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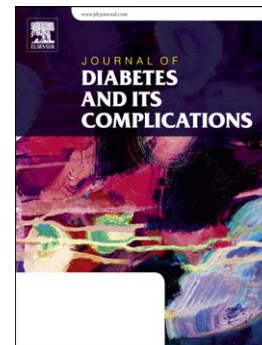
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Food Addiction Associations with Psychological Distress among People with Type 2**Diabetes**

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Abstract

Aims

To assess the relationship between a food addiction (FA) model and psychological distress among a type 2 diabetes (t2d) sample.

Methods

A cross-sectional study of 334 participants with t2d diagnoses were invited to complete a web-based questionnaire. We measured variables of psychological distress implementing the Depression Anxiety and Stress Scale (DASS-21), the Yale Food Addiction Scale (YFAS), and other factors associated with t2d.

Results

In our study a novel finding highlighted people with t2d meeting the FA criterion had significantly higher depression, anxiety, and stress scores as compared to participants who did not meet the FA criterion. Moreover, FA symptomology explained 35% of the unique variance in depression scores, 34% of the unique variance in anxiety scores, and 34% of the unique variance in stress scores, while surprisingly, BMI explained less than 1% of the unique variance in scores.

Conclusion

We identified that psychological distress among people with t2d was associated with the FA model, apparently more so than BMI, thereby indicating further research being necessary lending support for future research in this realm. Moreover the FA model may be beneficial when addressing treatment approaches for psychological distress among people with t2d.

Keywords: Type 2 diabetes; psychological distress; BMI; food addiction.

Food Addiction Associations with Psychological Distress among People with Type 2

Diabetes

1. Introduction

Type 2 diabetes is a major international health crisis with its associated high morbidity and mortality rates. Reflecting an increase in awareness that people with t2d are confronted with a range of biopsychosocial challenges, recent research has documented strong associations between t2d and poor mental health (Bener, Al-Hamaq & Dafeeah, 2011; Mezuk, Eaton, Albrecht & Golden, 2008). While the direction of a causal relationship between having t2d and experiencing poor mental health, such as depression, is still somewhat contentious, it is likely to be a bidirectional relationship. Higher levels of depression, anxiety, and stress associated with t2d not only present in themselves as poor health, but may also increase the risk of potential diabetes complications. Such potential complications may include increased insulin resistance (Sinja & Jastreboff, 2013) or increased risk of cognitive decline and Alzheimer's disease (Feinkoh, Price, Strachan, & Frier, 2015). Additional complications of t2d with depression stem from the reported higher incidences of unhealthy behaviours, such as smoking, physical inactivity, unhealthy diet, and poor glycaemic management compliance (Lin et al., 2004). Indeed, dating back to 1864 Thomas Willis – a British Physician, implied that diabetes ensued from 'sadness or long sorrow and other depressions and disorders' (Willis, 1971).

While increased psychological distress appears to be associated with t2d, current empirically evidenced understandings of why people with t2d have such poor psychological well-being is somewhat limited (Rubin & Peyrot, 2002). Much of the previous research in this area has focused on biological and obesity related explanations of poor mental health (e.g., variations in glycaemic levels, neurological alterations in metabolism of serotonin and norepinephrine, trophic agent changes, biochemical changes associated with increased

dyslipidemia, and stigmatisation of obesity) (Lustman et al., 2000; Miller, Maletic, & Raison, 2009; Sutin & Terracciano, 2013; Valabhji, & Elkeles, 2003). Indeed, research continues to demonstrate that obesity is one of the strongest predictors of depression in t2d samples, as well as non-type 2 diabetes populations, with risk of depression being 20% to 50% higher among obese individuals than normal weight individuals (Mather, Cox, Enn, & Sareen, 2009; Simon, et al., 2006; Svenningsson, Bjorkelund, Marklund, & Gedda, 2012). Furthermore, these risks are reported to be even higher for extremely obese individuals. (Abilés et al., 2010; Petry, Barry, Pietrzak, & Wagner, 2008).

