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Eating disorder examination questionnaire (EDE-Q): validity and norms for Saudi nationals

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Abstract

Purpose The aim of this study was to develop an Arabic version of the EDE-Q and to assess its psychometric properties and utility as a screener in the Saudi population. An additional aim was to establish EDE-Q norms for Saudis.

Method EDE-Q data were collected in a convenience sample of the Saudi community ($N=2690$), of which a subset was also subjected to the EDE interview ($N=98$). Various models for the factor structure were evaluated on their fit by CFA. With ROC analysis, the AUC was calculated to test how well the EDE-Q discriminated between Saudis at high and low risk for eating disorders.

Results The original four factor model of the EDE-Q was not supported. Best fit was found for a three factor model, including the weight/shape concern scale, dietary restraint scale and eating concern scale. The ROC analysis showed that the EDE-Q could accurately discriminate between individuals at high and low risk for an eating disorder according to the EDE interview. Optimal cut off of 2.93 on the global score yielded a sensitivity of 82% and specificity of 80%. EDE-Q scores were fairly associated with BMI.

Discussion Psychometric characteristics of the Saudi version of the EDE-Q were satisfactory and results support the discriminant and convergent validity. Severity level of eating disorder pathology can be determined by the EDE-Q global score. Global scores were high compared to what is found in Western community samples, leading to high prevalence estimates for Saudis at high risk for eating disorders.

Level of evidence Not applicable, empirical psychometric study

Keywords Eating disorder examination questionnaire · Eating disorders · Norms · Validity · Saudi Arabia

Introduction

Prevalence of eating disorders (EDs), which occur all over the world [1, 2] is increasing in the Middle East [3–5]. The Eating Disorder Examination (EDE) interview is the most

widely used assessment tool to assess EDs and ED symptoms and is generally considered reliable and valid [6]. As administration of the EDE is time consuming a self-report questionnaire, the Eating Disorder Examination Questionnaire (EDE-Q) was created to screen for EDs and assess its severity [7–9]. EDE-Q is a reliable assessment tool with a high test–retest reliability [10, 11], internal consistency [8, 10], discriminative validity [7, 12] and sufficient sensitivity to changes in eating pathology [10]. If it proves to be a sufficiently sensitive and specific screener, it can be used prior to the EDE interview as part of a two-staged assessment procedure.

There is a lack of valid ED assessment tools in the Middle East [2, 13]. Normative data of the EDE-Q are only available for Western populations [7, 8, 10], and due to cultural differences, norms for Western and Arabic populations may differ [14]. An Arabic version of the EDE-Q is needed to facilitate

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detection of Saudis at high risk of an ED and subsequently treatment of EDs in Saudi Arabia [15, 16].

The aim of this study was to translate the EDE-Q in Arabic, to assess its psychometric properties among Saudi nationals, and to assess its utility as a screener to identify Saudis at high risk for EDs. An additional aim was to establish EDE-Q norms for Saudis.

Methods

Procedure

This study recruited a convenience sample, from students of Princess Noura bint Abdulrahman University (PNU), King Saud University, and the Sixth High School for Quran Memorization, all located in Riyadh. Additional participants were recruited through the principal investigator her social network, and through a project explanation shared through social media, targeting Saudi nationals all over the country. One influencer (@Eyaad) and several sports facilities also distributed a link to the questionnaire: NuYu gym (Riyadh, Dammam & Jeddah), Sukoun Yoga studio in Riyadh, and the Belgian embassy in Riyadh sent a link to Saudi nationals residing in or who previously had resided in Belgium. The Saudi embassies in Germany, France and Switzerland did the same in those countries. Recruitment was conducted between April 2017 and May 2018. Participants were asked to complete an online survey, available in Arabic ($n=2599$ participants, 96.6%) and English ($n=91$ participants, 3.4%). Prior to assessment, all participants were asked to provide informed consent. Minors were asked to get their guardian (father, brother or uncle) to sign the informed consent form. Questions were sent by email to the principal investigator. Participants were recruited in two phases. In the first, based on self-report, the EDE-Q and a demographics questionnaire were administered. During the second phase, the EDE interview was administered to a subset of participants ($N=98$). Participants who provided their contact details in the online questionnaire were contacted for EDE interview, which took place between November 2017 and February 2018, in English (52.5%) and Arabic (46.5%). The majority of the participants were Saudi nationals (97.4% for the EDE-Q and 99.0% of the EDE sample. For demographic details (Table 1).

Measures

Self-report questionnaire: EDE-Q 6.0

The EDE-Q is based on the DSM [17, 18]. EDE-Q is a self-report questionnaire of 28 items with a 7-point Likert scale ranging from 0 (feature was absent) to 6 (feature was markedly present or present every day), measuring purging

and bingeing behaviors during the previous 28 days [9], consists of four subscales: dietary restraint, weight concern, shape concern, and eating concern [18] and a global score for general severity [7, 8, 10, 18]. Dietary restraint, weight concern and eating concern are each measured by five items, shape concern by eight items and six additional items measure frequency of binge episodes, overeating, purging and laxative abuse. Subscale scores are the mean of the items that compose them, with a range of 0 to 6. The global score is the mean of the subscale scores, with higher scores indicating higher severity/frequency of EDs. Questions about weight, height and menstrual functioning are also included in the EDE-Q [8].

The Arabic version of the EDE-Q was translated by a native speaker, a clinical psychology student of Princess Noura bint Abdulrahman University with a parallel translation by a professional translator. Minor differences in word choice and phrasing between both versions were discussed then resolved and translated back, and the following cultural adaptations were made by the principal investigator. In item 2 on restraint eating behavior, it was stipulated that not eating for a long period while being awake should be motivated by shape and weight concerns and not by religious motivates arising from the holy month of Ramadan. Item 28, involving shape concern (avoidance of exposure) was also adapted, because communal changing rooms and public swimming pools are rare in Saudi Arabia and the few that exist are strictly genders separated. Thus, communal changing rooms and swimming pools were replaced by weddings and the gym, which are locations where women do not cover themselves, because they are strictly gender separated. When this study was conducted, female gyms were about to be legalized and were a popular place to work-out and meet friends. Still, since women consider weddings a good place to find future wives for their male family members, some women in the principal investigators personal network admitted feeling exposed while attending them.

