Behavioral Psychology / Psicología Conductual, Vol. 32, No 2, 2024, pp. 381-402
https://doi.org/10.51668/bp.8324209n

PRELIMINARY EFFICACY DATA OF A MOBILE APP TO ADDRESS DYSFUNCTIONAL BELIEFS ASSOCIATED WITH EATING DISORDERS IN ADULTS

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Abstract

A module has recently been developed within a mobile application (app) with the purpose of addressing dysfunctional beliefs associated with eating disorders (ED). The aim was to conduct a preliminary efficacy study by analyzing changes after use of the app in a general adult population. A quasi-experimental design was used in which 86 people completed a baseline assessment, and of them, 32 used the app daily for 3 minutes over a period of 15 days and completed the post-treatment assessment. Results before and after use of the app showed a decrease in mean scores for dysfunctional beliefs about perfectionism associated with physical appearance, vulnerability to weight gain, and the importance of thought control, as well as an increase in self-esteem. No significant reduction in eating symptomatology or depressive symptoms was observed. The results suggest that the app could be useful in reducing dysfunctional beliefs associated with ED.
KEY WORDS: *disorders, mobile application, dysfunctional beliefs, mHealth, cognitive training.*

Resumen

Recientemente se ha desarrollado un módulo dentro de una aplicación móvil (App) con el objetivo de abordar las creencias disfuncionales asociadas a los trastornos de la conducta alimentaria (TCA). El objetivo fue realizar un estudio preliminar sobre la eficacia analizando los cambios tras el uso de la App en un grupo de población general adulta. Se utilizó un diseño cuasiexperimental en el que 86 personas completaron una evaluación en la línea base, de las cuales 32 emplearon la App durante 3 minutos al día durante 15 días y completaron la evaluación postratamiento. Los resultados antes y después del uso de la aplicación mostraron una disminución en las puntuaciones medias de las creencias disfuncionales sobre el perfeccionismo asociado a la apariencia física, la vulnerabilidad al aumento de peso y la importancia del control de los pensamientos, así como un aumento en la autoestima. No se observó reducción

This study is funded by the Conselleria d'Innovació, Universitats, Ciència i Societat Digital, Generalitat Valenciana, research grants for emerging groups (GV/2021/162).

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significativa en la sintomatología alimentaria, ni en los síntomas depresivos. Los datos sugieren que la aplicación podría ser útil para reducir creencias disfuncionales asociadas a los TCA.
PALABRAS CLAVE: *trastornos de conducta alimentaria, aplicación móvil, creencias disfuncionales, mHealth, entrenamiento cognitivo.*

Introduction

Eating disorders (EDs) share core symptoms such as overvaluation of weight and/or figure, dissatisfaction with body image and excessive influence of body image on self-worth, as well as the use of maladaptive measures to maintain or reduce weight, according to the Diagnostic and Statistical Manual of mental Disorders, DSM-5 (American Psychiatric Association [APA], 2013). People who suffer these disorders are characterized by a lack of self-acceptance, fear of losing control and difficulties in accepting their problem (Graell et al., 2014). All this results in a significant decline in their psychosocial, physical and personal well-being (Escandón-Nagel et al., 2017; Guerri, 2013; Striegel-Moore & Bulik, 2007; Treasure et al., 2010).

On a theoretical level, the different categories within EDs are clearly differentiated. However, a phenomenon of migration between diagnoses frequently occurs in patients. This is known as crossover and refers to a patient going through different eating disorder diagnoses over the years (Fairburn & Harrison, 2003). This phenomenon led Fairburn et al. (2003) to formulate the first transdiagnostic theory, according to which there are four basic common elements in the development and maintenance of all eating disorders: clinical perfectionism, low self-esteem, intolerance to mood changes, and interpersonal difficulties. In this regard, beliefs such as fear of making mistakes, the belief that only perfection will lead to social acceptance, pressure to achieve unrealistic ideals, negative self-evaluation, and low self-esteem have been found to be associated with an increased likelihood of developing an eating disorder (Keel & Forney, 2013; Striegel-Moore & Bulik, 2007). Other dysfunctional cognitions of great relevance in individuals with eating disorders (ED) have also been described. One such cognition is thought-shape fusion, whereby the individual has the belief that having thoughts about self-prohibited foods makes them gain weight and causes them to feel as though they have gained weight. Additionally, thought-figure fusion includes the belief that having such thoughts is immoral (Shafran et al., 1999).