Despite the gains that such biological and obesity orientated research have made to the understanding of psychological distress in populations with t2d, we are still presented with large variances in psychological distress that remain unaccounted for. This gap in our knowledge compromises the design of evidence based interventions to provide effective care to ameliorate psychological distress associated with t2d. This highlights the need to consider new approaches to the understanding of psychological well-being in persons with t2d.

1.1 Food addiction model

One such approach to explaining the high levels of depression, anxiety, and stress in people with t2d is to consider an addiction model, or, more specifically, a ‘food addiction’ (FA) model (Corwin & Grigson, 2009). The concept of FA parallels that of substance abuse in terms of mechanism and associated negative consequences characterised by the classic symptoms of addiction: tolerance and withdrawal (Ifland, et al., 2009). Food addiction behaviours associated with highly processed and hyperpalatable foods (typically refined carbohydrates, sweeteners, fats, and processed foods) have been shown to mimic the DSM–IV–TR, (American Psychiatric Association, 2000, 4th ed., text rev.) criteria for substance use disorders (Corsica & Pelchat, 2010; Gearhardt, Davis, Kushner, & Brownell, 2011). It should also be noted that there has been reported overlap between FA and other ways of

conceptualizing disordered eating; especially binge eating disorder where strong relationships between binge eating and FA as well as parallel relationships between these constructs and distress, poor weight loss, have been observed. (Burmeister, Hinman, Koball, Hoffmann, & Carels, 2013).

While the FA model has been a contentious topic (Ziauddeen & Fletcher, 2013), evidence suggests it has many similarities in the neurochemical mechanisms and behavioural symptomology underlying other substances of abuse (Gearhardt, White, Masheb, Grilo, 2013; Volkow, Wang, Tomasi & Baler, 2013). Of key importance to t2d and a FA model, substance abuse has been linked to psychological distress and obesity (Martins & Gorelick, 2011; Tolliver & Anton, 2015), both of which separately and together have been linked to t2d (Furaya, Hayashino, Tsujii, Ishii & Fukuhara, 2013; Kaur, Tee, Ariaratnam, Krishnapillai & China, 2013; Svenningsson, Björkelund, Marklund & Gedda 2012).

Previously measuring a person's FA symptomology or eating related problems has been challenging. Issues have been encountered such as appraising whether an addictive element applies to disordered eating (Schulte, Joyner, Potenza, Grilo & Gearhardt, 2015). Currently, the most generally accepted measure for assessing FA is the Yale Food Addiction Scale (YFAS; Gearhardt, Corbin & Brownell, 2009). The YFAS was introduced as a valid and reliable self-report measurement for the assessment of FA symptomology paralleling the DSM-IV-TR Substance Disorder criteria (Gearhardt, et al., 2009; Muele & Gearhardt, 2014). Pedram et al., (2013) utilised the YFAS investigating the degree that the FA framework contributed to obesity among a general populous. Results demonstrated that FA was a key player; over 80% of food addicted people were overweight/obese suggesting the FA phenomenon is significantly contributing to the fast-growing obesogenic climate.

1.2. Substance abuse, psychological distress, and type 2 diabetes

Earlier research has shown a relationship between various forms of substance use disorders and psychological distress (Martins & Gorelick, 2011; Pettinati, O'Brien & Dundon, 2013; Tolliver & Anton, 2015). Results from the large scale National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), covering the co-morbidity of DSM-IV substance use disorders and nine separate mood and anxiety disorders ($n = 43,093$), found that 60 percent of the participants seeking treatment for any drug use disorder in the past year had a mood disorder and 43 percent presented with at least one anxiety disorder (Grant et al., 2004). Additionally, a recent literature review demonstrated over one-third of alcohol dependence was associated with other mental illnesses (Klimkiewicz, Klimkiewicz, Jakubczyk, Kieres-Salomoński, & Wojnar 2015). Martins and Gorelick (2011) highlighted substance use over the lifespan was higher in participants with psychiatric illness than in participants without a disorder.