The Arabic version of the EDE-Q 6.0 is available from the principal investigator upon request. A pilot study among 50 Princess Noura bint Abdulrahman Health faculty students conducted in January 2017, offered the choice of completing the English or Arabic version of the EDE-Q. Although bilingual, most students preferred the Arabic to the English. Participant feedback on the pilot indicated that the quality of the translation was good. Substantial non-response (14 persons, 28%) was noticed on the questions regarding menstrual functioning, probably due to Saudi Arabia being a closed society, leading to a taboo on discussing fertility and menstrual issues. Besides, Islam considers women as impure during their menstruation and they are not allowed to fast during menstruation in the holy month of Ramadan, or to pray and do their ablutions.

Table 1 Demographics of the EDE and EDE-Q sample

	EDE-Q (<i>N</i> =2690)	EDE (<i>N</i> =98)	Saudi statistics	Source
Age (SD)	24.7 (9.3)	25.2 (9.8)	30.3%	Plecher. 2019 [64]
Male	592 (22.0%)	29 (29.6%)	57.3%	MLA. 2019 [24]
Female	2098 (78.0%)	69 (70.4%)	42.7%	MLA. 2019 [24]
Weight status				
BMI (SD)	31.0 (5.9)	25.7 (5.9)	28.5%	WHO. 2004 [65]
Underweight	269 (9.8%)	6 (6.2%)	8.5%	Higa, Himpens. 2017 [66]
Normal weight	1149 (43.0%)	45 (46.4%)	39.0%	Higa, Himpens. 2017 [66]
Overweight	623 (23.0%)	26 (26.8%)	23.8%	Al-Khaldi. 2016 [67]
Obese	634 (24.8%)	20 (20.6%)	29.0%	El-Gilany and Hammad. 2010 [29]
Marital status				General Authority for Statistics. 2016 [68]
Single	1894 (70.4%)	80 (81.6%)	33.0%	
Married	740 (27.5%)	15 (15.3%)	58.8%	
Divorced	56 (2.1%)	3 (3.1%)	2.6%	
Occupation (highest completed)				
High school	745 (27.7%)	0	5.4%	Puri- Mirza. 2019 [26]
University in Saudi Arabia	686 (25.5%)	55 (56.1%)	4.4%	Habibi. 2015 [27]
Employed	549 (20.4%)	24 (24.5%)	30.2%	Trading Economics. 2019 [28]
Unemployed	401 (14.9%)	11 (11.2%)	12.5%	Arab News. 2019 [69]
University in another Arab country	56 (2.1%)	1 (1.0%)	1.8%	Top Universities. 2015 [70]
University in a Western country	27 (1.0%)	2 (2.0%)	0.4%	Habibi. 2015 [27]
Other ^a	218 (8.1%)	5 (5.1%)		
City of residence ^{b,c}				MLA. 2019 [24]
Riyad	1065 (39.9%)	43 (44.0%)	12.2%	
Jedda	191 (7.1%)	19 (19.4%)	8.3%	
Mecca	80 (3.0%)	1 (1.0%)	3.8%	
Medina	48 (1.8%)	2 (2.0%)	3.8%	
Dammam	88 (3.3%)	5 (5.0%)	2.2%	
Taif	38 (1.4%)	1 (1.0%)	1.5%	
Tabuk	24 (0.9%)	1 (1.0%)	1.3%	
Bariatric surgery				
Underwent surgery	207 (7.7%)	4 (4.1%)	8.0%	Ahmed, Alanazi. 2018 [71]

^aUnable to find statistical data

^bData were missing of *n*=685 (32.1%) participants in the EDE-Q sample

^cOnly largest cities mentioned

Interview: EDE 16.0

The EDE [9] 16th edition is a semi-structured interview that is widely used to assess ED pathology [19] in the previous 28 days to 6 months [20]. The EDE, has good internal consistency [21], test–retest reliability [22], and discriminative and concurrent validity is supported [23]. ED pathology severity is measured on a 7-point Likert scale (0: feature was absent, to 6: feature was markedly present or present every day) [9], and the global score calculated as the mean of all individual items. Subscale scores are calculated as average score of the relevant

items. For the Arabic version, some items were first culturally adapted by the principal investigator and two of her students, then translated to Arabic by the students. As with the EDE-Q, for questions regarding dietary restriction, it was made clear that this must not involve religious motivation during Ramadan. The question regarding discomfort about exposure, swimming and communal changing rooms were replaced by gym and weddings, and wearing a wider or dark colored abaya (mandatory coat for women) was added. Because of the high non-response to the question about menstruation, interview questions regarding menstruation were introduced after asking for permission to

discuss a potentially taboo topic. All female participants agreed to discuss taboo topics.

Administration of measures

The EDE-Q was administered online through Survey Monkey. For cultural reasons, as Saudi law does not allow being in public places with a non-relative of the opposite sex, leading to some participants feeling uncomfortable being interviewed in a public place or at home, participants who agreed to participate in the EDE interview were asked to propose locations for their interviews. Most interviews with female participants were held at the principal investigator her office, which was only accessible to women. Most interviews with male participants were held at the principal investigators home office. Other locations were restaurants and participants' homes.

Participants

The EDE-Q was completed by 2769 participants, a substantial proportion of female respondents declined to respond to the question about their menstrual cycle (143 participants, 5.3%) in the EDE-Q. Those respondents were included, as were participants with missing data on the behavioral frequency items, 79 (2.9%) participants had missing data in their EDE-Q so were excluded. In total, 2690 respondents completed the EDE-Q without any missing items.

The EDE interview was conducted in a subset ($N = 102$). Six participants did not attend their scheduled EDE assessment, four participants (3.9%) who completed the EDE and EDE-Q had $\geq 5\%$ missing data in their EDE-Q and were also excluded. In total, there was complete data for both the EDE and the EDE-Q for 98 participants. All participants were Saudi passport holders, ≥ 14 years and literate.

EDE-Q sample

Participants were 2690 Saudi nationals (Table 1), and the EDE-Q was completed between April 2017 and May 2018. There were differences between the EDE-Q sample and the Saudi population: females were over-represented, with the EDE-Q sample including 78% females, vs. 42.3% in the Saudi population [24]. There was a greater percentage of single participants (70.4% vs 33.0%) and a smaller percentage married (27.5% vs 58.8%) [25]. The EDE-Q sample was also more highly educated: most participants attended high school (27.7%) compared to 5.4% of the wider population [26], and around a quarter of the sample attended university in KSA, compared to 4.4% generally [27]. Besides, 20.4% of the sample was employed, compared to 30.2% generally [28]. Participants resided all over Saudi Arabia (details available with the principal investigator), though most resided in

the larger cities, and some regions were over-represented in the EDE-Q sample [24]. Some participants lived abroad, 56 of them lived in another Gulf country and one female participant resided in Spain. Nationality statistics of Saudi Arabia were unavailable.