Regarding the treatment of eating disorders (EDs), there is evidence indicating that cognitive-behavioral therapy (CBT) is the most effective treatment, particularly for bulimia nervosa (Fonseca-Pedrero et al., 2021). However, there is a paucity of well-established treatments for EDs, which pose significant challenges in the recovery process, including resistance to change, chronicity, comorbidity, and a high relapse rate (Kazdin et al., 2017; Kirszman, 2020). It is therefore necessary to

develop new tools and treatments that improve the recovery and maintenance efficacy rates of these disorders.

Currently, the use of information and communication technologies for therapeutic purposes is widespread. This area is called Telehealth or eHealth, which includes the concept of mHealth ("mobile Health") to refer to the practice of medicine supported by mobile devices (WHO, 2011). Within mHealth, the use of mobile applications (apps) as the main and most widespread tool is worth highlighting. Some of the advantages of their therapeutic use include their integration into our daily lives, easy accessibility anytime and anywhere, relatively low costs, potential reduction in resistance to seeking professional help due to anonymity, and the ability to reach a large number of people. However, we should not overlook their limitations, such as possible confidentiality issues, difficulties in interpersonal communication, or frequent dropouts (Olff, 2015; Perpiñá & Roncero, 2014). A systematic review (Wang et al., 2018) suggests mental health apps have the potential to effectively manage or improve the symptoms of specific mental disorders. These applications, with their broad reach, can be an effective tool in mental health treatment. One of the apps developed in the field of mHealth is called OCD.app mobile platform (GGtude). This application has different modules that aim to provide a simple tool to address maladaptive beliefs associated with different issues such as low self-esteem, depression, and obsessive-compulsive disorder (OCD). The key elements of the OCD.app mobile platform are the following (Akin-Sari et al., 2022a): (1) psychoeducation to consolidate the basic principles of CBT, (2) daily rating exercises to increase individual's awareness of their internal dialogue, (3) repeated exposure to self-affirmations that challenge individual's maladaptive beliefs to improve their accessibility and their ability to generate adaptive self-affirmations, and (4) exposure to maladaptive versus adaptive statements to favor the reflection process. The app is based on the basic principles of CBT, trying to make the individual's adaptive cognitions about themselves, others and the world more accessible than dysfunctional beliefs. The first module developed in the OCD.app mobile platform is dedicated to OCD and is known as GGOC (GG Obsessive-Compulsive). This module aims to modify the ascription to dysfunctional beliefs relevant to individuals with OCD such as perfectionism, intolerance of uncertainty, importance of thoughts, responsibility, and overestimation of threat. Individuals with OCD show a high ascription to some of these beliefs, higher than that observed in the general population, who also shows a certain degree of ascription to them (Belloch et al., 2010). In this sense, cognitive models of OCD assume that dysfunctional beliefs and appraisals contribute to the onset and/or maintenance of OCD (e.g., Clark, 2004). From a dimensional perspective on normality and psychopathology, it is assumed that the contents of these beliefs are akin to those held by individuals in the general population, but the difference lies in the intensity of these beliefs, which is lower in the general population. In this sense, these beliefs have been found to predict the frequency of intrusive thoughts (Belloch et al., 2007) and obsessive-compulsive symptoms in the general population (Abramowitz et al., 2006; Sica et al., 2007).

The GGOC module also includes addressing self-esteem. To test the efficacy of GGOC, a randomized controlled study was conducted in a general adult population. The sample consisted of 97 students from the Faculty of Psychology of the University of Valencia, with an age range of 18 to 65 years (M_{age}= 21.56). Participants used it for three minutes daily over a period of 15 days. The results showed a significant decrease in maladaptive beliefs related to OCD and an increase in self-esteem. No differences in negative affect were found (Roncero et al., 2019). Likewise, other OCD.app mobile platform modules have shown to be effective in decreasing the ascription to maladaptive beliefs associated with depression, low self-esteem and negative body image, among others (Aboody et al., 2020; Ben-Zeev et al., 2021; Cerea et al., 2020, 2022; Giraldo-O'Meara & Doron, 2020; Roncero et al., 2018, 2019).