Specifically, nicotine dependence and active smoking have been recognised among people with t2d (Pan, Wang, Talaei, Hu & Wu Zhang, 2015; Willi, Bodenmann, Ghali, Faris & Cornuz, 2007) and mood disorders including depression was shown to be of greater intensity amongst nicotine addicts than non-smokers (Pietras, Witusik, Panek, Janusz, & Gorski, 2011). Furthermore, recent research indicates that people with t2d and with a diagnosed substance abuse disorder are twice as likely to have a psychiatric mood disorder (Wu et al, 2015). While Wu et al's., (2015) research didn't consider FA, their conclusions do provide further evidence that people with t2d and FA symptomology are likely to have an increased risk of psychological distress.

Taken together previous research evidences high associations between psychological distress and substance abuse. Although research has examined the relationship between alcohol, tobacco, and drug substance abuse with psychological distress among people with t2d, no research has considered the association between psychological distress and a FA

model in this population. This is despite recent research demonstrating that over 70% of people with t2d met a FA criteria (Raymond & Lovell, 2015). Hence the current study aimed to assess the relationship between a FA model and psychological distress among a t2d sample. Specifically, two research objectives were approached: firstly, whether depression, anxiety, and stress scores significantly differed between participants who met a FA criterion and those that did not. Secondly, to compare the cross-sectional predictive contributions to depression, anxiety, and stress scores made by FA and body mass index (BMI), while controlling for covariation between the assessed variables. Positive findings to support such hypotheses would have substantial implications for the design of interventions to provide care for people with t2d and the enhancement of their psychological well-being.

2. Methods

This study was approved by the University of the Sunshine Coast Ethics committee.

2.1. Participants

An online survey set on the SurveyMonkey platform recruited 381 participants. Twenty-four participants withdrew immediately after the informed consent section, 15 participants withdrew during the survey, nine participants did not confirm that they had a current t2d diagnosis, leaving a total of 334 participants. The final sample included 221 females (65.6%) and 110 males (32.9%; five participants did not indicate their gender). Ages ranged from 27 to 81 years ($M = 58.0$, $SD = 9.5$). Data from this sample have been published previously which demonstrated over 70% of people with t2d met the YFAS criteria for FA, and highlighted the FA classification group had significantly higher BMI scores. Furthermore FA and impulsivity (non-planning) were significant predictors of BMI (Raymond & Lovell, 2015).

The majority of participants were recruited from Australia (47%), with the remaining 53% participants from: USA (25.1%), UK (23.1%), New Zealand (1.8%), Germany (0.6%),

Ireland (0.3%), Malaysia (0.6%), Norway (0.3%), and Spain (0.3%), with 0.6% not reporting their domicile. Participants' weight ranged from 46 – 184 kg, $M_{\text{weight}} = 106.88$ kg, $SD_{\text{weight}} = 23.59$ kg; Height ranged from 147 – 194 cm, $M_{\text{height}} = 168.66$ cm, $SD_{\text{height}} = 9.06$ cm; BMI ranged from 18.9 – 58.6 kg/m², $M_{\text{BMI}} = 37.6$ kg/m², $SD_{\text{BMI}} = 7.99$. Seven percent of the participants were in the normal BMI category (≥ 18 -24.99 kg/m²), 11% were categorised as overweight (≥ 25 -29.99 kg/m²), and 79% were categorised as obese (≥ 30 kg/m²).

3. Procedure

Following institutional ethical approval and confirmation of informed consent, participants over 18 years of age with formalised diagnosis of t2d from a healthcare professional completed the online survey. Participants completed a self-report questionnaire, which included demographic questions regarding t2d status, age, gender, country of residence, and two separate test batteries: the Depression Anxiety Stress Scale (DASS-21) and the YFAS. Participant recruitment was achieved via Facebook, placing advertisements and flyers on message boards in medical practices and gymnasiums, and diabetes websites. Diabetes Australia placed a research advertisement on their website for the duration of the research, and Diabetes UK included an advertisement in their magazine. Potential participants received a Research Project Information Sheet detailing the aims of the research which entailed exploring FA and psychological distress associations in a t2d sample.