EDE sample

Participants with high EDE-Q global scores who provided email addresses were sent a request in Arabic and English, to schedule an appointment for an EDE interview. If they didn't respond but had left their phone number, they were called within one week. Text message reminders about the appointment were sent on the day the interview was scheduled. The EDE was generally conducted within two weeks of completion of the EDE-Q. The EDE ($N = 98$) was conducted in Arabic or English depending on the participants' preference; 53 (54%) in English by the principal investigator; 45 (46%) in Arabic by one of her female students, trained by the principal investigator. Differences between the average Saudi population and the participants interviewed with the EDE were as follows: females were over-represented, 70.4% in the sample vs. 42.7% in the general population [24], there were minor differences in BMI, with a smaller proportion of the sample (20.6%) suffering from obesity compared to the average population (29.0%) [29]. In addition, the majority of the sample was attending university in Saudi Arabia (56.1%), compared to 4.4% of the general population [27]; and most participants resided in the largest cities, Riyadh (44.0%) and Jeddah (19.4%), as compared to national percentages 12.2% and 8.3% respectively [24].

Statistical analysis

SPSS version 25 and AMOS version 26 were used for statistical analysis. Scores were inspected regarding the frequency distribution by skewness and kurtosis. A two way mixed intra class correlation (ICC) with consistency agreement was calculated to test for agreement between the EDE and EDE-Q scores. A Bland–Altman plot was used to investigate the relationship between severity level and differences between EDE and EDE-Q total scores, and to identify bias and outliers. Kappa (κ) between the EDE and EDE-Q was calculated to test concordance between both. Binge eating frequencies and compensatory behavior were also assessed and compared between instruments.

Cronbach's alpha was calculated to measure internal consistency of the EDE-Q subscales and total score. A score of ≥ 0.70 was considered to be acceptable, ≥ 0.80 good and ≥ 0.90 as excellent. Convergent validity with the EDE of ≥ 0.70 was considered to be acceptable, ≥ 0.80 good and ≥ 0.90 as excellent. Effect of age, gender and, level of education/profession on the EDE-Q global score were

investigated with ANOVA. To investigate the factor structure of the translated EDE-Q in both samples, the original four factor model [30] was evaluated on fit using a confirmatory factor analysis (CFA). In addition, the factor structure of a three factor model (1: weight/ shape concern, 2: eating concern, 3: dietary restraint) [31] and two factor model (1: eating/weight/shape concern, 2: dietary restraint) [32] were evaluated on fit using CFA.

Based on a subsample scoring at least 2SD above average ($n=44$, 45%) on the EDE (EDE + sample), a receiver operating characteristic (ROC) analysis was performed to test the discriminative validity of the EDE-Q for ED pathology severity according to the outcome of the EDE interview. The area under the curve (AUC) was calculated to test how well the EDE-Q discriminated between the groups at high and low risk for an ED. An $AUC \geq 0.90$ meant high accuracy, 0.70–0.90 moderate accuracy, and 0.50–0.70 low accuracy. To determine optimal cut-off values on the EDE-Q as a screener for EDs, sensitivity and specificity were calculated for various scores. In order to account for selective non-response percentile scores were weighted using inverse response probability weighting to obtain estimates for the prevalence of Saudis at high risk for EDs. Finally, the association between BMI and ED pathology was estimated [30]. *T*-tests were used to assess differences in severity level between groups.

Ethical considerations

The study design was approved on May 7, 2017 (17-0097) by the ethical review boards of PNU and the King Abdulaziz City for Science and Technology, both in Riyadh, Saudi Arabia.

Results

Internal consistencies of the EDE-Q were calculated based on the complete sample ($N=2690$). Cronbach's α was high for the global scale score ($\alpha=0.93$), the dietary restraint ($\alpha=0.81$), shape concern ($\alpha=0.84$) and weight concern ($\alpha=0.83$) scales. Internal consistency of the eating concern scale was lower ($\alpha=0.69$), but still acceptable. Convergent validity was excellent on the global, weight concern and shape concern scales, high on the eating concern scale and unacceptable on the dietary restraint scale. An ANOVA revealed no significant differences in score on the EDE-Q between age groups (age ≥ 18 versus age < 18) ($F(1, 2689)=0.90$, $p=0.343$), gender ($F(1, 2665)=2.38$, $p=0.123$), or level of education/profession ($F(6, 2659)=2.04$, $p=0.058$). Furthermore, all scales were normally distributed. BMI was strongly and positively correlated with the EDE-Q global score $r=0.96$, $p<0.001$ (Table 2).

Confirmatory factor analysis

There was a strong relationship between the weight concern and shape concern subscales ($r=0.86$, $p<0.001$). A moderate to strong relationship was found between the eating concern and weight concern scales ($r=0.68$, $p<0.001$) and the eating concern and shape concern ($r=0.67$, $p<0.001$) scales. These correlations indicate that these four subscales primarily assess the same underlying construct. None of the models tested showed acceptable fit (Table 3). All items loaded substantially on their respective factors in all models.

In the three factor model [31] correlations were high between the weight/shape concern and eating concern scale. Best fit was a found for a three factor model (with shape and weight concerns combined in a single factor) with RSMEA < 0.10 and TLI and CFI of 0.77 and 0.74. As the lack of fit may be due to low intercorrelations among items typically found in a community based sample, the CFA were

Table 2 Average scores, skewness, kurtosis, reliability, convergent validity and association with BMI of the EDE-Q and its subscales ($N=2690$) and AUC of the EDE-Q global score based on the EDE and concordance rates ($N=98$)

	Mean	SD	Skewness ^a	Kurtosis ^a	α	Convergent validity	R (BMI) ^b	AUC based on EDE	R (EDE)
EDE-Q global	2.25	1.32	0.23	-0.74	0.93	0.99	0.96	0.84	0.72
Dietary restraint	1.71	1.54	0.74	-0.39	0.81	0.63	0.36	0.40	0.60
Eating concern	1.40	1.40	1.02	0.26	0.69	0.83	0.95	0.44	0.65
Weight concern	2.43	1.65	0.34	-0.80	0.83	0.92	0.90	0.37	0.62
Shape concern	2.90	1.62	0.12	-0.94	0.84	0.93	0.91	0.36	0.68

