

Exercise addiction in adolescents and emerging adults – Validation of a youth version of the Exercise Addiction Inventory

MIA BECK LICHTENSTEIN^{1*}, MARK D. GRIFFITHS², SIMONE DAUGAARD HEMMINGSEN³ and RENÉ KLINKBY STØVING⁴

¹Department of Psychology, University of Southern Denmark, Odense C, Denmark

²International Gaming Research Unit, Psychology Department, Nottingham Trent University, Nottingham, United Kingdom

³Odense University Hospital, Mental Health Services in the Region of Southern Denmark, Odense C, Denmark

⁴Department of Endocrinology, Center for Eating Disorders, Odense University Hospital, Odense C, Denmark

(Received: August 24, 2017; revised manuscript received: December 25, 2017; accepted: January 7, 2018)

Background: Behavioral addictions often onset in adolescence and increase the risk of psychological and social problems later in life. The core symptoms of addiction are tolerance, withdrawal symptoms, lack of control, and compulsive occupation with the behavior. Psychometrically validated tools are required for detection and early intervention. Adolescent screening instruments exist for several behavioral addictions including gambling and video gaming addiction but not for exercise addiction. Given recent empirical and clinical evidence that a minority of teenagers appear to be experiencing exercise addiction, a psychometrically robust screening instrument is required. **Aims:** The aim of this study was to develop and test the psychometric properties of a youth version of the Exercise Addiction Inventory (EAI) – a robust screening instrument that has been used across different countries and cultures – and to assess the prevalence of exercise addiction and associated disturbed eating. **Methods:** A cross-sectional survey was administered to three high-risk samples ($n = 471$) aged 11–20 years (mean age: 16.3 years): sport school students, fitness center attendees, and patients with eating disorder diagnoses. A youth version of the EAI (EAI-Y) was developed and distributed. Participants were also screened for disordered eating with the SCOFF Questionnaire. **Results:** Overall, the EAI-Y demonstrated good reliability and construct validity. The prevalence rate of exercise addiction was 4.0% in school athletes, 8.7% in fitness attendees, and 21% in patients with eating disorders. Exercise addiction was associated with feelings of guilt when not exercising, ignoring pain and injury, and higher levels of body dissatisfaction.

Keywords: behavioral addiction, exercise dependence, exercise addiction, adolescent addiction, disordered eating

INTRODUCTION

Adolescence is a period at great risk for development of addictive behaviors, such as gambling and gaming addiction (Griffiths, 2002), and binge eating (Ross & Ivis, 1999). Adolescents who develop addiction disorders in youth have increased risk of mental and social problems later in life (Burge, Pietrzak, & Petry, 2006; Pontes, Macur, & Griffiths, 2016; Villeda et al., 2011). It is important to be able to detect early signs of addiction to prevent severe distress and to study if behavioral addictions are increasing problems in western society. Thus, validated tools are required to assess disease-specific symptoms in adolescents. There are now several robust psychometric tools that assess problematic and addictive adolescent gambling behavior (Edgren et al., 2016) and video gaming behavior (King, Haagsma, Delfabbro, Gradisar, & Griffiths, 2013) but not for adolescent exercise addiction.

Exercise addiction is characterized by excessive and obsessive exercise patterns that eventually lead to physical and psychological distress (Adams, 2009; Adams & Kirkby, 1998; Allegrè, Souville, Therme, & Griffiths, 2006; Hausenblas & Downs, 2002a). Exercise addiction and disordered eating often appear together and both have been conceptualized

as behavioral addictions (e.g., Davis & Claridge, 1998; Demetrovics & Griffiths, 2012). The two disorders share personality traits, such as compulsiveness, body perfectionism, and neuroticism (Davis & Fox, 1993; Davis & Kaptein, 2006), and they can be primary and secondary to each other.

The prevalence rates of exercise addiction range worldwide from 3% to 9% among different adult sport samples, mostly sport students and fitness exercisers (Griffiths, Szabo, & Terry, 2005; Lindwall & Palmeira, 2009). Some preliminary results have shown that younger age is associated with higher risk of exercise addiction in adult samples (Lichtenstein, Larsen, Stoving, & Bredahl, 2014; Zeulner, Ziemanz, Beyer, Hammon, & Janka, 2016). However, only few studies have measured the prevalence of exercise addiction in a youth sample. A cross-cultural study on the prevalence rates of 11 adolescent addictions found that exercise addiction was the second most common addiction disorder with 23% sufferers in a Russian sample

* Corresponding author: Mia Beck Lichtenstein, Associate Professor; Department of Psychology, University of Southern Denmark, J. B. Winsløvs Vej 18, 220 B, Odense C DK-5000, Denmark; Phone: +45 2621 8846; E-mail: m.lichtenstein@health.sdu.dk

(mean age: 16.3 years) and with 27% sufferers in a Spanish sample (mean age: 14.9 years). These results were based on self-reported addictions and did not use validated tools (Tsai et al., 2017). An Italian youth sample (aged: 13–20 years) found 8.5% at risk of exercise addiction (Vilella et al., 2011). Consequently, more studies are warranted to explore the prevalence and incidence of primary exercise addiction among children and emerging adults.