4. Data collection

4.1. Assessment of Depression, anxiety and stress

The Depression Anxiety Stress Scale (DASS-21) was utilised to measure depression, anxiety, and stress, (Lovibond & Lovibond, 1995). The DASS-21 is scored on a four-point scale with scores from 0 (*Did not apply to me at all – never*) to 3 (*Applied to me very much, or most of the time – almost always*). The range of possible scores for each of the three 7-item subscales is 0-21, where a higher score represents a higher level of depression, anxiety, or

stress. The DASS-21 has shown adequate internal consistency ($\alpha = .93$), discriminant validity, as well as satisfactory convergent validity when compared to other measures of depression and anxiety (Henry & Crawford, 2005).

4.2. Assessment of food addiction symptomology

The Yale Food Addiction Scale was utilised to assess FA symptomology; a self-report 25-item scale designed to measure FA symptomology over the past 12 months (Gearhardt et al., 2009). The YFAS measure focuses on operationalising addictive eating behaviours, which parallel the symptomology of substance dependence criteria, listed in the DSM-IV-TR (American Psychiatric Association; APA, 2000). The seven food criteria include: 1) substance taken in larger amount and for longer period than intended; 2) persistent desire or repeated unsuccessful attempt to quit; 3) much time/activity to obtain, use, and recover; 4) important social, occupational, or recreation activities given up or reduced; 5) use continues despite knowledge of adverse consequences (e.g., failure to fulfil role obligation, use when physically hazardous); 6) tolerance (marked increase in amount; marked decrease in effect); and 7) characteristic withdrawal symptoms; substance taken to relieve withdrawal. The YFAS scoring provides a dichotomous FA addiction classification and a continuous FA symptom count score. The continuous score is the total number of symptoms endorsed and ranges from 0 to 7. For a classification of FA to be inferred, respondents needed to have experienced three or more symptoms over the past year, as well as meeting the “clinically significant impairment” criterion. The YFAS has been found to exhibit good internal reliability ($\alpha = .86$), along with good convergent and divergent reliability (Brunault, Ballon, Gaillard, Reveillere, & Courtois, 2014), and is considered to be an appropriate tool for assessing eating behaviours (Muele & Gearhardt, 2014).

4.3. Data analysis and statistical methods

Descriptive statistics - One-sample *t*-tests were employed to compare the depression, anxiety, and stress scores of participants against Crawford et al's., (2011) Australian general adult population norm scores. Research objective one (employing the YFAS) was investigated by a one-way between-groups multivariate analysis of variance (MANOVA) examining the dependent variables of depression, anxiety, and stress with FA criteria (2 levels): i) meeting the criterion for FA diagnosis; ii) not meeting the FA criteria for diagnosis representing the independent variable. Research objective two (to explore the variables of BMI and FA as significant predictors of depression, anxiety and stress scores in people with t2d) was investigated by three multiple regression analyses.

5. Results

SPSS (version 20; SPSS Inc., Chicago, IL, USA) was used for statistical analyses. Data screening was conducted to ensure that appropriate assumptions were met with no serious violations noted for any of the reported analyses. The internal consistency of all scales and subscales was analyzed. Sample statistics, variables' descriptive statistics, and intercorrelations are reported in Table 1.

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5.1. Descriptive statistics

One-sample *t*-tests were used to compare the depression, anxiety, and stress scores of our sample of participants with t2d against Crawford et al's (2011) Australian general adult population norms. Our sample of people with t2d had significantly and meaningfully higher scores on each of the DASS-21 subscales than Crawfords et al's (2011) Australian norms: depression, $t(333) = 27.59$ $p < .001$, $d = 3.02$ (Cohen, 1988); anxiety, $t(333) = 24.56$ $p < .001$, $d = 2.69$ (Cohen, 1988); and stress, $t(333) = 25.04$ $p < .001$, $d = 2.74$ (Cohen, 1988). As

shown in Table 2, approximately three quarters of the sample had higher than normal scores across the depression, anxiety, and stress subscales. Overall, the anxiety subscale demonstrated the most elevated scores, with almost half of the sample having scores in the extremely severe range. Similarly, well over a third of the sample had scores in the extremely severe range for the depression subscale.