AUC area under curve; BMI body mass index

^a $0.05 \leq SE \leq 0.10$

^b $p < 0.001$

Table 3 Fit statistics for alternate models of EDE-Q data in sample with elevated scores on the EDE-Q ($n=538$) and community sample ($N=2690$)

Fit indices	χ^2 (df)	RMSEA	GFI	AGFI	NFI	CFI	TLI	IFI
Four factor model Fairburn et al. 1993 [33]								
Community sample	23924.5 (224) ^b	0.199 ^b	0.719	0.654	0.486	0.487	0.368	0.488
Elevated scores sample ^c	51760.5 (224)	NA	0.792	NA	NA	NA	NA	NA
Bifactor model Fairburn et al. 1993 [33]								
Community sample	5452.9 (201) ^b	0.099	0.827	0.763	0.883	0.886	0.857	0.887
Elevated scores sample ^c	26283 (208)	NA	NA	NA	NA	NA	NA	NA
Three factor model Peterson et al. 2007 [31]								
Community sample	6697.9 (206) ^b	0.108 ^b	0.782	0.732	0.765	0.770	0.742	0.770
Elevated scores sample	922.3 (206) ^b	0.080 ^b	0.861	0.830	0.606	0.660	0.619	0.614
Two factor model Byrne et al. 2010 [32]								
Community sample	8527.6 (208) ^b	0.122 ^b	0.723	0.663	0.700	0.706	0.706	0.706
Elevated scores sample	1050.5 (208) ^b	0.087 ^b	0.843	0.809	0.551	0.600	0.556	0.605
One factor model Aardoom et al. 2012 [7]								
Community sample	9769.5 (209) ^b	0.131 ^b	0.677	0.607	0.657	0.661	0.626	0.662
Elevated scores sample	1389.8 (209) ^b	0.103 ^b	0.790	0.745	0.406	0.440	0.381	0.446
Re-specified three factor model								
Community sample	3383.9 (87) ^b	0.119	0.829	0.765	0.846	0.850	0.819	0.850
Elevated scores sample	355.6 (87) ^b	0.076 ^b	0.916	0.884	0.760	0.805	0.765	0.807

χ^2 (df) minimum discrepancy, *RMSEA* root mean square error of approximation, *GFI* goodness of fit index, *AGFI* adjusted goodness of fit index, *NFI* normed fit index, *CFI* comparative fit index, *TLI* comparative fit index, *IFI* incremental fit index

^aEstimates

^b $p < 0.001$

^cNon-positive method: Estimates

repeated for a subsample with elevated scores on the EDE-Q. We selected the 20% respondents with the highest scores ($n=538$). All items loaded positive and significantly on their respective factors in all models. As, even when non-normal items were removed and items with estimated correlations greater than 1 were merged, the four factor and bifactor did not yield a solution, the non-positive method was used, which only provides estimates. Best fit for the sample with elevated scores was the three factor model with the smallest χ^2 to degrees of freedom ratio, $GFI=0.86$, $AGFI=0.83$ and $RSMEA < 0.10$. CFA were repeated for a female subsample with elevated scores on the EDE-Q, the results were comparable (results not shown in Table 3). The subsample involving males with elevated scores was too small to conduct a CFA.

Exploratory factor analysis

As CFA revealed limited fit, an Exploratory Factor Analysis (EFA) with promax rotation was conducted on the entire sample and on sample with elevated scores. The scree-plot suggested four factors explaining 69.9% of the variance. However, item allocation to these four factors did not correspond at all with the purported factor structure. A three factor model was better interpretable and resulted in 15

items loading between 0.21–0.76 in the sample with elevated scores (supplementary Table 1). The first factor (dissatisfaction and discomfort) was comprised of three items of the shape concern scale and two items of the weight concern scale (two items describing dissatisfaction with shape or weight and two items about seeing or exposing body), the second factor (dietary restraint) was comprised of all the items of the dietary restraint subscale, the third factor, four items, included two items of the weight concern scale. Pre-occupation with food, guilt about eating, preoccupation with shape and weight and flat stomach did not load substantially on any factor. An EFA conducted for males and females separately provided comparable results, although the item loadings on the first factor were a bit higher in the female than in the male sample. Fit of this three factor model sample with elevated scores was compared to the fit indices of the CFA. The re-specified three factor model had the best fit for the current sample in comparison to other models according to CFA with χ^2 being relatively small in comparison to the degrees of freedom, $GFI=0.916$, $AGFI=0.884$ and $RSMEA < 0.10$ for the subclinical sample, although these indices reveal still not acceptable fit. Cross loadings on other factors are low (0.00–0.29) (Table 3).

Other aspects of validity

Since the CFA and EFA did not support the purported factor structure, in further analyses the EDE-Q global score was based on equally weighed item scores rather than the average score on the four subscales. Several analyses were conducted to investigate whether the EDE-Q actually measured a high risk for EDs and ED symptoms. An ICC indicated an acceptable relationship between the EDE and EDE-Q global ($r=0.78$, 95% CI [2.03, 4.51]), eating concern ($r=0.75$, 95% CI [1.01, 3.78]), shape concern ($r=0.79$, 95% CI [2.35, 5.03]), weight concern ($r=0.73$, 95% CI [2.21, 4.78]) and dietary restraint ($r=0.73$, 95% CI [1.03, 3.51]) scale scores. The EDE and EDE-Q global scores were compared: the mean difference in score was -2.42 (SD = 2.01) with higher scores for the EDE-Q. There are differences between the EDE and EDE-Q and the difference increases for higher scores (Fig. 1).

Concordance rates between the EDE and the EDE-Q on the global ($\kappa=0.009$, $p=0.054$) and shape concern ($\kappa=0.022$, $p=0.137$) scales were low and not significant. Concordance rates on the eating concern ($\kappa=0.10$, $p<0.001$), weight concern ($\kappa=0.07$, $p<0.001$) and dietary restraint ($\kappa=0.07$, $p<0.001$) scales between the EDE and EDE-Q were low and significant.