There are several apps in English in the field of ED, such as *Recovery Record (RR),* focused on the self-management of typical ED behaviors and related thoughts and feelings. This app also includes feedback from the therapist. The *RR* app has several studies analyzing its efficacy in clinical populations, being the results limited given that the experimental group did not obtain better results in the reduction of ED symptoms compared to the control group (Keshen et al., 2020; Kim et al., 2021; Neumayr et al., 2019; Schlegl et al., 2020; Tregarthen et al., 2015, 2019). The *Noom Monitor* app is focused on the self-monitoring of meals, compensatory behaviors, exercise, body check, cravings, and weight. The use of this app together with regular CBT obtained better results in two studies in adult patients with binge eating disorder and bulimia nervosa compared to patients who only received regular CBT (Study 1: M_{age}= 41.19; Study 2: M_{age}= 32.11) (Hildebrandt et al., 2017, 2020). The *Break Binge Eating* app is based on the principles and techniques of transdiagnostic CBT for ED, and aims to normalize eating behavior, reduce the importance placed on both weight and figure, and promote adaptive emotional regulation strategies. There is a study with this app that shows positive results in adult ED patients (M_{age}= 28.95), showing a reduction in overall ED psychopathology (Linardon et al., 2020). There are other apps aimed at EDs, but with less empirical support, such as *FFT* (Darcy et al., 2014), *Jourvie Resear* app (Kolar et al., 2017), *FoodT* (Keeler et al., 2022), *TCapp* (Anastasiadou et al., 2018, 2020), *MT - BD* (Kollei et al., 2017), and *BodiMojo* (Rodgers et al., 2018).

Regarding the apps available in Spanish, there are currently no apps on the subject of ED with studies on their efficacy. It should be noted that there are several apps related to food and the physical body in Spanish in which self-registration of intakes and habits can be performed, but they are not focused on the psychotherapeutic approach to ED. To date, there is no application available that is designed to work on the core beliefs that underlie ED, neither in English nor in Spanish. In this context, within the OCD.app platform described above, a specific module has been developed that focuses on food and physical appearance, called GGED (GG Eating Disorders). This module is aimed at working on the dysfunctional beliefs associated with the development and maintenance of

EDs such as the importance of body image, perfectionism, the need for control or negative beliefs about oneself, which are present in the clinical population, but also in a dimensional way in the general population in the context of what is traditionally known as "normative discontent" (Rodin et al., 1984). Therefore, the aim of the GGED module is to provide simple cognitive training to enhance flexibility and decrease attachment to these maladaptive beliefs (Abellán et al., 2012; Fairburn et al., 1986; Garner & Benis, 1982). Appendix 1 shows the different contents included in the module, which cover topics associated with body image, nutrition and other more general but equally relevant topics, such as perfectionism or self-esteem.

Given that the GGED module has not yet been tested, the aim of the present study was to evaluate its efficacy in a preliminary way in the general population. Specifically, we analyzed whether the GGED module reduced the level of attachment to dysfunctional beliefs related to the development and maintenance of EDs, and whether it produced changes in eating symptomatology, self-esteem, and depressive symptomatology. The hypothesis was that people who used the application for 15 days, 3 minutes a day, would show a reduction in dysfunctional beliefs associated with ED and an increase in self-esteem. However, given that this was a general population, no changes in eating symptomatology were expected. Changes in depressive symptomatology were also not expected, given that in this module, as in others in the OCD.app platform, beliefs specifically associated with depression are not addressed. Moreover, previous studies in other modules of the same app did not find changes in this variable (Roncero et al., 2018, 2019).

Method

Participants

In the present study, the general population was invited through messages shared on social networks, as well as among students of the Psychology Degree at the University of Valencia between April and June 2022. An invitation to voluntarily participate in a study on beliefs related to food and body image was disseminated. The inclusion criteria for the study were to be between 18 and 35 years old, and to have a mobile device (Android or iOS) to install the GGED app. A sample of 86 people was obtained from the general population (57 women; 66.3%). The mean age was 23.38 years (*SD*= 2.62; range 18-33). Based on the WHO classification (WHP, 2023), the mean body mass index (BMI) was 22.14kg/m2 (*SD*= 4.5; range= 15.82-46.11). Of the 86 individuals, 7 (8.4%) were in the "underweight" weight range; 62 (74.4%) in "normal or healthy weight"; 14 (16.8%) in "overweight"; and 3 (3.6%) in "obese". Regarding marital status, 84.9% were single and 15.1% were living with a partner. In terms of socioeconomic status, 59.3% of the sample indicated "middle", 26.7% "middle-low", 9.3% "low", and 4.7% "middle-high". Finally, with regard to the highest educational level completed, 33.7% indicated high school or intermediate level

training, 32.6% university studies, 16.3% higher level professional training, 12.8% postgraduate university studies, 4.7% compulsory secondary education, and 1% primary education.