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5.2 Depression, Anxiety, and Stress Differences Between Food Addiction Classifications

Research objective 1 examined whether depression, anxiety, and stress scores significantly differed between people with t2d who met the criterion for FA and people with t2d who did not meet this criterion. To assess this, a one-way between-groups MANOVA was performed on the dependent variables of depression, anxiety, and stress with FA classification (meeting the criterion for FA diagnosis or not) representing the independent variable. Results of the MANOVA demonstrated a main effect of FA, $F(3, 330) = 135.53, p < .001$, Wilks Lambda = .45, $n_p^2 = .55$, with this being a large effect size (Cohen, 1988). Subsequent univariate tests of the same design demonstrated that those meeting the criterion for FA diagnosis had significantly higher levels of depression, $F(1, 332) = 336.29, p < .001, n_p^2 = .50$; anxiety, $F(1, 332) = 336.86, p < .001, n_p^2 = .50$; and stress, $F(1, 332) = 282.52, p < .001, n_p^2 = .46$, than those who did not meet the criterion. As shown in Fig. 1, the mean scores tripled for anxiety, and significantly doubled for depression and stress when compared to those in the sample whom did not meet the FA criteria.

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5.3 Predictors of Depression, Anxiety and Stress

Objective 2 aimed to determine what extent BMI and FA symptomology were significant cross-sectional predictors of depression, anxiety, and stress scores among people with t2d. To estimate the proportion of variance in depression, anxiety, and stress scores that could be accounted for by the predictor variables of BMI and FA, three separate simultaneous multiple regression analyses were performed. While multicollinearity is always a concern when variables are correlated, as all variance inflation factor (VIF) scores were well below 10 with tolerance statistics all above .2, we confidently conclude that there were no collinearity within our data.

5.3.1. Depression.

Results of the multiple regression demonstrated that the overall model was significant and that in combination, BMI and FA accounted for a 63% of the variation in participants' depression scores, $R^2 = .63$, *adjusted R*² = .62, $F(2, 331) = 276.22$, $p < .001$. This represented a large effect size. Food addiction made a substantially larger unique contribution to depression scores than BMI, with 35% of the unique variation in depression scores being explained by FA ($\beta = .73$, $t = 17.57$, $p < .05$, $sr^2 = 35\%$) as compared to 1% of the variation being explained by BMI ($\beta = .10$, $t = 2.53$, $p < .05$, $sr^2 = 1\%$).

5.3.2 Anxiety.

Results of the multiple regression showed that the overall model for anxiety was significant, demonstrating that BMI and FA in combination accounted for 62% of the variance in participants' anxiety scores, $R^2 = .62$, *adjusted R*² = .62%, $F(2, 331) = 267.05$, $p < .001$. An overall large effect size was observed. FA was again observed to make a far larger unique contribution to explaining variation in anxiety scores than BMI, with 34% of the unique variation in anxiety scores being explained by FA ($\beta = .72$, $t = 17.18$, $p < .001$, $sr^2 = 34\%$) and 1% of the unique variation explained by BMI ($\beta = .11$, $t = 2.64$, $p < .01$, $sr^2 = 1\%$).

5.3.3 Stress.

The multiple regression demonstrated that, in combination, BMI and FA significantly predicted stress scores, together accounting for 58% of the variance in stress scores, $R^2 = .58$, *adjusted* $R^2 = .57$, $F(2, 331) = 225.43$, $p = .001$. An overall large effect size was observed. Moreover, 34% of the unique variation in stress scores was explained by FA ($\beta = .72$, $t = 16.39$, $p < .001$, $sr^2 = 34\%$), while BMI failed to account for a significant proportion of unique variance in stress scores ($\beta = .07$, $t = 1.49$, $p = .138$, $sr^2 < 1\%$).

6. Discussion

This study aimed to assess the association between FA model and psychological distress in a t2d sample. The results supported those already evidenced in previous research that individuals with t2d are at substantial risk of heightened depression, anxiety, and stress (Bener et al., 2011). Our data demonstrated that three quarters of the participants had depression, anxiety, and stress levels beyond the normal range. With regard to our study, novel yet significant results relating to the first research objective, showed that people with t2d who met the YFAS criterion for FA reported significantly higher depression, anxiety, and stress scores than people who did not meet the criterion. The results relating to the second research objective highlight the potential importance of FA in the etiology of psychological distress in people with t2d and the unique contribution of FA to predicting depression, anxiety, and stress scores was substantially larger than that made by BMI (which accounted for around 1% of the unique variation in scores once FA was factored in). This novel finding suggests that implementing a FA model in treatment, prior to or in tandem with BMI and other treatment frameworks for t2d, may well produce substantially greater effects upon individuals' psychological well-being outcomes.