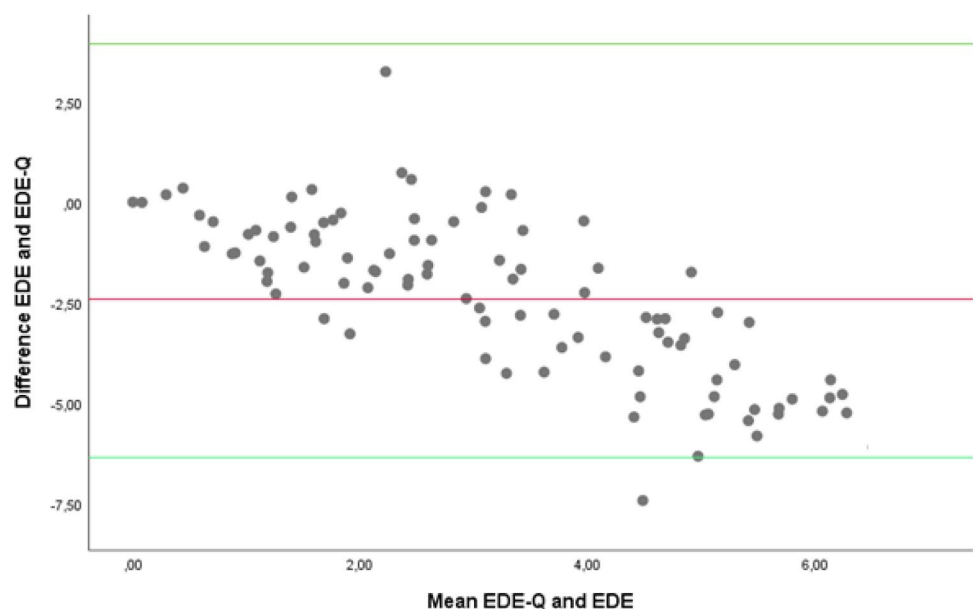
The ability of the EDE-Q to discriminate between Saudis at high and low risk for an ED (according to the EDE) was assessed with a ROC analyses in the subsample of interviewed participants. EDE+ was defined as a global score of ≥ 2.5 [33]; 44 respondents (45%) met this criterion. The ROC analysis of the EDE-Q data showed an AUC of 0.84 (95% CI [0.69–0.90]), indicating that the EDE-Q is an excellent classifier [34]. Apparently, the EDE-Q global score

discriminates well between Saudi nationals at high and low risk for an eating disorder. With a cut-off of 4.87 (based on 2 SD above average), sensitivity of the EDE-Q was 89%, specificity was 69%. There were 31% false positives and 11% false negatives. EDE-Q cut-off score of 2.68 had good sensitivity 84% with a specificity of 75%, a cut-off value of 3.40 had a sensitivity of 64% and a specificity of 85% and a cut-off score of 2.93 yielded a good compromise, a specificity of 80% and a sensitivity of 82%.

Using this last cut-off value of an EDE-Q score (≥ 2.93) it is estimated that 28.8% ($n=775$) of the sample was at high risk for an ED. This was 28.5% of the females and 29.7% of the males included in the sample, there were no differences between both genders ($p=0.205$). In addition, of the total sample scored 2.1% ($n=57$) 2 SD's above average and 20.0% ($n=538$) of the participants scored 1 SD above average. Of the participants with obesity ($n=648$) scored 5.4% ($n=35$) 2SD above average and 52.2% ($n=338$) of off them scored ≥ 2.93 . In addition, 25.9% of the females, 28.4% of males had an EDE-Q score of 2.05 or lower and, 58.1% of the females, 45.9% of male participants had an EDE-Q score below international cut-off of 2.77 or lower. These results are presented in Table 4, along with the prevalence of specific ED behaviors according to the two measures in both samples, which clearly differ according to both measures. There were no differences in EDE-Q scores ($p=0.124$) between the subgroup that participated in EDE interview ($N=98$; $M=2.21$, $SD=1.27$), and the subgroup ($N=2690$; $M=2.25$, $SD=1.32$) that did not participate.

Percentile scores were weighted for education/occupation, and presented separately for males and females (Table 5). The average EDE-Q scores were 2.24 (SD = 1.53) and 2.30 (SD = 1.28) for females and males respectively. There were

Fig. 1 Bland Altman plot revealing a weak association between severity and the difference in score between the EDE interview and the EDE-Q



no differences in EDE-Q scores ($p=0.205$) between females and males.

Discussion

Aim of this study was to assess psychometric properties of a Saudi version of the EDE-Q, to assess its utility as a screener for Saudis at high risk for EDs, and to establish EDE-Q norms for the Saudi population. This is the first study to assess the psychometric properties, including norms and discriminative validity of a culturally adapted EDE-Q in a large Saudi community sample. As in other studies, the results did not support the four factor structure of the English original [7, 9, 31, 32, 35], or the alternative three factor model [36, 37], questioning the validity of EDE-Q subscale scores. Moreover, attempts to establish an alternative factor structure with sufficient fit to the data were not successful.

Females and highly educated Saudis were oversampled, therefore percentile scores were presented separately for males and females and weighted for education/occupation. Although the living conditions for males and females diverge considerably in Saudi Arabia, no gender differences were found in scores on the EDE-Q, nor on the factor structure of the measure. Compared to Western community samples [7–9, 38–41], the global and subscale scores were higher in the Saudi sample. However, Luce et al. [10] reported comparable dietary restraint scores for USA students as found among Saudi students in this sample. Whether these high scores are specific to Saudi's or rather reflect an aspect more general in the Arabic culture is unclear, as no data are available of other countries in the Gulf area. Interestingly, in somewhat comparable societies, such as Turkey [42] and Iran [43] the EDE-Q global score is also higher compared to western societies. Severity of ED pathology was associated with BMI, a finding consistent with other international [44, 45] and Saudi studies where associations were found between BMI and body dissatisfaction [46], binge eating behavior and irregular eating patterns [47]. Furthermore, EDE-Q scores of Saudis suffering from obesity were comparable with Mexicans suffering from obesity [48], slightly higher than Dutch with obesity [7] and, higher than Iranians with obesity [43], Norwegians [49] and Australians [32]. High EDE-Q scores in the population might reflect the high rates of obesity and maladaptive strategies to lose weight among the Saudi population. This is especially important because Saudi Arabia has the highest rates of obesity worldwide [50], increasing the risk of developing an ED two to three times [15], although it is remarkable that the items restraint, food avoidance and dietary rules were negatively associated with importance of weight and shape, guilt about eating, social eating and reaction to prescribed weighing.