Instruments

a) Questionnaire designed *ad hoc* to assess sociodemographic variables (gender, age, height, weight, highest level of education completed, marital status, and socioeconomic status).
b) *Thought-Shape Fusion Questionnaire* (TSF-Q, Shafran et al., 1999), Spanish version by Lobera et al. (2012). The TSF-Q assesses the dysfunctional belief of thought-figure fusion. It is a self-report composed of 34 items, which are divided into two subscales. First, a conceptual subscale, consisting of 17 items, which assesses the importance that the individual gives to thoughts related to food and the body and which comprises the three components of thought-figure fusion (probability, moral, and feeling component). Said scale has an adequate internal consistency with the sample of the present study, specifically, a Cronbach's alpha value of .96. Second, an interpretive subscale consisting of 17 items that assesses how the person interprets such thoughts about ingesting forbidden or weight-gaining foods. In this case, the Cronbach's alpha value obtained is .97. The TSF-Q is completed with a Likert-type scale from 0 to 4 (0= "Not at all" and 4= "Completely") depending on the person's degree of agreement.
c) *Obsessive Beliefs about Body Size and Eating Survey* (OBBSES; Freid, 2007). The OBBSES was created from the *Obsessive-Compulsive Beliefs Questionnaire* (OBQ; Obsessive-Compulsive Cognitions Working Group, 2005) with the aim of explaining the comorbidity between OCD and ED beliefs. The OBBSES consists of 57 items, which involve beliefs associated with eating, food, weight and body shape, divided into 5 factors: 1) appearance perfectionism; 2) vulnerability to weight gain; 3) eating control; 4) magical thinking; and 5) thought control. Given that there is no validated Spanish version of this questionnaire, the present study used the translation-retranslation method (Acquadro et al., 2008). First, two native Spanish-speaking members of the research team performed a direct translation of the original questionnaire into Spanish in a completely independent manner. Subsequently, both the people who carried out the direct translation and the other members of the research team met to agree on a translation of the questionnaire. This Spanish version was sent to a native English speaker who, totally blind to the original version, back translated it into English. Again, the research team verified the coincidence between the back-translation and the original questionnaire. This questionnaire has shown adequate internal consistency in the present study, with a Cronbach's alpha value of .88, .95, .86, .81 and .77 in its factors, respectively. Individuals have to indicate in each item to what extent they

agree using a Likert-type scale from 1 to 7 (1= "Strongly disagree" and 7= "Strongly agree"), based on what they believe "most of the time".

d) *Single-Item Self-Esteem Scale* (SISE; Robins et al., 2001). The SISE is a self-report measure where the statement "I have high self-esteem" is presented and the person has to indicate how that statement describes them on a 9-point scale (1= "Not very true for me" and 9= "Very true for me"). This scale, in its original version, has presented high test-retest reliability, criterion validity coefficients with the Rosenberg Self-Esteem Scale (Rosenberg, 1965) above .80 and a similar pattern of construct validity coefficients with that scale.
e) *Depression, Anxiety and Stress Scale* (DASS-21; Lovibond & Lovibond, 1995), Spanish version by Fonseca-Pedrero et al. (2010). The DASS-21 is a self-report that assesses negative emotional symptoms, that is, depression, anxiety, and stress. It consists of 21 items that are answered on a Likert-type scale from 0 to 3 (0= "It does not affect me at all" and 4= "It affects me a lot or most of the time"). In the present study, only the depression scale was used, which presented an internal consistency of .95 in the sample of this study.
f) *Eating Attitudes Test* (EAT-26; Garner & Garfinkel, 1979; Garner et al., 1982), Spanish version by Castro et al. (1991). The EAT consists of 26 items assessing attitudes and behaviors related to eating disorders grouped into three factors: 1) dieting; 2) bulimia and preoccupation with eating; 3) oral control. The EAT-26 is answered through a Likert-type scale from 0 to 6 (0= "Never" and 6= "Always"). The Cronbach's alpha values for their respective factors in the present study are: .77, .90 and .68.

Procedure

A quasi-experimental design with pre-post design was carried out through an open trial in a general adult population. The study consisted of cognitive training through the GGED app installed on the users' mobile devices. Participation consisted of a pre-assessment (T_0) which includes a series of instructions, and then the participants had to use the application over a period of 15 consecutive days (3 minutes daily) and perform an assessment after completing all levels of the app (T_1). The present study was approved by the Ethics Committee of the University of Valencia (Ref. 1057_1890675).

Following dissemination of the study, all people who showed interest in participating were informed about the study and gave their consent. To increase motivation, participants who completed the study were entered into a draw to win two Amazon shopping vouchers (valued at €25 each). Of the 86 people who gave informed consent and completed the first evaluation prior to using the app (T_0), 32 people (37.2%) used the application and completed the subsequent evaluation (T_1). It was verified that a minimum of 10 days had passed between the two evaluations of the participants. Of the 86 participants, a total of 7 scored higher than the cut-off point in eating symptomatology as assessed by the EAT-26

questionnaire (Garner and Garfinkel, 1979; Castro et al., 1991). All of them dropped out of the study and failed to complete the T_1 assessment.