The Danish Patient Organization Against Eating Disorders (Landsforeningen mod Spiseforstyrrelser og Selvskade, <https://www.lmsos.dk>) and Center of Knowledge (Videncenter om Spiseforstyrrelser og Selvskade, <https://www.viooss.dk>) have experienced an increasing number of young people (or their parents) reporting problems with excessive and compulsive exercise patterns, even in the absence of an eating disorder, and they request assessment methods for exercise addiction in adolescents.

Different instruments to assess exercise addiction in adults have been developed over the past 30 years (Egorov & Szabo, 2013). One of the most widely used over the past decade is the Exercise Addiction Inventory (EAI; Griffiths et al., 2005; Terry, Szabo, & Griffiths, 2004). The EAI is a 6-item screening tool that directly maps onto to the six components of behavioral addictions (salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse) proposed in Brown's (1993, 1997) model and adapted by Griffiths (1996, 2005). It has good psychometric properties and has been used across different cultures (Griffiths et al., 2015; Lichtenstein, Christiansen, Bilenberg, & Stoving, 2014). Furthermore, its advantage is a clear cut-off point for assessing the risk of exercise addiction, which makes it possible to identify and describe addictive risk profiles.

However, the EAI has only been validated in adult samples and it is inappropriate to assume that the adult EAI is applicable to adolescents. Consequently – and as with other behavioral addictions (e.g., gambling and gaming) – a youth version of an already validated adult addiction scale was developed. Given the aforementioned preliminary empirical and clinical evidence that young people appear to be more susceptible to behavioral addictions, the aim of this study was to develop a *youth* version of the EAI (EAI-Y) and to test its psychometric properties among adolescents and emerging adults. Furthermore, the study attempted to estimate the prevalence proportion of exercise addiction and to explore the potential association with disordered eating attitudes.

METHODS

The study employed a cross-sectional design containing a questionnaire survey administered to three different adolescent and emerging adult sub-groups expected to perform regular exercise (i.e., sport school students, attendees at fitness centers, and eating disorder patients). A total of 471 adolescents and emerging adults (age range: 11–20 years, mean age: 16.3 years) participated in the study.

Participants

The young sport school students were recruited from three boarding schools with a special athlete grade level where

students received extra sport lessons. They all performed regular and planned exercise on a daily basis in school and in their leisure time. They were invited to participate in the study and were given access to an online version of the survey. A total of 257 sport school students completed the survey ($M = 15.8$ years, $SD = 1.25$, range: 12–20 years). The young fitness exercisers were recruited from three fitness centers where an online version of the survey was advertised at the center's online pages and directed toward members up to 20 years of age. A total of 127 fitness attendees participated in the study ($M = 17.6$ years, $SD = 1.41$, range: 14–20 years). Finally, for a 1-year period, adolescent patients referred for eating disorder visitation and treatment in the mental health services were enrolled. A total of 89 patients were invited to participate in the survey and 87 completed the questionnaires ($M = 15.8$ years, $SD = 2.33$, range: 11–19 years).

Procedure

As with the EAI, the EAI-Y was developed on the basis of the six components of behavioral addictions. The items address: salience (exercise is very important), conflicts (large exercise amounts lead to conflicts with parents), mood modification (exercise is used to change emotions), tolerance (increasing exercise over time), withdrawal symptoms (abstinence symptoms occur when exercise is missed), conflict (compromising of relationships, education, job, etc.), and relapse (returning to excessive exercise following a period of abstinence). The items are responded on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

In developing the EAI-Y, the item sentences were made shorter, simpler, and more youth specific (e.g., the word “partner” was changed to “friends”). Following this, 10 young exercisers examined readability and comprehensibility, whereas two child psychiatrists and two psychologists evaluated face validity. Finally, the EAI-Y was two-way translated independently by two bilingual adolescents forth and back from Danish to English and from English to Danish. The English version of the EAI-Y was then sent to one of the original co-developers of the EAI for adults and approved. The Danish version was used in this study.