Reliability (internal consistency and convergent validity) was high and the EDE-Q discriminates accurately between individuals at high and low risk for an ED according to the EDE interview. EDE-Q global scores can be used to determine severity level of ED pathology and screen for Saudis at high risk for EDs in community samples. Participants were consistent in presentation of the severity of their ED pathology, but not in symptom presentation between the EDE and EDE-Q. These findings are also similar to what has been found in other studies. Even in a clinical sample, classification concordance between the EDE and EDE-Q was moderate at best [51] and concordance between the subscales varied from poor to excellent [52]. It was remarkable that the concordance rate was higher in items regarding eating and eating behavior than in the other items. Apparently, EDE and EDE-Q results tend to diverge. The low concordance rate might result from participants' lack of knowledge and understanding about EDs and their symptoms, invalidating their self-reports on the EDE-Q. In general, there is a lack of knowledge and awareness of EDs and its risk factors and EDs are rarely recognized and properly treated in Arab clinics [53, 54]. Participants who are better informed about EDs indeed appear to have more valid scores on the EDE-Q [52].

The EDE-Q should not be used for classification assessment, and might therefore better suited as a treatment outcome measure [55] or as part of two-staged sampling using the EDE-Q as a screener to identify Saudis at high risk for an ED, and to conduct the EDE or another clinical interview to formally establish an ED diagnosis in case of elevated EDE-Q scores. The explanation and expression in Arab countries of EDs as somatic rather than in psychiatric symptoms may also contribute to the low concordance rate [56, 57]. Besides, Saudis with an ED generally seek psychiatric help only after suffering from somatic complaints such as diabetes, kidney failure and infertility.

The study has several strengths. First of all, while Saudis are an understudied population, this is the first study to explore the psychometric properties of the EDE-Q in Saudi Arabia, testing also alternative factorial models. Psychometric analysis was based on a large sample, which allowed the CFA to be fully powered. Second, it is the first study to evaluate psychometric properties of the EDE-Q in the Gulf. Moreover, EDE-Q scores were verified by the semi-structured diagnostic EDE interview in a subsample to understand the involved culture. Furthermore, this is the first study based on interview data, as they were not available in Saudi Arabia. Since we were unable to identify a clinical population by classification, all psychometric tests were done in subsamples at high risk for EDs. Although classification concordance was low, as there is statistically significant association between both global scores, severity of ED pathology appeared to be measured accurately. Therefore the discriminant validity of the Arabic EDE-Q

got confirmed and a cut-off point for the identification of Saudis at risk for EDs was obtained. Due to the short time span between the EDE-Q and EDE differences in measurement outcome are likely to be due to differences in response patterns and not due to change in ED pathology. This study provides data on a widely used assessment tool on EDs, which will allow future comparisons of Saudis with samples from other socio-cultural contexts. As data were collected in a closed society with a taboo on mental health care [16] this is a first step towards expanding knowledge about EDs in Saudi Arabia.

Notwithstanding the strengths several limitations must be considered. First, although this study contains a large sample, reflecting the whole Saudi population well regarding age, geographical location and weight status, the sample was biased regarding gender and education level. A too large proportion of the sample was female, single and highly educated. To counteract potential effects of selection bias, the prevalence estimates and percentile scores were presented separately for males and females and corrected for educational level by propensity weighting [58]. Still, unmeasured factors may have caused selection bias: respondents to the EDE-Q, but EDE interviewees in particular, can be expected to be more interested in health care, mental health care, EDs or to have more concerns regarding their body image or eating behavior compared to the general population. Since sexes are strictly separated in Saudi Arabia and all EDE interviews were conducted by females, it is also likely that more progressive section of the population, especially among the males, participated in the EDE interview. Thus, although the presented norms were based on a large Saudi community sample, it should be noted that it was a web-based convenience sample and results should be interpreted with care.

The EDE was used as a reference to determine discriminative validity of the EDE-Q. The EDE was somewhat adapted to the Saudi culture. However, formal assessment of reliability and validity of a Saudi version of the EDE has not yet taken place in a clinical Saudi sample. The EDE could unfortunately not be validated in a clinical sample due to the unavailability of such a sample in Saudi Arabia. Still, as it is an assessor based detailed interview assessing ED pathology over the same time period, by the same rating scale and similar phrases and wording are used in the EDE and EDE-Q [9] it deemed suitable as criterion but it should not yet be considered as the gold standard. An alternative that has been evaluated on its validity is the shortened Eating Attitude Test (EAT26). Its use was considered but dismissed for the following reasons: high rates of false positives were found, and psychometric properties of the EAT26 were only assessed among teenage schoolgirls [59], while our study aimed to target a representative community sample. In addition, the EAT26 was validated more than 20 years ago while

the country has undergone rapid socio-cultural changes [54, 60] and EDs were perceived as diseases of globalization [61]. Therefore, the established norms might not be accurate anymore.

Last, use of a clinical sample would be of great value but this appeared to be impossible since there were no specialized clinics and therapists [62] and EDs were rarely recognized in Saudi Arabia [53]. A few off the respondents got ED treatment in Germany and the United Kingdom. Furthermore, within our sample we tried to identify participants with AN, BN and BED. Participants were consistent in severity presentation, but their symptom presentation between the EDE and EDE-Q was inconsistent. Therefore, classification identification appeared to be impossible.

The results implicate several areas of future research regarding the EDE and EDE-Q. Future validation of the EDE among Saudis is important, as differences may exist in the presentation and manifestation of ED pathology between populations [56, 57, 63]. Availability of a validated diagnostic interview will improve classification of these conditions, which may be quite prevalent given the high EDE-Q scores in our population sample. In addition, since none of the evaluated models of the EDE-Q provided fit, it's imperative to further evaluate the factor structure of the EDE-Q in different Saudi populations, including patients suffering from obesity classified with an ED.

In summary, the results indicate poor fit for the four factor model of the EDE-Q, which is in line with previous research. However, the total score on the Saudi version of the EDE-Q adequately measures ED pathology and identifies Saudis at high risk for EDs.

What is already known on this subject?

The EDE-Q is a widely used screener to assess for EDs and its severity. It has been translated and used in many, but not in Arab countries. In most studies the results do not support the purported four factor structure of the English original. In Saudi Arabia, only psychometric properties of the EAT26 were assessed. However, the established norms might not be accurate anymore.

What does this study add?

A Saudi version of the EDE-Q discriminates well between Saudis at high and low risk for EDs according to the EDE interview. There were no differences in gender. Global scores were high compared to Western community samples and fairly associated with BMI. This is the first study regarding EDs based on interview data in Saudi Arabia. Data were

collected in a closed society with a taboo on mental health care. This study involves a first step towards expanding knowledge about EDs in Saudi Arabia.