DESCRIPTION OF THE INTERVENTION PROGRAM

If As explained in the introduction, the GGED module included in the OCD.app platform consists of a series of cognitive training exercises whose purpose is for individuals to identify and accept adaptive beliefs about eating and body image, thus increasing accessibility to self-affirmations that promote adaptive interpretations of thoughts, emotions and actions related to ED. Likewise, the person is trained to reject maladaptive beliefs about eating and body image, thus facilitating identification when these thoughts appear in the person's consciousness. GGED is made up of 15 themes (Appendix 1), similar to those that are worked on in therapy from a cognitive-behavioral approach. Each theme is divided into 3 levels of the same content, and in each level 10 sentences are presented, so that 30 sentences appear in each theme. These sentences appear on the screen randomly in a positive sense (e.g., "I can overcome my fear of getting fat" or "My body is not an object"), or in a negative sense (e.g., "I should look like an influencer" or "I have to measure any change in my weight"). Thus, when presented with the different statements, the individual has to either "accept" the positive (adaptive) statements by dragging them downwards on the mobile screen (attracting them towards themselves), or "reject" the negative (maladaptive) statements by dragging them upwards on the screen (pushing them away from themselves). After completing each topic, a reinforcement screen of the worked content is presented among the following options: 1) The person is asked to try to remember which out of the 3 thoughts that are on the screen has appeared previously; 2) The person is asked to choose which of the statements presented on the screen they would recommend to a friend. 3) A candle appears symbolically and when touched, it lights up and a positive thought can be read. In addition to these three types of reinforcement, a meditation exercise is presented in which the person is instructed to breathe and relax while adopting a positive thought such as "I can take it easy", waves are visualized on the screen that move according to a slow rhythm of breathing, and the importance of that particular belief is recalled (Appendix 2).

Data analysis

Statistical analyses were performed using SPSS 25.0 software. Descriptive statistics were analyzed to report means, standard deviations and frequencies. Independent samples t-tests were conducted to analyze possible differences between people who used the app and completed both assessments, and those who only completed T_0 and did not continue using the application under study. Next, repeated measures t-tests were calculated to evaluate possible changes in the assessment before (T_0) and after (T_1) the use of the GGED module.

Subsequently, Cohen's *d* was also calculated to determine the effect size of the differences between the two evaluations (< 0.20= no effect; 0.21-0.49= small effect; 0.50-0.70= moderate effect; > 0.80= large effect). This was considered in those variables in which significant differences were found.

Results

First, we analyzed the differences between those who completed the study and those who did not. As can be seen in Table 1, no differences were found in mean age or mean BMI between the two groups. The group that did not complete the study obtained higher scores in eating symptomatology (EAT-26) and in dysfunctional beliefs assessed with the OBBSES questionnaire (except for the Thought Control factor). In contrast, the group that completed the study obtained significantly higher scores in the thought-figure fusion belief (TSF-Q) and in Depression (DASS-21). Finally, no significant differences were found in self-esteem between the two groups.

Table 1

Differences in the distribution of means and standard deviations at T_0 (baseline) between people who completed the application (App use group) and those who did not (no App use group)

Variables	App use *M (SD)*	No App use *M (SD)*	*t*	*p*	Cohen's *d*
Age	23.78 (2.68)	23.15 (2.58)	1.08	.88	0.27
BMI	22.75 (3.65)	22.78 (7.35)	-0.18	.55	0.00
TSF-Q: Conceptual factor	1.17 (0.21)	0.97 (0.94)	0.17	<.001	0.15
TSF-Q: Interpretative factor	1.24 (0.23)	1.06 (1.08)	0.89	<.001	0.13
OBBSES: Appearance perfectionism	42.15 (13.93)	50.67 (21.01)	-2.03	.008	-0.24
OBBSES: Vulnerability to weight gain	25.81 (10.68)	32.38 (18.06)	-1.87	.001	-0.21
OBBSES: Eating control	21.96 (7.00)	27.61 (13.09)	-2.27	.001	-0.25
OBBSES: Magical thought	6.68 (2.47)	9.27 (5.65)	-2.45	<.001	-0.29
OBBSES: Thought control	22.56 (7.48)	24.88 (9.66)	-1.16	.94	-0.53
EAT-26: Dieting	1.37 (1.99)	4.81 (6.05)	-3.10	<.001	-0.38
EAT-26: Bulimia	0.15 (0.44)	1.40 (3.23)	-2.17	<.001	-0.28
EAT-26: Oral control	1.03 (1.67)	2.55 (3.15)	-2.52	<.001	-0.29
SISE: Self-esteem	4.50 (1.24)	4.26 (1.67)	0.70	.09	0.08
DASS-21: Depression	10.87 (3.58)	8.31 (6.91)	1.94	<.001	0.23