Measures

The survey included the EAI-Y, the SCOFF Questionnaire for eating disorders, sociodemographic items, and questions concerning disturbed attitudes toward exercise and eating. To estimate probability of eating disorder pathology, the SCOFF Questionnaire was used. SCOFF is an acronym of five keywords from the following questions:

1. Do you make yourself Sick because you feel uncomfortably full?
2. Do you worry you have lost Control over how much you eat?
3. Have you recently lost more than One stone in a 3-month period?
4. Do you believe yourself to be Fat when others say you are too thin?
5. Would you say that Food dominates your life?

The five questions are rated on a dichotomous scale (yes = 1/no = 0), where a total score of two or more indicates risk of eating disorder. The SCOFF was chosen because it is easy to administer, complete, and score. It has been validated in youth populations and in different languages including Danish (Berger et al., 2011; Hansson, Daukantaite, & Johnsson, 2015; Lichtenstein, Hemmingsen, & Stoving, 2017; Muro-Sans, Amador-Campos, & Morgan, 2008; Rueda et al., 2005).

Demographic questions were asked concerning age, gender, weekly exercise amounts and type of exercise performed, height and weight to calculate body mass index (BMI), and age- and gender-specific percentiles for children and adolescents. To further describe the populations' characteristics and to test the construct validity of the EAI-Y, five items were added based on validated exercise-dependence instruments and theoretical conceptualizations of problematic exercise and eating behavior:

1. *I exercise in spite of injury and illness.* This behavior refers to continuance where exercise is continued despite persistent or recurrent physical problem that is likely to have been caused or exacerbated by the exercise (e.g., continued running despite injury). The Exercise Dependence Scale (items 2, 9, and 16) includes this aspect of addiction, which is not covered by the EAI (Hausenblas & Downs, 2002b).
2. *I feel guilty when I don't exercise.* This statement refers to the compulsive element of exercise addiction, which is not covered by the EAI. The Obligatory Exercise Questionnaire (OEQ: item 4) includes this aspect in the assessment of compulsive exercise (Thompson & Pasman, 1991).
3. *My sport performance is reduced due to excessive exercise.* This statement refers to the overtraining

syndrome (OTS), which is recognized by fatigue and reduced sport performance. It has been suggested that the OTS is the body's attempt to protect physical health of a subject who exercises excessively (Bär & Markser, 2013). This item was constructed by the authors for preliminary insight of potential overtraining as a consequence of exercise addiction.

In addition, two questions were added concerning negative eating patterns related to exercise:

4. *I eat less to regulate weight if I don't exercise.* The relationship between exercise, eating, and weight concerns is covered in three exercise dependence questionnaires but not in the EAI. The OEQ asks: "If I feel I have overeaten, I will try to make up for it by increasing the amount I exercise" (Thompson & Pasman, 1991). The Exercise Beliefs Questionnaire asks: "If I do not exercise I will become overweight" (Loumidis & Wells, 1998). The Exercise Dependence Questionnaire contains the following statement: "I exercise to control my weight" (Ogden, Veale, & Summers, 1997).
5. *My sport performance is reduced due to loss of body weight.* This item was developed to provide preliminary insight concerning the potential relationship between weight loss and sport performance, as it might be an early warning of bodily overload such as the OTS.

Statistical analyses

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 24. Descriptive methods were used to compile participant characteristics (Table 1). Analysis of variance was used to describe the mean score of the variables and χ^2 was used to describe the presence of a variable in percent and number. The internal consistency of the

Table 1. Demographic characteristics and responses to exercise and eating concerns