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Author contributions The manuscript has been written by BM in collaboration with EdB and EvF. BM was responsible for cultural adaptation of the EDE-Q and EDE, data collection and conducted EDE interviews in English. We gratefully acknowledge the help of Sara Abdullah Al Nuwayran and Abeer Ali Al Ghamdi who participated as native speakers in the translation and cultural adaptation of the EDE-Q and recruited participants and conducted EDE interviews in Arabic. Jeehan Abdulrahman al Qasim helped out recruiting participants as well as did influencer @Eyaad, Sukoun yoga studio and NuYu gym. Finally, we wish to express our gratitude to all respondents who participated in this study.

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Compliance with ethical standards

Conflict of interest There are no conflicting interests.

Ethics approval Study approval was given on May 7, 2017 (17-0097) by the ethical review boards of PNU and King Abulaziz city for Science and Technology, Riyadh, Saudi Arabia.

Consent to participate An informed consent was obtained from all participants included in the study.

References

- Keel PK, Klump KL (2003) Are eating disorders culture-bound syndromes? Implications for conceptualizing their etiology. *Psychol Bull* 129(5):747–769
- Thomas JJ, Lee S, Becker AE (2016) Updates in the epidemiology of eating disorders in Asia and the Pacific. *Curr Opin Psychiatry* 29(6):354–362
- Nasser M (1994) Screening for abnormal eating attitudes in a population of Egyptian secondary school girls. *Soc Psychiatry Psychiatr Epidemiol* 29(1):25–30
- Abou-Saleh MT, Younis Y, Karim L (1996) Anorexia nervosa in an Arab culture. *Int J Eat Disord* 23(2):207–212
- Pike KM, Hoek HW, Dunne PE (2014) Cultural trends and eating disorders. *Curr Opin Psychiatry* 27(6):436–442
- Cooper PJ, Fairburn CG (1993) Confusion over the core psychopathology of bulimia nervosa. *Int J Eat Disord* 13(4):385–389
- Aardoom JJ et al (2012) Norms and discriminative validity of the Eating Disorder Examination Questionnaire (EDE-Q). *Eat Behav* 13(4):305–309
- Isomaa R et al (2016) Development and preliminary validation of a Finnish version of the Eating Disorder Examination Questionnaire (EDE-Q). *Nord J Psychiatry* 70(7):542–546
- Fairburn C, Beglin SJ (1994) Assessment of eating disorders: interview or self-report questionnaire? *Int J Eat Disord* 16(4):363–370
- Luce KH, Crowther JH, Pole M (2008) Eating Disorder Examination Questionnaire (EDE-Q): norms for undergraduate women. *Int J Eat Disord* 41(3):273–276
- Berg KC et al (2011) Psychometric evaluation of the eating disorder examination and eating disorder examination questionnaire (EDE-Q 6.0). *Int J Eating Disord* 45(3):428–438
- Streiner DL, Norman GR, Cairney J (2015) Health measurement scales: a practical guide to their development and use. Oxford University Press, USA
- Schulte SJ (2016) Predictors of binge eating in male and female youths in the United Arab Emirates. *Appetite* 105:312–319
- Welch E et al (2011) Eating disorder examination questionnaire and clinical impairment assessment questionnaire: general population and clinical norms for young adult women in Sweden. *Behav Res Ther* 49(2):85–91
- Musaiger AO et al (2013) Risk of disordered eating attitudes among adolescents in seven Arab countries by gender and obesity: a cross-cultural study. *Appetite* 60(1):162–167
- Latzer Y, Azaiza F, Tzischinsky O (2009) Eating attitudes and dieting behavior among religious subgroups of Israeli-Arab adolescent females. *J Relig Health* 48(2):189–199
- Abdollahi P, Mann T (2001) Eating disorder symptoms and body image concerns in Iran: comparisons between Iranian women in Iran and in America. *Int J Eat Disord* 30(3):259–268
- Hilbert A, De Zwaan M, Braehler E (2012) How frequent are eating disturbances in the population? Norms of the eating disorder examination-questionnaire. *PLoS ONE* 7(1):e29125
- Guest T (2000) Using the eating disorder examination in the assessment of bulimia and anorexia: issues of reliability and validity. *Soc Work Health Care* 31(4):71–83
- Cooper Z, Fairburn C (1987) The eating disorder examination: a semi-structured interview for the assessment of the specific psychopathology of eating disorders. *Int J Eat Disord* 6(1):1–8
- Cooper Z, Cooper PJ, Fairburn CG (1989) The validity of the eating disorder examination and its subscales. *Br J Psychiatry* 154(6):807–812
- Rizvi SL et al (2000) Test–retest reliability of the eating disorder examination. *Int J Eat Disord* 28(3):311–316
- Rosen JC et al (1990) Validity studies of the eating disorder examination. *Int J Eat Disord* 9(5):519–528
- MLA, Saudi Arabia Population (2019)
- General Authority for Statistics, S.A., Demography survey, in Kingdom of Saudi Arabia, 2016
- Puri-Mirza A (2019) Number of high school students in Saudi Arabia from 2013 to 2017, by school type. 1 June 2019 [cited 19 October 2019]. <https://www.statista.com/statistics/629415/saudi-arabia-number-of-high-school-students-by-school-type/>
- Habibi N (2015) Is Saudi Arabia training too many graduates? 17 July 2015 [cited 19 October 2019]. <https://www.universityworldnews.com/post.php?story=20150714013422488>.
- Trading Economics (2019) Saudi Arabia unemployment rate. Trading Economics
- El-Gilany A-H, Hammad S (2010) Body mass index and obstetric outcomes in Saudi Arabia: a prospective cohort study. *Ann Saudi Med* 30(5):376–380
- Fairburn CG, Beglin SJ (2008) Eating disorder examination-questionnaire (6.0)
- Peterson CB et al (2007) Psychometric properties of the eating disorder examination-questionnaire: factor structure and internal consistency. *Int J Eat Disord* 40(4):386–389
- Byrne SM et al (2010) The factor structure of the eating disorder examination in clinical and community samples. *Int J Eat Disord* 43(3):260–265
- Fairburn CG, Cooper Z, O'Connor M (1993) The eating disorder examination. *Int J Eat Disord* 6:1–8