Notes: BMI= Body Mass Index; TSF-Q= Thought-Shape Fusion Questionnaire; OBBSES= Obsessive Beliefs about Body Size and Eating Survey; EAT-26= Eating Attitudes Test, version 26; SISE= Single-Item Self-Esteem Scale; DASS-21= Depression-Anxiety-Stress Scale. Cohen's *d* (effect size of differences): < 0.20= no effect; 0.21-0.49= small effect; 0.50-0.70= moderate effect; > 0.80= large effect.

Subsequently, differences were calculated between baseline (T_0) and after the use of the app (T_1) in the group of people who completed the study. As can be seen in Table 2, in the TSF-Q questionnaire, no significant differences were observed ($p > .05$). Regarding the OBBSES questionnaire, statistically significant differences were obtained in three of the five factors evaluated by this questionnaire. Thus, as shown in Table 2, there was a reduction in the scores of Perfectionism associated with physical appearance, Vulnerability to weight gain, and Thought control. In the remaining two factors of the questionnaire, there was also a decrease in the mean scores obtained, although it was not statistically significant. In the case of the self-esteem variable, measured by the SISE questionnaire, a statistically significant increase was observed after using the app. Finally, there were no significant differences in the factors found in the results obtained for eating symptoms (EAT-26) and depressive symptoms (Depression factor of the DASS-21 questionnaire).

Table 2

Differences in the distribution of means and standard deviations at T_0 (pre-intervention) y T_1 (post-intervention)

Variables	T_0 *M (SD)*	T_1 *M (SD)*	$t_{(31)}$	*p*	Cohen's *d*
TSF-Q: Conceptual factor	1.17 (0.21)	1.13 (0.17)	1.16	.12	0.11
TSF-Q: Interpretative factor	1.24 (0.23)	1.20 (0.23)	1.27	.10	0.09
OBBSES: Appearance perfectionism	42.25 (14.15)	36.19 (12.26)	4.12	<.001	0.23
OBBSES: Vulnerability to weight gain	25.96 (10.82)	20.48 (8.50)	3.48	<.001	0.28
OBBSES: Eating control	21.96 (7.11)	20.12 (8.07)	1.17	.12	0.13
OBBSES: Magical thought	6.74 (2.47)	6.25 (2.20)	0.83	.20	0.12
OBBSES: Thought control	22.74 (7.54)	18.96 (9.27)	2.20	.01	0.23
EAT-26: Dieting	1.37 (1.99)	1.59 (2.16)	-0.94	.17	0.13
EAT-26: Bulimia	0.15 (0.44)	0.09 (0.39)	1.43	.08	-0.05
EAT-26: Oral control	1.03 (1.67)	0.90 (1.57)	0.68	.25	0.30
SISE: Self-esteem	4.50 (1.27)	4.81(1.23)	-2.26	.01	-0.13
DASS-21: Depression	10.87 (3.50)	10.87 (3.57)	0	.50	0

Notes: BMI= Body Mass Index; TSF-Q= Thought-Shape Fusion Questionnaire; OBBSES= Obsessive Beliefs about Body Size and Eating Survey; EAT-26= Eating Attitudes Test, version 26; SISE= Single-Item Self-Esteem Scale; DASS-21= Depression-Anxiety-Stress Scale. Interpretation of Cohen's *d* for the effect size of differences: < 0.20= no effect; 0.21-0.49= small effect; 0.50-0.70= moderate effect; > 0.80= large effect.

Discussion

The aim of the present study was to analyze whether after completing the GGED module, there was a reduction in the ascription to maladaptive beliefs related to ED, in eating symptomatology, self-esteem and depression. For this purpose, an open trial was conducted to compare the results obtained before and after the use of this module.

