, we conducted a network analysis to establish which variables interact more heavily among the women sampled. It is interesting to note that both self-regulation of eating and physical activity behaviors as a whole were the most connected variables of the network, while the anthropometric measures were the less connected ones. Also, with respect to the sub-scales of self-regulation, the connectivity resides in self-observation and self-reaction, and not in self-evaluation; however, the only self-regulation variable that significantly correlates with BMI was self-evaluation of eating behavior (Fig. 1).

Finally, regression logistic analyses showed that age, self-evaluation and self-reaction of eating behaviors have a significant association with obesity, in which age and self-evaluation seems to increase the probability to develop obesity, whereas self-reaction of eating behaviors diminishes it (Table 4).

Discussion

Overweight and obese populations have reached epidemic proportions worldwide [21] and regionally in México [22]. Nowadays both conditions affect all age groups throughout the population but are especially high in women. It is imperative to develop measures in order to deal with overweight issues/obesity since early ages. Among the female population sampled, 26% were found to be obese. This contrasts with the 12% estimate reported for Mexican teenagers [22]. Although this difference could be attributed to misrepresentation of the sample, it might also reflect regional differences of the distribution of obesity across the country. Also, in our sample, a higher than normal obesity rate could be explained by the low levels of physical activity that were reported by the students, since only 22% of them met the World Health Organization (WHO) recommendations for this population age of conducting moderate aerobic physical activity for over 150 min of per week [35]. On the other hand, only around a third of the students reported that they followed a nutritional plan; moreover, this number was smaller among those with obesity.

Almost all obese and half of the undergraduate female students having normal weight showed high cardiovascular risk, even though many of the latter students were self-regulating their E&PaB. This observation suggests, on one hand, that "rudimentary" self-regulation might not be enough to avoid fat accumulation in the abdominal area in individuals with normal weight, a sign that entails higher health risks [36]. On the other hand, body weight is not

Table 1 Sample description

Variables	Obesity ($n = 28$)	Normal weight ($n = 80$)	p
Age, median, IQR (years)[a]	20.0 (18.0–24.0)	20.0 (18.0–21.8)	0.60
Waist circumference, median, IQR (cm)[a]	98.4 (91.3–104.8)	74.0 (70.0–76.2)	<0.001*
Waist-to-hip ratio, mean, SD[b]	0.89 (±0.06)	0.85 (±0.05)	<0.01*
Cardiovascular risk, percentage[c]	78.6%	51.3%	0.01*
Following an nutrition plan, percentage[c]	14.3%	41.3%	0.01*
Physical activity, percentage[c]	17.9%	23.8%	0.52

IQR interquartile range, *SD* standard deviations

[a] Determined using Mann–Whitney *U* test

[b] Determined using Student's *t* test

[c] Determined using Chi-square

* $p < 0.05$ indicate statistical significance

Table 2 Comparisons among self-regulation variables in students with obesity and normal weight

Variables	Obesity ($n = 28$)		Normal weight ($n = 80$)		p
Self-regulation of EB, mean, SD[b]	40.0	±8.9	44.1	±9.1	0.04*
Self-observation of EB, mean, SD[b]	15.4	±2.3	16.3	±2.9	0.11
Self-evaluation of EB, mean, SD[b]	11.0	±3.6	10.7	±3.0	0.68
Self-reaction of EB, median, IQR[a]	13.0	12.0–17.5	16.5	13.0–21.0	<0.01*
Self-regulation of PAB, mean, SD[b]	38.4	±8.3	41.3	±8.6	0.13
Self-observation of PAB, mean, SD[b]	18.2	±4.2	19.1	±4.2	0.35
Self-evaluation of PAB, median, IQR[a]	8.0	6.0–9.0	8.0	7.0–10.0	0.05
Self-reaction of PAB, mean, SD[b]	12.7	±4.3	13.8	±4.3	0.23

EH eating behavior, *PAH* physical activity behavior, *IQR* interquartile range, *SD* standard deviations