The current study's results mirror findings regarding other substances of abuse. The relationship between increased psychological distress and FA symptomology found in our

study expands on the already existing empirical evidence base typically demonstrating co-occurring substance use disorders and psychological distress (Martins & Gorelick, 2011; Tolliver & Anton, 2015). Moreover, this finding stimulates and justifies advocacy for clinical research regarding the routine screening of people with t2d for FA symptomology, implementing standardised self-report instruments such as the YFAS (Gearhardt et al., 2009; Schulte, et al., 2015). Furthermore, the development and implementation of programs to ameliorate psychological distress in people with 2td may consider adopting a FA model which involves a recovery treatment plan; for example Sheppard (Sheppard, 2000). Likewise, potential care interventions to alleviate psychological distress and obesity based on a FA addiction model also borrow from our colleagues working with traditional addictions. Accepted foundations of addiction interventions include the Minnesota Model (Lefever, 2000), outpatient treatments, and continuing care models including: self-help groups, telephone-based continuing care, individual therapies (Cognitive-behavioural therapy; 12 step facilitation; Motivational Enhancement therapy; Marital and family therapies) and 12 step focussed group counselling (McKay & Hiller-Sturmhöfel, 2011).

6.1 Strengths of the study

Importantly, there are potentially additional benefits of using a FA model to treat psychological distress in people with t2d. Not only does our research suggest that FA symptomology is a substantial risk factor the development of psychological distress, but previous research also suggested that FA is strongly related to obesity in both t2d and non-t2d samples (Pedram, et al., 2013; Raymond & Lovell, 2015); both risk factors for complications of t2d. Thus interventions focussed on alleviating FA symptomology in people with t2d has the potential to decrease the incidence of obesity as well as psychological distress, in turn decreasing the risk of t2d.

Notwithstanding, the question of causality still remains: does FA cause obesity and psychological distress, or *vice versa*? A complete answer to this question is beyond the scope of this current investigation as no longitudinal data were collected. Hence, we suggest that, similar to the relationships between obesity and poor mental health, the relationships between FA, BMI, and mental health are very likely to be bidirectional. It is important to note that a third undiscussed variable may be contributing to the association between distress and obesity such as low activity level, stigmatization, or poor nutrition. However this goes beyond our data; future research may benefit from further investigations of such variables. The sensible implication of such a model would be that for optimal outcomes, interventions should attempt to simultaneously directly reduce both BMI and psychological distress through a range of approaches including physical activity, a healthy diet, and through the treatment of FA symptomology. We are not arguing that FA interventions are the *panacea*, but instead, this approach is worthy of further investigation and appears to be a strong candidate as an additional treatment method for the challenges, both psychological and biological, faced by people with t2d.

6.2. *Limitations of the study*

While our findings have clear implications for the care of people with t2d, the current study does have limitations. Primarily, findings of cross-sectional studies are associations and do not infer causality. The second limitation pertains to the use of self-report measures. As many of our participants were overweight, having to provide information relating to their weight and height may have been somewhat confronting, which may have led to an underestimation of body weight (Gorber, Tremblay, Moher, & Gorber, 2007). Lastly, another consideration links to gender differences with there being more female participants than male participants in our study. Future research focused upon identifying any potential gender differences in the impact of FA on psychological distress in t2d would appear

warranted. Nevertheless, these results do present initial empirical data to suggest that using a FA model in t2d populations is worthy of further examination, including investigation of any underlying genetic influences contributing to the propensity to become a food addict as well as clinical trials of FA-informed treatment approaches.

7. Conclusion

In conclusion this present research found that the FA model was associated with psychological distress in people with t2d and identified as a significant predictor; meaningfully stronger than BMI. This novel finding justifies further research exploring the efficacy of employing a FA model when treating psychological distress among people with t2d.