Prior to calculating the pre- and post-use differences of the app, we analyzed whether the individuals who completed the study differed from those who did not complete it. It was observed that those who dropped out (n= 54) had higher eating symptomatology scores than the group that did complete the study. In fact, of the 54 people who dropped out, 7 of them exceeded the cut-off point of 20 on the EAT-26 scale, indicating a subclinical or at-risk score for ED (Castro et al., 1991; Garner et al., 1982). Likewise, those who did not complete the study showed higher scores on the beliefs assessed with the OBBSES. This finding suggests that, in general, those who dropped out of the study had a higher risk of having an ED, together with a higher overvaluation of weight and body image. One possible explanation for the dropout could be that people were invited to participate with the information that this was "research on diet and body image". This could have led some to develop an incorrect expectation about the study. Therefore, having the app address the dysfunctional beliefs, which they possibly held, may have made them feel uncomfortable. It should be noted that the app "forces" people to reject beliefs that they might hold, such as "only attractive people get what they want" and instead "forces" them to accept other beliefs that they might not agree with such as "I don't need to judge my physique". Thus, the app may have been "annoying" to precisely those who needed it most given their lack of awareness of the irrationality of their beliefs. In clinical populations with ED, lack of illness awareness is also often observed, given that cognitions are experienced as egosyntonic (Roncero et al., 2013).

Regarding those who did complete the study, we compared their scores before and after completing the app. First, a statistically significant increase was observed in the variable self-esteem, fulfilling the hypothesis put forward in the present study. This variable is worked on in the GGED module with items such as "I can trust myself" or "People focus on my positive aspects". Low self-esteem is associated with the development and maintenance of EDs (Beato-Fernández et al., 2004; Berengüí et al., 2016; Ghaderi & Scott, 2001; Kim & Lennon, 2007), as well as with feelings of insecurity, inadequacy, ineffectiveness, lack of self-worth, autonomy deficits and problems in interpersonal relationships (Levine, 2012; Rutsztein et al., 2014). In addition, low self-esteem is one of the core components of ED according to the transdiagnostic approach of Fairburn et al. (2003). Therefore, the increase in this variable after using the GGED app is particularly relevant. As has been observed in the review of ED apps, there is no mobile application in English or Spanish that works on self-esteem. Other studies carried out with the OCD.app have evaluated this variable. Giraldo-O'Meara & Doron

(2021) investigated the effects of daily cognitive training with an application that specifically worked on self-esteem (GGself-esteem). They assessed the level of self-esteem at three points in time during the use of the app and observed significant increases in self-esteem scores. Likewise, in another study conducted to evaluate the effectiveness of another module of the OCD.app focused on challenging maladaptive beliefs related to obsessions of the OCD of personal relationships subtype (GGRO), showed an increase in self-esteem after using the app for 15 days and the results were maintained after two weeks of follow-up (Roncero et al., 2019). These results are also supported by the study of Cerea et al. (2020) in which, after the use of the GGOC module translated into Italian, a significant increase in self-esteem was also observed.

Regarding dysfunctional beliefs associated with ED, the results show that after completing the GGED module, there were statistically significant differences in three out of five OBBSES factors, partially supporting the hypothesis. In the appearance perfectionism factor, a statistically significant reduction was observed, with a small effect size. This factor focuses on the belief that it is important to have a "perfect" physical appearance and is composed of phrases such as "People will not find me attractive if my body is not perfect" or "An imperfect body is a real body". This result may be related, in turn, to the increase in self-esteem produced after the use of GGED, given that there is a negative relationship between the two variables, i.e., the higher the self-esteem, the lower the concern for body image. Several studies have observed that self-esteem is a factor in the prevention of unhealthy eating behaviors (Asuero et al., 2012; Moreno-González & Ortiz-Viveros, 2009). On the other hand, the reduction of this belief is very relevant as it includes perfectionism, a core component of ED (Fairburn et al. 2003), although in this case it is perfectionism associated with body image, and not general perfectionism. As noted in the introduction, there are different apps in English that have been shown to be effective in reducing body dissatisfaction. Specifically, the *MT-BD* and *BodiMojo* apps for preventing the development of ED (Kollei et al., 2017; Rodgers et al., 2018), and GGBI for body dysmorphic disorder (Cerea et al., 2022). In the present study, measures of satisfaction with body image were not included, so we cannot know whether after use of the app, in addition to the reduction in the Perfectionism associated with appearance factor, one's own satisfaction with body image improves.

In the OBBSES questionnaire, statistically significant differences with a small effect size were also observed in the Vulnerability to weight gain dimension, a variable focused on the susceptibility to weight gain due to lack of physical exercise, eating foods considered unhealthy or having thoughts related to food or body image. This factor is composed of beliefs addressed in the app such as "I can overcome my fear of gaining weight" or "We experience body changes all the time". Susceptibility to weight gain may be influenced by social pressure surrounding body image, the desire to have a slim body and the fear of getting fat, which has given way to the proliferation of myths and misconceptions related to food and the body. Hence the importance of developing psychoeducation

programs for the prevention of problems associated with body image and eating (Zamora-Navarro & Pérez-Llamas, 2013).