* $p < 0.05$ indicate statistical significance

[a] Determined using Mann–Whitney *U* test

[b] Determined using Student's *t* test

Table 3 Correlations among anthropometric and self-regulation variables in nursing students ($n = 108$)

Variables	1	2	3	4	5	6	7	8	9	10	11
Body mass index											
Waist-to-hip ratio	0.28**										
Waist circumference	0.86**	0.48**									
Age	0.22*	−0.10	0.24**								
Self-regulation of EB	−0.05	−0.15	−0.12	−0.04							
Self-observation of EB	−0.15	−0.05	−0.16	−0.00	0.70**						
Self-evaluation of EB	0.24*	−0.05	0.17	−0.08	0.72**	0.33**					
Self-reaction of EB	−0.16	−0.23*	−0.24*	−0.05	0.89**	0.45**	0.49**				
Self-regulation of PAB	−0.04	−0.11	−0.10	−0.04	0.69**	0.54**	0.43**	0.62**			
Self-observation of PAB	−0.05	−0.10	−0.12	−0.05	0.60**	0.53**	0.40**	0.48**	0.87**		
Self-evaluation of PAB	−0.14	−0.01	−0.11	0.07	0.41**	0.59**	0.20*	0.27**	0.51**	0.38**	
Self-reaction of PAB	0.03	−0.11	−0.02	−0.04	0.64**	0.33**	0.42**	0.67**	0.86**	0.59**	0.25**

EB eating behavior, *PAB* physical activity behavior

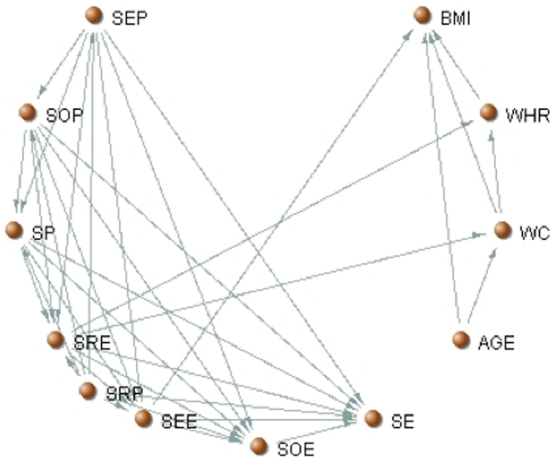
* $p < 0.05$, ** $p < 0.01$

necessarily a good index to infer the tendencies of an individual to accumulate abdominal fat. Therefore, programs aimed at improving E&PaB must focus not only on overweight/obese people, but also on subjects with normal weight. This might be particularly important if one wishes to prevent young adults from developing obesity later in life.

Obesity features overeating, low levels of physical activity and supra-normal body fat storage. Obese patients also display a deficient self-regulation of E&PaB. A method that has been shown to be effective to help control weight gain or obesity is to self-regulate E&PaB [13, 20]. It is yet unclear whether this behavioral deficit appears before or after obesity onset. In this research we report evidence that supports the hypothesis that behavioral deficit is more significantly detected in the obese subjects of the sample. Even though our results cannot precisely establish whether deficient E&PaB occurs before the onset of obesity, we believe the data reported supports the premise that deficient self-regulation may be a factor that promotes the installation of a flourished obesity phenotype. As previously reported, obese subjects have poor executive function performance with some relevant characteristics, such as impulsivity and reduced decision-making abilities, resulting in inadequate self-control [14].

Thus, training of E&PaB self-regulation could be used not only as a treatment method but also to prevent the development of weight gain/obesity at least in young adult individuals since a significant fraction of students with normal weight reported to regulate their E&PaB. In support of this possibility, previous studies have shown that training E&PaB self-regulation improves the effectiveness of obesity treatments [37, 38]. Annesi et al. conducted a randomized controlled trial where they randomly assigned subjects to a 6-month physical activity support treatment alongside with some method for weight loss: nutrition

(A)



(B)