	Sport school students (n = 257)	Fitness members (n = 127)	Eating disorder patients (n = 87)
ANOVA	Mean (SD)	Mean (SD)	Mean (SD)
Mean age in years	15.8 (1.3)	17.6 (1.4)	15.8 (2.3)
BMI mean	21.3 (2.4)	22.0 (2.5)	18.2 (4.1)
BMI percentile mean	74.3 (22.3)	72.3 (23.7)	32.9 (34.3)
Weekly exercise amounts	9.0 (1.8)	8.2 (2.0)	4.8 (3.2)
EAI-Y total score	18.1 (3.3)	18.9 (3.7)	16.9 (6.8)
SCOFF total score	0.8 (1.0)	1.3 (1.3)	2.6 (1.4)
Chi-square	Percent (number)	Percent (number)	Percent (number)
Exercise in spite of pain + injury	34.9 (89 of 255)	42.5 (54 of 127)	24.1 (21 of 87)
Feeling guilty when not exercising	41.0 (105 of 256)	63.8 (81 of 127)	51.7 (45 of 87)
Eating less to regulate weight	17.6 (45 of 256)	30.7 (39 of 127)	37.9 (33 of 87)
Reduced performance due to excessive exercise	4.7 (12 of 254)	3.9 (5 of 127)	6.9 (6 of 87)
Reduced performance due to weight loss	2.4 (6 of 255)	3.2 (4 of 126)	28.7 (23 of 80)
SCOFF 1: vomit to compensate	8.2 (21 of 256)	11.8 (15 of 127)	32.9 (27 of 82)
SCOFF 2: loss of control over eating	12.9 (33 of 256)	21.4 (27 of 126)	61.0 (50 of 82)
SCOFF 3: weight loss	5.1 (13 of 254)	14.2 (18 of 127)	40.2 (33 of 82)
SCOFF 4: feeling fat though thin	32.8 (84 of 256)	46.5 (59 of 127)	65.9 (54 of 82)
SCOFF 5: food dominates life	19.6 (50 of 255)	34.1 (43 of 126)	58.0 (47 of 81)

Note. BMI: body mass index; EAI-Y: Exercise Addiction Inventory for youth; SCOFF: eating disorder screening tool; ANOVA: analysis of variance; SD: standard deviation.

EAI-Y was tested with the Cronbach's α coefficient α , which is a function of the number of items in the EAI-Y, the average covariance between item-pairs and the variance of the total score. A confirmatory factor analysis (CFA) was used to test whether data were consistent with the hypothesis that the EAI represents one underlying construct (or factor) (Table 2). Pearson's logistic regression models were used to test construct validity of EAI-Y and related excessive and obsessive exercise attitudes/consequences: weekly exercise amounts, exercise in spite of pain and injury, feelings of guilt when not exercising, and reduced sport performance due to excessive exercise (Table 3). Logistic regression with bootstrapped variance estimation was used to test the association between exercise addiction and disturbed exercise and eating attitudes. Crude level odds ratios and adjusted odds ratios are displayed in Table 4.

Ethics

All participants or their parents gave their informed consent for scientific use and all data were anonymized. The research met the required ethical standards and was approved by the Regional Committees on Health Research Ethics for Southern Denmark and by the Danish Data Protection Agency.

RESULTS

Description of the participants

The most common types of exercise performed were handball ($n = 108$), fitness ($n = 104$), football ($n = 89$), and gymnastics ($n = 46$). The gender distribution in the three samples was: 126 girls (49%) and 131 boys (51%) of school athletes, 98 girls (79%) and 26 boys (21%) of fitness exercisers, and 80

girls (98%) and 7 boys (8%) of patients with eating disorders. BMI was calculated as the body mass divided by the square of the body height, and was expressed in units of kg/m^2 . The BMI range in the three groups was school athletes: 15.4–33.4, fitness exercisers: 17.3–35.8, and patients with eating disorders: 11.7–36.6. The BMI percentile ranged from 3 to 99 in the school athletes, 10–99 in fitness exercisers, and 1–99 in patients with eating disorders. In Table 1, the characteristics of the three sub-groups are presented. The table presents demographic information as well as negative attitudes and beliefs concerning exercise and eating.

Psychometric properties of the EAI-Y

The EAI-Y items and the original adult items are presented in Appendix. A total score is calculated by adding the ratings from the six items. The range of the total score is 6–30 and the cut-off for exercise addiction in the EAI-Y was 24 (as in the adult version).

The internal consistency of the EAI-Y was tested with the Cronbach's α coefficient and the α was .7 in the total sample. When participants were divided into the three sub-groups, the α was .6 in the adolescent sport school students, .7 in the fitness center attendees, and .9 in the patients with eating disorders. To further test the internal structure of the EAI-Y, a CFA was conducted. The results indicated a single factor structure as presented in Table 2.

Next, construct validity of the scale was explored by testing the correlation between the total EAI score and four variables related to excessive and obsessive exercise attitudes/consequences. Pearson's regression models demonstrated positive significant ($p < .001$) correlations as listed in Table 3.