Finally, the third dimension of the OBBSES questionnaire where participants have shown a significant reduction, also with a small effect size, is the belief Thought control which assesses the importance of being able to control all thoughts related to food and body image. In the GGED module, this belief is addressed in a block on the need for control with phrases such as "Trying to control what I eat makes me think about food even more" or "Listening to your body is better than trying to control it". The need for control is a central aspect in the etiopathogenesis of EDs. In relation to this and especially in the context of AN, Fairburn et al. (1999) report that there is a need for self-control that is probably a product of the feeling of ineffectiveness and perfectionism, which in turn is associated with low self-esteem. It is interesting to note that, in the present study, we observed precisely an increase in self-esteem together with a reduction in the importance of a "perfect" physical appearance and a reduction in the importance of trying to control thoughts related to weight, food or body image.

As observed in the results, after the use of the GGED module, no statistically significant differences were obtained in the rest of the beliefs that compose the OBBSES questionnaire, that is, in the factors Magical thinking and Eating control. Nor were significant differences obtained in the TSF-Q questionnaire, which assesses the dysfunctional belief of the fusion between thoughts and body shape or body image.

Finally, as predicted in the hypotheses, no changes were found in either eating symptomatology (EAT-26) or depressive symptomatology (DASS-21). This result may be due to the fact that the sample comes from the general population and, therefore, the scores prior to the use of the app were low (floor effect).

This study has some limitations. The first limitation is the sample size in combination with a high dropout rate, as only 37.2% of the participants completed the second assessment (T_1). The high dropout rate is one of the main difficulties of studies using mobile apps (Arean et al., 2016; Roncero et al., 2019). It is not uncommon for dropout rates in this type of study to be around 50%. For example, a randomized controlled trial comparing a mood app with a control app obtained a dropout rate of 82% (Roepke et al., 2015). Another limitation of the present study is the absence of satisfaction or usability scales to gather feedback from the participants regarding the examined app. Future studies should include these measures to assess the GGED module in greater detail. It should also be noted that how participants distributed their app use over time could not be controlled. Although instruction was given to perform one topic per day to complete the second assessment at 15 days, the rate at which they performed the app could not be monitored. In order to complete the post-application evaluation, it was necessary to have completed all levels, and the time elapsed between the two evaluations was checked to ensure that it was greater than 10 days. Finally, another limitation of the study is that the evaluation was carried out by means of

self-reports and possible associated biases, i.e., simulation, social desirability or response tendencies such as central tendency, were not controlled for.

Despite the aforementioned limitations, the results obtained from the present pilot study suggest that the GGED module, the first one focused on core beliefs of EDs, could be a valuable tool for addressing maladaptive beliefs related to these disorders. It presents the advantages of being a mobile application with a simple exercise (accepting or rejecting sentences) and requires a daily use of only 3 minutes. In addition, the results are in line with previous research on the OCD.app platform conducted with general population samples but also in at-risk population and patients, which support the efficacy of cognitive training associated with other areas: OCD (Pascual-Vera et al., 2018; Roncero et al., 2018), body image (Aboody et al., 2020; Cerea et al., 2020, 2022), anxiety (AkinSari et al., 2022a; Akin-Sari et al., 2022b; Oron et al., 2022), emotional disorders (Ben-Zeev et al., 2021), and self-esteem (Giraldo-O'Meara & Doron, 2021).

Future controlled studies on the GGED module should be conducted by increasing the sample and including a follow-up evaluation to check whether the results are maintained over time. In addition, given that a significant decrease in the belief "importance of having a perfect body image" has been found, it would be interesting to include measures associated with satisfaction with body image in the evaluation in order to understand the relationship between both. After analyzing the effects in the general population with positive results in some beliefs and self-esteem, future studies should evaluate the effects of the use of the app in samples of the adolescent population, given that this is the period of greatest risk for developing an ED. The present study represents an encouraging first step towards having an app that could be effective in reducing some of the core dysfunctional beliefs associated with ED and improving self-esteem in the at-risk population and ED patients.

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RECEIVED: October 9, 2022
ACCEPTED: March 27, 2024

Appendix 1

Topics addressed in the GGED module

No.	Topic	No.	Topic
1	Perfect physical appearance	9	Fear of thoughts about food
2	Fear of being judged	10	Importance of the physical
3	The ugliness of body fat	11	Physical appearance and social media
4	Body as an object	12	Fear of shame
5	Controlling my weight	13	Appearance, social media and shame
6	Need for control	14	Negative internal image
7	Complacency	15	Fear of abandonment
8	Self-esteem		

Appendix 2

Images from the GGED module: Examples of an adaptive phrase, a maladaptive phrase, and the meditation exercise