Node	N	M	I	R
SE	7	0.66	4.65	1
SP	7	0.65	4.52	2
SOP	7	0.55	3.85	3
SRP	7	0.54	3.76	4
SOE	7	0.50	3.47	5
SRE	9	0.38	3.40	6
SEE	8	0.40	3.23	7
SEP	7	0.42	2.95	8
BMI	4	0.40	1.60	9
WC	4	0.34	1.34	10
WHR	3	0.18	0.53	11
AGE	2	0.23	0.46	12

Fig. 1 Networks of association among the anthropometric and self-regulation variables on nursing students. **a** Significant Spearman correlations were introduced in the Agna software to build the network of associations. *BMI* body mass index, *WHR* waist-to-hip ratio, *WC* waist circumference, *SE* self-regulation of eating behaviors, *SOE* self-observation of eating behaviors, *SEE* self-evaluation of eating behaviors, *SRE* self-reaction of eating behaviors, *SP* self-regulation of physical activity behaviors, *SOP* self-observation of physical activity behaviors, *SEP* self-evaluation of physical activity behaviors, *SRP* self-reaction of physical activity behaviors. **b** The connection intensity (*I*) between variables (nodes) of the network was calculated according to the number (*N*) of significant correlations ($p < 0.05$) and the average magnitude (*M*) of the correlations, $I = N \times M$. The nodes were ordered by their intensity ranking order (*R*)

Table 4 Associated factors to obesity ($n = 108$)

Variables	Crude model			Adjusted model		
	OR	CI 95%	*p*	OR	CI 95%	*p*
Age (years)	1.2	(1.04–1.37)	0.01	1.2	(1.03–1.33)	0.01*
Self-observation of EB	1.0	(0.79–1.31)	0.89	–	–	0.67
Self-evaluation of EB	1.3	(1.08–1.64)	<0.01	1.3	(1.08–1.61)	<0.01*
Self-reaction of EB	0.7	(0.60–0.88)	0.001	0.8	(0.69–0.90)	<0.001*
Self-observation of PAB	1.0	(0.88–1.20)	0.71	–	–	0.50
Self-evaluation of PAB	0.8	(0.59–1.16)	0.27	–	–	0.35
Self-reaction of PAB	1.1	(0.94–1.38)	0.18	–	–	0.15

ORs calculated by logistic regression. Those variables adjusting the ORs are not shown

EB eating behavior, *PAB* physical activity behavior, *OR* odds ratio, *CI* confidence interval

* $p < 0.05$ indicate statistical significance

education ($n = 83$) or cognitive-behavioral nutrition ($n = 82$). There was significantly greater weight loss in the behavioral nutrition group when contrasted with the nutrition education group. Self-regulation for eating was a significant predictor of weight loss over both 3 and 6 months [38].

An intriguing aspect of our results is that not all dimensions of self-regulation were found to be altered in obese women. Indeed, whereas self-observation and self-evaluation were similar between normal weight and obese women, scores for self-reaction of eating behavior were significantly lower in obese ones. Since the identification of the self-reaction of eating behavior as an associative factor for obesity includes motivational strategies in order to achieve its goals and the implementation and monitoring of feeding plans [28]; according to these results, the ability to initiate and maintain feeding plans is key to deal obesity. Although previous studies had indicated the predictive capacity of self-regulation of E&PaB in the reduction of weight [13] and the predictive capacity of self-regulation of

physical activity in an overweight sample [18], the discovery of this specific dimension of self-regulation associated to obesity, makes it a key issue that must be developed in a subject and that must be considered in the design of health programs. It also provides information on gaps in knowledge that lead to the inadequate self-assessment of their behaviors.

It is interesting to note that self-evaluation of eating behavior, in contrast to self-reaction, increase the probability of becoming obese. Self-evaluation of eating behavior refers to the comparison between the current eating and the way the subject ate before, the ideal standards of quality and quantity of the food, the food that others take and the effects of the food consumption on the body [28]. This fact could be explained if obese women used unhealthy reference standards (a circumstance that underpins the need for interventions to strengthen their capacities) and/or if they had deficient cognitive abilities affecting the evaluation process [39, 40]. Moreover, in spite of the evidence about the positive effects of the mass media to reduce the prevalence of overweight and obese people [41], the social networks and the massive means of communication can be also harmful, since they could promote extremely critical and rigid standards of self-evaluation [42, 43]. For example, there is evidence that young women judge their appearance as worse after an online comparison of their physical appearance [42]. In addition, it has been shown that media broadcasting has a negative influence in the emotions of young women, which in turn changes their internalized standards of the ideal body [43] and their perception of self-evaluation of eating behavior. Thus, as can be seen, the dimension of self-evaluation is affected by several factors and could also be a risk condition for obesity.