Prevalence of exercise addiction

The prevalence of exercise addiction with cut-off fixed at EAI scores ≤ 24 was 4.0% in the adolescent school athletes (EAI range: 6–27, mean EAI score: 18, $SD = 3.3$), 8.7% in fitness attendees (EAI range: 9–28, mean EAI score: 19, $SD = 3.7$), and 21.2% in patients with eating disorders (EAI range: 6–30, mean EAI score: 17, $SD = 6.8$). The difference in prevalence between the groups was significant ($p < .001$). When data from the SCOFF questionnaire were analyzed, 21.8% of the school athletes had total SCOFF-scores ≥ 2 , which is above the cut-off for risk of eating disorder pathology. In the fitness group, it was 38.7%, and in the eating disorder group, it was 76.3%.

Participants at risk of exercise addiction were compared with the remainder of the sample. These analyses were

Table 2. Factor loadings and model fit for the Exercise Addiction Inventory for youth

Factor loadings				
Eigenvalues	Item	Loading	Model fit	
Factor 1	1.95	EAI_1	0.56	CFI 0.92
Factor 2	0.30	EAI_2	0.58	TLI 0.86
Factor 3	0.00	EAI_3	0.57	RMSEA 0.10
Factor 4	-0.02	EAI_4	0.49	
Factor 5	-0.12	EAI_5	0.71	
Factor 6	-0.14	EAI_6	0.48	

Note. EAI: Exercise Addiction Inventory; CFI: comparative fit index; TLI: Tucker–Lewis index; RMSEA: root mean square error of approximation.

Table 3. Pearson's correlation coefficients between total EAI score and four variables related to excessive and obsessive exercise attitudes/consequences

	Weekly exercise amount	Exercise in spite of pain and injury	Feelings of guilt when not exercising	Reduced sport performance
Pearson's r	.4*	.5*	.4*	.3*

Note. EAI: Exercise Addiction Inventory.

* $p < .001$.

Table 4. Exercise addiction predicting disordered exercise and eating attitudes

	Addiction Prevalence ^a	No addiction Prevalence ^a	Crude level OR	95% CI	Eating disorder adjustment	95% CI	Age + gender adjustment	95% CI
Exercise in spite of pain and injury	64.1% (25 of 39)	32.3% (137 of 424)	3.7***	[1.71, 8.15]	5.3***	[2.27, 12.23]	4.3**	[1.78, 10.59]
Feeling guilty when no exercise	97.4% (38 of 39)	45.2% (192 of 425)	45.9***	[19.66, 107.25]	49.1***	[20.50, 117.63]	42.7***	[15.95, 114.24]
Reduced performance due to excessive exercise	61.5% (24 of 39)	21.6% (92 of 425)	4.9**	[1.89, 12.91]	5.0**	[1.72, 14.32]	3.9**	[1.47, 10.27]
Eating less to regulate weight	17.9% (7 of 39)	3.8% (16 of 423)	5.8***	[2.83, 11.79]	5.0***	[2.50, 9.81]	4.2***	[1.85, 9.45]
Reduced performance due to weight loss	17.9% (7 of 39)	6.3% (26 of 416)	0.5	[0.24, 1.06]	1.0	[0.37, 2.90]	1.1	[0.43, 3.00]
SCOFF 1: vomit to compensate	23.1% (9 of 39)	12.9% (54 of 420)	2.0	[0.91, 4.50]	1.2	[0.40, 3.62]	1.1	[0.34, 3.30]
SCOFF 2: loss of control over eating	48.7% (19 of 39)	21.7% (91 of 419)	4.4***	[1.88, 10.41]	3.4**	[1.53, 7.72]	2.7*	[1.12, 6.65]
SCOFF 3: weight loss	23.1% (9 of 39)	13.2% (55 of 418)	3.4**	[1.52, 7.66]	2.0	[0.89, 4.59]	1.8	[0.72, 4.43]
SCOFF 4: feeling fat though thin	74.4% (29 of 39)	39.5% (166 of 420)	8.0***	[3.34, 19.03]	6.1***	[2.83, 13.16]	5.0***	[2.09, 11.82]
SCOFF 5: food dominates life	74.4% (29 of 39)	26.6% (111 of 417)	2.0	[0.92, 4.23]	1.0	[0.35, 2.71]	0.9	[0.31, 2.57]

Note. Logistic regression with bootstrapped variance estimation. Exercise addiction defined as EAI-Y ≥24 and SCOFF items representing eating disorder symptoms. Adjusted for presence of eating disorder and subsequently for age, gender, and eating disorder. OR: odds ratio; 95% CI: 95% confidence interval.

^aPrevalence rates are reported in percentage and numbers. Statistical significance was tested with χ^2 . All prevalence results were significantly different between the two groups at p level .05, except SCOFF1 and SCOFF3 that were above .05.