34. Mandrekar JN (2010) Receiver operating characteristic curve in diagnostic test assessment. *J Thorac Oncol* 5(9):1315–1316
35. Becker AE et al (2010) Validity and reliability of a Fijian translation and adaptation of the Eating Disorder Examination Questionnaire. *Int J Eat Disord* 43(2):171–178
36. Heiss S, Boswell JF, Hormes JM (2018) Confirmatory factor analysis of the Eating Disorder Examination-Questionnaire: a comparison of five factor solutions across vegan and omnivore participants. *Int J Eat Disord* 51(5):418–428
37. Allen KL et al (2011) Confirmatory factor analysis of the Eating Disorder Examination-Questionnaire (EDE-Q). *Eat Behav* 12(2):143–151
38. Villarroel AM et al (2011) Screening for eating disorders in undergraduate women: norms and validity of the Spanish version of the Eating Disorder Examination Questionnaire (EDE-Q). *J Psychopathol Behav Assess* 33(1):121–128
39. Machado PP et al (2014) Eating disorder examination questionnaire: psychometric properties and norms for the Portuguese population. *Eur Eat Disord Rev* 22(6):448–453
40. Rø Ø, Reas DL, Stedal K (2015) Eating disorder examination questionnaire (EDE-Q) in Norwegian adults: discrimination between female controls and eating disorder patients. *Eur Eat Disord Rev* 23(5):408–412
41. Mond JM et al (2004) Validity of the Eating Disorder Examination Questionnaire (EDE-Q) in screening for eating disorders in community samples. *Behav Res Ther* 42(5):551–567
42. Yucel B et al (2011) The Turkish version of the eating disorder examination questionnaire: reliability and validity in adolescents. *Eur Eat Disord Rev* 19(6):509–511
43. Mahmoodi M et al (2016) The Persian version of eating disorder examination questionnaire and clinical impairment assessment: norms and psychometric properties for undergraduate women. *Iran J Psychiatry* 11(2):67
44. Burke NL et al (2017) Measurement invariance of the Eating Disorder Examination in black and white children and adolescents. *Int J Eat Disord* 50(7):758–768
45. Grilo CM et al (2015) Factor structure and construct validity of the eating disorder examination-questionnaire in college students: further support for a modified brief version. *Int J Eat Disord* 48(3):284–289
46. Abdel- Fattah MM et al (2008) Depression and body image disturbances among females seeking treatment for obesity in Saudi Arabia. *Eur J Psychol* 4(3):1–8
47. Rasheed PJPH (1998) Perception of body weight and self-reported eating and exercise behaviour among obese and non-obese women in Saudi Arabia. *Public Health* 112(6):409–414
48. Unikel Santoncini C et al (2018) Validation of eating disorders examination questionnaire in Mexican women. *Int J Eat Disord* 51(2):146–154
49. Rø Ø, Reas DL, Rosenvinge J (2012) The impact of age and BMI on Eating Disorder Examination Questionnaire (EDE-Q) scores in a community sample. *Eat Behav* 13(2):158–161
50. Mirkim B (2012) Population levels, trends and policies in the Arab region. Challenges and opportunities. Arab Human Development Report, United Nations Development Programme, USA
51. Berg KC et al (2012) Diagnostic concordance of the interview and questionnaire versions of the eating disorder examination. *Int J Eat Disord* 45(7):850–855
52. Berg KC et al (2013) Response patterns on interview and questionnaire versions of the Eating Disorder Examination and their impact on latent structure analyses. *Compr Psychiatry* 54(5):506–516
53. Alkhadari S et al (2016) Prevalence of psychiatric morbidity in the primary health clinic attendees in Kuwait. *J Affect Disord* 195:15–20
54. Melisse B, Beurs E, Furth EF (2020) Eating disorders in the Arab world: a literature review. *J Eat Disord*. <https://doi.org/10.1186/s40337-020-00336-x>
55. Dingemans A (2017) Measuring changes during the treatment of eating disorders: a comparison of two types of questionnaires. *Tijdschr Psych* 59(5):278–285
56. Viernes N et al (2007) Tendency toward deliberate food restriction, fear of fatness and somatic attribution in cross-cultural samples. *Eat Behav* 8(3):407–417
57. Kayano M et al (2008) Eating attitudes and body dissatisfaction in adolescents: cross-cultural study. *Psychiatry Clin Neurosci* 62(1):17–25
58. Bethlehem J (2010) Selection bias in web surveys. *Int Stat Rev* 78(2):161–188
59. Al-Subaie A et al (1996) Validity of the Arabic version of the Eating Attitude Test. *Int J Eat Disord* 20(3):321–324
60. Eapen VM, Mabrouk AA, Bin Othman S (2006) Disordered eating attitudes and symptomatology among adolescent girls in the United Arab Emirates. *Eat Behav* 7(1):53–60
61. Gordon RA (2001) Eating disorders East and West: a culture-bound syndrome unbound. *Int J Eat Disord* 1:16
62. Qadan L (2009) Anorexia nervosa: beyond boundaries. *Int J Eat Disord* 42(5):479–481
63. Marques L et al (2011) Comparative prevalence, correlates of impairment, and service utilization for eating disorders across US ethnic groups: implications for reducing ethnic disparities in health care access for eating disorders. *Int J Eat Disord* 44(5):412–420
64. Plecher H (2019) Saudi Arabia: average age of the population from 1950 to 2050 (median age in years). [cited 19 October 2019]. <https://www.statista.com/statistics/262482/median-age-of-the-population-in-saudi-arabia/>
65. WHO (2004) BMI classification. World Health Organisation
66. Higa K et al (2017) The international federation for the surgery of obesity and metabolic disorders. Third IFSO global registry report, vol 19(8), pp 953–1076
67. Al-Khaldi Y (2016) Bariatric surgery in Saudi Arabia: the urgent need for standards. *Saudi J Obes* 4(1):1–1
68. General Authority for Statistics, S.A., Chapter 04 Health (2016)
69. Arab News, S.A., Saudi Arabia's unemployment rate drops to 12.5%, in Arab News (2019)
70. Top Universities (2015) Middle Eastern students abroad: in numbers [20 October 2019]. <https://www.topuniversities.com/blog/middle-eastern-students-abroad-numbers>
71. Ahmed AE et al (2018) The influences of bariatric surgery on hemoglobin A1c in a sample of obese patients in Saudi Arabia. *Diabetes Metab Syndr Obes* 11:271–276. <https://doi.org/10.2147/DMSO.S161540>

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