Another element that was not considered in the present study is the possible confounding effect that anxiety and depression could have on the association found between self-regulation and obesity. The evidence has showed that anxiety and depression lead to an overestimation of threats and harms, as well as negative evaluations of oneself [44]. In addition, anxiety and depression have also been associated with a major body mass index [45]. Therefore, it is necessary to study the effect of these factors in order to know their association to the relationship that was found between obesity and self-regulation.

Even though this observation seems to undermine the use of self-regulatory processes to deal with obesity, we think it may be explained by the fact that none of the students have received formal training in self-regulation. Taking this argument into account, we think our observations suggest that even a "rudimentary" self-regulation process with adequate knowledge of food, could help individuals reduce the possibility of developing obesity at least when young adult ages are attained. Future studies must then assess the impact that formal training on self-regulatory process has on obesity prevention. In carrying out such assessments one may want to provide formal instruction on nutrition and physical activity, since in our sample, some obese female undergraduate students referred to keep track of what they eat. In addition, as has been referred by Pich et al., the self-regulation process should be related to an ideal body image, since the concern with body image may represent the incentive to a more balanced food intake and regular physical activity [46].

The main limitation of the study is its cross-sectional design that does not establish causality of its associations. Thus, it is necessary to confirm if self-regulation precedes obesity with a longitudinal study. In addition, both the design and the random selection of the sample, in which we do not discriminate among the presence of the event or exposure to it, resulted in groups of sizes different than as they appear in real life, this situation can be also corrected by a longitudinal study.

Conclusions

Since students with obesity showed significantly inferior values of self-regulation, and the high levels of self-reaction were associated with an adequate nutritional state, self-regulation should be an essential component in the strategies for obesity prevention as an integral approach that must include orientation about healthy eating and physical activity behaviors. In addition, further studies on the effect of self-regulation in the treatment of the obesity are needed.

Acknowledgements Authors would like to thank Claudia Enriquez-Hernández, Eva Karen Mendiola, Oswaldo Pérez, Efraín Espinosa and the administrative staff of the Nursing School, Region Veracruz, Universidad Veracruzana, who provided support during data collection. Authors acknowledge the Coordinación de la Investigación Científica, Universidad Nacional Autónoma de México and to the Dirección General de Relaciones Internacionales Coordinación de Movilidad Estudiantil y Académica, Universidad Veracruzana for providing financial support for an exchange program on behalf of Gabriel Gutierrez Ospina. Sara Robledo Waters proofread all the manuscript.

Compliance with ethical standards

Funding This study was not funded.

Conflict of interest All authors declare that there are no conflicts of interest.

Ethical approval All procedures performed with the participants were in accordance with the ethical standards and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The College of Researchers at the Institute of Public Health

of the Universidad Veracruzana reviewed and approved the protocols used to gather the data.

Informed consent An informed consent was obtained from all individual participants included in the study.