* $p < .05$. ** $p < .01$. *** $p < .001$.

important to the questions concerning the addiction construct: How is exercise addiction expressed in relation to negative exercise attitudes, and is it highly related to disturbed eating behavior? Analyses were conducted on two groups. The first group contained all participants with total EAI score: 24–30 ($n = 39$). Therefore, both primary ($n = 21$) and secondary ($n = 18$) exercise addictions were present in this group and were compared with all remaining participants. χ^2 analyses were used to compare the percentages of negative exercise and eating attitudes. Following this, the odds ratios of the total samples were estimated and adjusted for eating disorder, age, and gender. The results are shown in Table 4.

We found that 97% of those with high risk of addiction reported feelings of guilt when not exercising, 64% reported to exercise despite pain and injury, and 62% experienced reduced sport performance due to excessive exercise. According to eating-related characteristics, we found that 74% in the addiction group reported feeling fat and 18% stated to eat less to regulate weight. All results were significant compared with the non-addiction group and also after adjustment for eating disorder, age, and gender.

DISCUSSION

The primary aim of this study was to develop and test the psychometric properties of an EAI-Y. Second, we wanted to estimate a preliminary prevalence proportion of exercise addiction in our adolescent samples and to examine the association with disturbed eating.

Psychometric properties of EAI-Y

The overall psychometric properties of the EAI-Y were evaluated and demonstrated positive results. The reliability of the scale was good given a Cronbach's α coefficient of .7 to be considered acceptable, especially for a short-item scale (Furr & Bacharach, 2008). This indicates that all EAI-Y-items appear to be assessing the same unidimensional construct. The internal consistency was best among the eating disorder group indicating that the scale is more reliable in this sub-group, probably due to a tendency of higher EAI-Y scores. The CFA showed that all six EAI-Y items had loadings of at least 0.48, supporting the expectation that EAI measures only one underlying construct. Comparing the total EAI-score with negative exercise attitude variables, the construct validity of the EAI-Y was examined. The EAI-Y appears to measure exercise addiction because high EAI-Y scores were highly correlated with high weekly exercise amounts, exercising in spite of pain and injury, feelings of guilt when not exercising, and reduced sport performance due to excessive exercise. These relationships indicate that the EAI-Y assesses negative exercise behaviors and feelings. It is therefore concluded that the use of EAI-Y can be recommended for use in screening addiction-prone teenagers in exercise communities and in clinical samples.

Exercise addiction prevalence and associated negative behaviors

The prevalence proportion for those participants at risk of exercise addiction was 4.0% in the sport school students and 8.7% in the fitness center attendees. These preliminary prevalence rates are in line with the results from the Italian youth study conducted by Vilella et al. (2011) who found 8.5% at risk of exercise addiction. As expected, the risk of exercise addiction was highest among patients with eating disorders (prevalence = 21.2%). The causality between eating disorders and exercise addiction remains unclear and therefore longitudinal studies are required to further examine this relationship. Nevertheless, there are overlaps in the two syndromes and adolescents who display symptoms of both disordered eating and addiction to exercise may need special attention.

Those at high risk of exercise addiction appeared to suffer from more mental distress, because they reported a higher presence of negative exercise behaviors and eating attitudes compared with those without addiction: more than two third of those at risk of exercise addiction reported they continued to exercise in spite of pain and injury; almost all of those at risk of exercise addiction reported feelings of guilt when they did not exercise; two third of those at risk of exercise addiction had experienced reduced sport performance due to excessive exercise; and almost one fifth at risk of exercise addiction stated that they ate less to regulate body weight when they did not exercise.

It is also worth noting that a relatively large proportion of the young people without exercise addiction reported feelings of guilt when they did not exercise (45%), feelings of being fat although others think they are thin (40%), exercising in spite of pain/injury (32%), and food dominates life (27%). When the results were controlled for eating disorder, age, and gender, exercise addiction was still found to increase the odds for negative exercise behaviors and eating attitudes.

Thus, the results of this study indicate that a very high percentage of physically active adolescents are concerned about body appearance and have obsessive traits related to exercise and food. A recent report from the World Health Organization reported that young Danes (aged 11–15 years) are more engaged in weight reduction than any of the other 41 European countries. They have high scores in “feeling they are too fat” even though they are the thinnest adolescents of all 41 countries (World Health Organization, 2016). Negative body image and weight-reduction behavior appear to be increasing problems among adolescents in western societies (Littleton & Ollendick, 2003). Prevention programs based on psychoeducation have been developed focusing on proper nutrition. Based on the findings here, further education relating to exercise addiction needs to be addressed in schools and colleges along with intervention and prevention programs in such settings.