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Table 1

Dependent Variables' Descriptive Statistics and Intercorrelations

Measure	α	M	SD	1	2	3	4	5
1. BMI (kg/m ²)	-	37.6	8.0	-				
2. DASS-21 A	.90	8.8	5.2	.53**	-			
3. DASS-21 S	.91	10.6	4.9	.48**	.85**	-		
4. DASS-21 D	.94	11.2	5.7	.53**	.83**	.86**	-	
5. YFAS	.98	4.7	2.2	.58**	.78**	.76**	.79**	-

Note. ** $p < .001$

Table 2

Percentage of Sample of People with Type 2 Diabetes Classified by DASS-21 Severity

Categories

Classification	Depression (%)	Anxiety (%)	Stress (%)
Normal	18.6%	21.5%	26.9
Mild	5.2%	9.1%	8.2%
Moderate	11.9%	7.3%	26.0%
Severe	22.9%	13.0%	29.9%
Extremely severe	41.5%	49.1%	9.1%

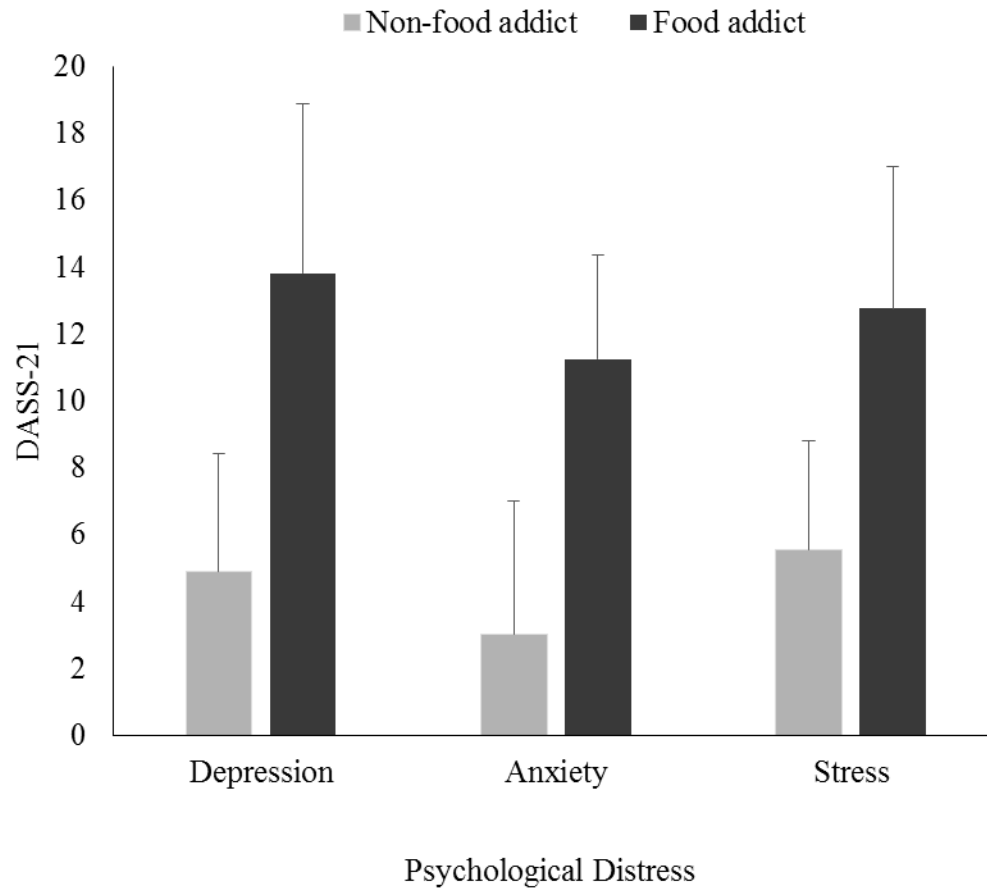


Fig. 1. Mean and standard deviation depression, anxiety, and stress scores by YFAS food addiction classification