References

1. Food and Agriculture Organization, World Health Organization (2003) Diet, nutrition and the prevention of chronic diseases. In: World Health Organization (ed) Report of a Joint WHO/FAO Expert Consultation. http://www.who.int/dietphysicalactivity/publications/trs916/en/
2. Borch KH, Nyegaard C, Hansen JB, Mathiesen EB, Njolstad I, Wilsgaard T, Braekkan SK (2011) Joint Effects of Obesity and Body Height on the Risk of Venous Thromboembolism: The Tromso Study. Arterioscler Thromb Vasc Biol. doi:10.1161/ATVBAHA.110.218925
3. Suzuki T (2011) Lifestyle-related diseases and bone metabolism. Exercise for prevention of osteoporosis and other lifestyle-related diseases. Clin Calcium 21(5):722–729
4. Ogden CL, Carroll MD, Kit BK, Flegal KM (2014) Prevalence of childhood and adult obesity in the United States, 2011–2012. JAMA 311(8):806–814. doi:10.1001/jama.2014.732
5. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, Mullany EC, Biryukov S, Abbafati C, Abera SF, Abraham JP, Abu-Rmeileh NM, Achoki T, AlBuhairan FS, Alemu ZA, Alfonso R, Ali MK, Ali R, Guzman NA, Ammar W, Anwari P, Banerjee A, Barquera S, Basu S, Bennett DA, Bhutta Z, Blore J, Cabral N, Nonato IC, Chang JC, Chowdhury R, Courville KJ, Criqui MH, Cundiff DK, Dabhadkar KC, Dandona L, Davis A, Dayama A, Dharmaratne SD, Ding EL, Durrani AM, Esteghamati A, Farzadfar F, Fay DF, Feigin VL, Flaxman A, Forouzanfar MH, Goto A, Green MA, Gupta R, Hafezi-Nejad N, Hankey GJ, Harewood HC, Havmoeller R, Hay S, Hernandez L, Husseini A, Idrisov BT, Ikeda N, Islami F, Jahangir E, Jassal SK, Jee SH, Jeffreys M, Jonas JB, Kabagambe EK, Khalifa SE, Kengne AP, Khader YS, Khang YH, Kim D, Kimokoti RW, Kinge JM, Kokubo Y, Kosen S, Kwan G, Lai T, Leinsalu M, Li Y, Liang X, Liu S, Logroscino G, Lotufo PA, Lu Y, Ma J, Mainoo NK, Mensah GA, Merriman TR, Mokdad AH, Moschandreas J, Naghavi M, Naheed A, Nand D, Narayan KM, Nelson EL, Neuhouser ML, Nisar MI, Ohkubo T, Oti SO, Pedroza A, Prabhakaran D, Roy N, Sampson U, Seo H, Sepanlou SG, Shibuya K, Shiri R, Shiue I, Singh GM, Singh JA, Skirbekk V, Stapelberg NJ, Sturua L, Sykes BL, Tobias M, Tran BX, Trasande L, Toyoshima H, van de Vijver S, Vasankari TJ, Veerman JL, Velasquez-Melendez G, Vlassov VV, Vollset SE, Vos T, Wang C, Wang X, Weiderpass E, Werdecker A, Wright JL, Yang YC, Yatsuya H, Yoon J, Yoon SJ, Zhao Y, Zhou M, Zhu S, Lopez AD, Murray CJ, Gakidou E (2014) Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 384(9945):766–781. doi:10.1016/S0140-6736(14)60460-8
6. Graur LI, Nita O, Popescu DS, Mihalache L, Datcu G (2011) Correlations between anthropometric parameters and cardiovascular risk factors related to lifestyle in a rural population. Rev Med Chir Soc Med Nat Iasi 115(3):705–711
7. Ogunbode AM, Ladipo M, Ajayi IO, Fatiregun AA (2012) Obesity: an emerging disease. Niger J Clin Pract 14(4):390–394. doi:10.4103/1119-3077.91741
8. Abdel-Megeid FY, Abdelkarem HM, El-Fetouh AM (2011) Unhealthy nutritional habits in university students are a risk factor for cardiovascular diseases. Saudi Med J 32(6):621–627
9. Sniehotta FF (2009) Towards a theory of intentional behaviour change: plans, planning, and self-regulation. Br J Health Psychol 14(Pt 2):261–273. doi:10.1348/135910708X389042