Limitations and strengths

This study has some psychometric limitations: First, this study did not directly compare the original adult EAI version with the EAI-Y version. Second, the linguistic

changes were minor (e.g., changing “partners” to “friends”) and the EAI might be as useful as the EAI-Y for adolescents and emerging adults. Third, a psychometric evaluation of the English version of the EAI-Y also needs to be conducted. Fourth, this study only investigated three subsamples of adolescents and emerging adults and therefore there are no evaluations of the EAI-Y for the general youth population or for sport sub-groups (e.g., running and team sports). Not all youth with exercise addiction reported negative consequences (almost 40% had not experienced reduced sport performance), and this indicates that EAI-Y might find cases of exercise addiction, who do not report problems related to their exercise patterns. On the other side, the EAI-Y might also miss some true positive cases. Further assessment and clinical interviewing should support the identification of exercise addiction.

The study also might be limited by selection bias as the data collection relied on self-report (e.g., recall bias, social desirability bias, etc.) and therefore some caution is warranted in relation to the findings reported. The strengths of the study were the use of validated tools (EAI and SCOFF) and a large number of participants in different high-risk subgroups. This is the first study to suggest a psychometrically evaluated tool for assessment of youth exercise addiction.

CONCLUSIONS

Validated instruments are required to assess disease-specific symptoms in adolescents. Psychometrically robust tools exist for adolescent gambling and gaming addiction. Based on this validation study, we recommend using the EAI-Y for identification of adolescent exercise addiction.

Exercise addiction appears to be prevalent in a minority of adolescents and emerging adults, especially among those with an eating disorder, and it is associated with negative exercise and eating attitudes. However, further research is required to investigate prevalence rates of exercise addiction in different adolescent sport cultures and to further explore the psychometric properties and utilities of the EAI-Y.

Funding sources: The authors have not received any financial support or benefits from commercial sources for this study.

Authors' contribution: MBL: study concept and design, analysis and interpretation of data, statistical analysis, and study supervision. MDG: study concept and design, interpretation and presentation of data, study supervision, and proof reading. SDH: study concept and design, analysis and interpretation of data, and statistical analysis. RKS: study concept and design, interpretation of data, and study supervision. All authors have contributed, seen, and agreed with the final submitted manuscript. All authors have full access to all data.

Conflict of interest: The authors report no financial or other relationship relevant to the subject of this article.

REFERENCES

- Adams, J. (2009). Understanding exercise dependence. *Journal of Contemporary Psychotherapy*, 39(4), 231–240. doi:10.1007/s10879-009-9117-5
- Adams, J., & Kirkby, R. J. (1998). Exercise Dependence: A review of its manifestation, theory and measurement. *Sports Medicine, Training and Rehabilitation*, 8(3), 265–276. doi:10.1080/15438629809512532
- Allegre, B., Souville, M., Therme, P., & Griffiths, M. (2006). Definitions and measures of exercise dependence. *Addiction Research and Theory*, 14(6), 631–646. doi:10.1080/16066350600903302
- Bär, K. J., & Markser, V. Z. (2013). Sport specificity of mental disorders: The issue of sport psychiatry. *European Archives of Psychiatry and Clinical Neuroscience*, 263(2), 205–210. doi:10.1007/s00406-013-0458-4
- Berger, U., Wick, K., Holling, H., Schlack, R., Bormann, B., Brix, C., Sowa, M., Schwartze, D., & Straub, B. (2011). [Screening of disordered eating in 12-Year-old girls and boys: Psychometric analysis of the German versions of SCOFF and EAT-26]. *Psychotherapie Psychosomatik Medizinische Psychologie*, 61(7), 311–318. doi:10.1055/s-0031-1271786
- Brown, I. (1997). A theoretical model of the behavioural addictions – Applied to offending. In J. E. Hodge, M. McMullan, & R. C. Hollin (Eds.), *Addicted to crime* (pp. 13–65). Chichester, UK: Wiley.
- Brown, R. I. F. (1993). Some contributions of the study of gambling to the study of other addictions. In W. R. Eadington & J. A. Cornelius (Eds.), *Gambling behaviour and problem gambling* (pp. 241–272). Reno, NV: University of Nevada Press.
- Burge, A. N., Pietrzak, R. H., & Petry, N. M. (2006). Pre/early adolescent onset of gambling and psychosocial problems in treatment-seeking pathological gamblers. *Journal of Gambling Studies*, 22(3), 263–274. doi:10.1007/s10899-006-9015-7
- Davis, C., & Claridge, G. (1998). The eating disorders as addiction: A psychobiological perspective. *Addictive Behaviors*, 23(4), 463–475. doi:10.1016/S0306-4603(98)00009-4
- Davis, C., & Fox, J. (1993). Excessive exercise and weight preoccupation in women. *Addictive Behaviors*, 18(2), 201–211. doi:10.1016/0306-4603(93)90050-J
- Davis, C., & Kaptein, S. (2006). Anorexia nervosa with excessive exercise: A phenotype with close links to obsessive-compulsive disorder. *Psychiatry Research*, 142(2–3), 209–217. doi:10.1016/j.psychres.2005.11.006
- Demetrovics, Z., & Griffiths, M. D. (2012). Behavioral addictions: Past, present and future. *Journal of Behavioral Addictions*, 1(1), 1–2. doi:10.1556/JBA.1.2012.1.0
- Edgren, R., Castrén, S., Mäkelä, M., Pörfors, P., Alho, H., & Salonen, A. H. (2016). Reliability of instruments measuring at-risk and problem gambling among young individuals: A systematic review covering years 2009–2015. *Journal of Adolescent Health*, 58(6), 600–615. doi:10.1016/j.jadohealth.2016.03.007
- Egorov, A. Y., & Szabo, A. (2013). The exercise paradox: An interactional model for a clearer conceptualization of exercise addiction. *Journal of Behavioral Addictions*, 2(4), 199–208. doi:10.1556/JBA.2.2013.4.2
- Furr, R. M., & Bacharach, V. R. (2008). *Psychometrics*. London: Sage Publication.