10. Gianessi CA (2012) From habits to self-regulation: how do we change? Yale J Biol Med 85(2):293–299
11. Michie S, Abraham C, Whittington C, McAteer J, Gupta S (2009) Effective techniques in healthy eating and physical activity interventions: a meta-regression. Health Psychol 28(6):690–701. doi:10.1037/a0016136
12. Carraca EV, Silva MN, Coutinho SR, Vieira PN, Minderico CS, Sardinha LB, Teixeira PJ (2013) The association between physical activity and eating self-regulation in overweight and obese women. Obes Facts 6(6):493–506. doi:10.1159/000356449
13. Annesi J, Porter K (2013) Self-Regulatory Skills for Controlled Eating Emanating From Newly initiated Physical Activity. J Soc Behav Health Sci 7(1):67–78. doi:10.5590/JSBHS.2013.07.1.05
14. Fagundo AB, de la Torre R, Jimenez-Murcia S, Aguera Z, Granero R, Tarrega S, Botella C, Banos R, Fernandez-Real JM, Rodriguez R, Forcano L, Fruhbeck G, Gomez-Ambrosi J, Tinahones FJ, Fernandez-Garcia JC, Casanueva FF, Fernandez-Aranda F (2012) Executive functions profile in extreme eating/weight conditions: from anorexia nervosa to obesity. PLoS One 7(8):e43382. doi:10.1371/journal.pone.0043382
15. Karoly P (1993) Mechanisms of self-regulation—a systems view. Annu Rev Psychol 44:23–52. doi:10.1146/annurev.psych.44.1.23
16. Bandura A (1991) Social cognitive theory of self-regulation. Organ Behav Hum Dec 50(2):248–287. doi:10.1016/0749-5978(91)90022-L
17. Bandura A (2005) The primacy of self-regulation in health promotion. Appl Psychol Int Rev 54(2):245–254
18. Campos-Uscanga Y, Morales-Ortiz A, Argüelles-Nava V (2016) Obesity in female student: ethnicity and self-regulation as predicting factors. Health Behav Policy Rev 3(4):315–322
19. Sobers-Grannum N, Murphy MM, Nielsen A, Guell C, Samuels TA, Bishop L, Unwin N (2015) Female gender is a social determinant of diabetes in the Caribbean: a systematic review and meta-analysis. PLoS One 10(5):e0126799. doi:10.1371/journal.pone.0126799
20. Annesi JJ, Mareno N, McEwen K (2015) Psychosocial predictors of emotional eating and their weight-loss treatment-induced changes in women with obesity. Eat Weight Disord. doi:10.1007/s40519-015-0209-9
21. Stevens GA, Singh GM, Lu Y, Danaei G, Lin JK, Finucane MM, Bahalim AN, McIntire RK, Gutierrez HR, Cowan M, Paciorek CJ, Farzadfar F, Riley L, Ezzati M (2012) National, regional, and global trends in adult overweight and obesity prevalences. Popul Health Metr 10(1):22. doi:10.1186/1478-7954-10-22
22. Instituto Nacional de Salud Pública (2012) Encuesta Nacional de Salud y Nutrición. Síntesis Ejecutiva. In: Secretaría de Salud (ed). http://ensanut.insp.mx
23. Armitage JA, Poston L, Taylor PD (2008) Developmental origins of obesity and the metabolic syndrome: the role of maternal obesity. Front Horm Res 36:73–84. doi:10.1159/0000115355
24. Nathanielsz PW, Poston L, Taylor PD (2007) In utero exposure to maternal obesity and diabetes: animal models that identify and characterize implications for future health. Obstet Gynecol Clin North Am 34(2):201–212. doi:10.1016/j.ogc.2007.03.006
25. Morgan AZ, Keiley MK, Ryan AE, Radomski JG, Gropper SS, Connell LJ, Simmons KP, Ulrich PV (2012) Eating regulation styles, appearance schemas, and body satisfaction predict changes in body fat for emerging adults. J Youth Adolesc 41(9):1127–1141. doi:10.1007/s10964-012-9757-8

26. Arnett JJ, Padilla-Walker LM (2015) Brief report: danish emerging adults' conceptions of adulthood. J Adolesc 38:39–44. doi:10.1016/j.adolescence.2014.10.011
27. Tan CC, Holub SC (2011) Children's self-regulation in eating: associations with inhibitory control and parents' feeding behavior. J Pediatr Psychol 36(3):340–345. doi:10.1093/jpepsy/jsq089
28. Campos-Uscanga Y, Lagunes R, Morales-Romero J, Romo-Gonzalez T (2015) Diseño y validación de una escala para valorar la autorregulación de hábitos alimentarios en estudiantes universitarios mexicanos. Arch Latinoam Nutr 65(1):44–50
29. Campos-Uscanga Y, Lagunes R, Morales-Romero J, Romo-Gonzalez T (2016) Diseño y validación de una Escala de autorregulación de la actividad física. Revista Psicología del Deporte 25(2):309–316
30. Center for Disease Control and Prevention (2011). Anthropometry Procedures Manual. National Health and Nutrition Examination Survey. http://www.cdc.gov/nchs/data/nhanes/nhanes_07_08/manual_an.pdf
31. World Health Organization (2015). Obesity and overweight. World Health Organization. http://www.who.int/mediacentre/factsheets/fs311/en. Accessed May 31 2014
32. Secretaría de Salud (2010) Norma Oficial Mexicana NOM-008-SSA3-2010 Para el tratamiento integral del sobrepeso y la obesidad. vol 008-SSA3. Diario Oficial de la Federación, México D.F
33. Benta M (2005) Studying communication networks with AGNA 2.1. Cognitie, Creier, Comportament 9:567–574
34. Ressing M, Blettner M, Klug SJ (2010) Data analysis of epidemiological studies: part 11 of a series on evaluation of scientific publications. Dtsch Arztebl Int 107:187–192
35. World Health Organization (2010) Global recommendations on physical activity for health. http://apps.who.int/iris/bitstream/10665/44399/1/9789241599979_eng.pdf
36. Staiano AE, Reeder BA, Elliott S, Joffres MR, Pahwa P, Kirkland SA, Paradis G, Katzmarzyk PT (2012) Body mass index versus waist circumference as predictors of mortality in Canadian adults. Int J Obes (Lond) 36(11):1450–1454. doi:10.1038/ijo.2011.268
37. Annesi J (2013) Effects of treatment differences on psychosocial predictors of exercise and improved eating in obese, middle-age adults. J Phys Act Health 10(7):1024–1031
38. Annesi JJ, Johnson PH, Porter KJ (2015) Bi-directional relationship between self-regulation and improved eating: temporal associations with exercise, reduced fatigue, and weight loss. J Psychol 149(6):535–553. doi:10.1080/00223980.2014.913000
39. Davidson TL, Martin AA (2014) Obesity: cognitive impairment and the failure to 'eat right'. Curr Biol 24(15):R685–R687. doi:10.1016/j.cub.2014.06.031
40. Shefer G, Marcus Y, Stern N (2013) Is obesity a brain disease? Neurosci Biobehav Rev 37:2489–2503
41. Hatfield DP, Sliwa SA, Folta SC, Economos CD, Goldberg JP (2016) The critical role of communications in a multilevel obesity-prevention intervention: lessons learned for alcohol educators. Patient Educ Couns. doi:10.1016/j.pec.2016.01.005
42. Walker M, Thornton L, De Choudhury M et al (2015) Facebook use and disordered eating in college-aged women. J Adolesc Health 57:157–163
43. Dakanalis A, Carra G, Calogero R et al (2015) The developmental effects of media-ideal internalization and self-objectification processes on adolescents' negative body-feelings, dietary restraint, and binge eating. Eur Child Adolesc Psychiatry 24:997–1010
44. Garnefski N, Kraaij V (2016) Specificity of relations between adolescents' cognitive emotion regulation strategies and symptoms of depression and anxiety. Cogn Emot 20:1–8
45. Paans NP, Bot M, Gibson-Smith D et al (2016) The association between personality traits, cognitive reactivity and body mass index is dependent on depressive and/or anxiety status. J Psychosom Res 89:26–31
46. Pich J, Bibiloni Mdel M, Pons A, Tur JA (2015) Weight self-regulation process in adolescence: the relationship between control weight attitudes, behaviors, and body weight status. Front Nutr 2:14. doi:10.3389/fnut.2015.00014