- Griffiths, M. D. (1996). Behavioural addictions: An issue for everybody? *Journal of Workplace Learning*, 8(3), 19–25. doi:10.1108/13665629610116872
- Griffiths, M. D. (2002). *Gambling and gaming addictions in adolescence*. Leicester, UK: British Psychological Society/Blackwells.
- Griffiths, M. D. (2005). A ‘components’ model of addiction within a biopsychosocial framework. *Journal of Substance Use*, 10(4), 191–197. doi:10.1080/14659890500114359
- Griffiths, M. D., Szabo, A., & Terry, A. (2005). The Exercise Addiction Inventory: A quick and easy screening tool for health practitioners. *British Journal of Sports Medicine*, 39(6), e30. doi:10.1136/bjism.2004.017020
- Griffiths, M. D., Urbán, R., Demetrovics, Z., Lichtenstein, M. B., de la Vega, R., Kun, B., Ruiz-Barquín, R., Youngman, J., & Szabo, A. (2015). A cross-cultural re-evaluation of the Exercise Addiction Inventory (EAI) in five countries. *Sports Medicine – Open*, 1, 1–7. doi:10.1186/s40798-014-0005-5
- Hansson, E., Daukantaite, D., & Johnsson, P. (2015). SCOFF in a general Swedish adolescent population. *Journal of Eating Disorders*, 3(1), 48. doi: 10.1186/s40337-015-0087-6
- Hausenblas, H. A., & Downs, D. S. (2002a). Exercise dependence: A systematic review. *Psychology of Sport and Exercise*, 3(2), 89–123. doi:10.1016/S1469-0292(00)00015-7
- Hausenblas, H. A., & Downs, D. S. (2002b). How much is too much? The Development and Validation of the Exercise Dependence Scale. *Psychology & Health*, 17(4), 387–404. doi:10.1080/0887044022000004894
- King, D. L., Haagsma, M. C., Delfabbro, P. H., Gradisar, M. S., & Griffiths, M. D. (2013). Toward a consensus definition of pathological video-gaming: A systematic review of psychometric assessment tools. *Clinical Psychology Review*, 33(3), 331–342. doi:10.1016/j.cpr.2013.01.002
- Lichtenstein, M. B., Christiansen, E., Bilenberg, N., & Stoving, R. K. (2014). Validation of the Exercise Addiction Inventory in a Danish sport context. *Scandinavian Journal of Medicine & Science in Sports*, 24(2), 447–453. doi:10.1111/j.1600-0838.2012.01515.x
- Lichtenstein, M. B., Hemmingsen, S. D., & Stoving, R. K. (2017). Identification of eating disorder symptoms in Danish adolescents with the SCOFF Questionnaire. *Nordic Journal of Psychiatry*, 14, 1–8. doi:10.1080/08039488.2017.1300322
- Lichtenstein, M. B., Larsen, K. S., Stoving, R. K., & Bredahl, T. V. G. (2014). Exercise addiction in team sport and individual sport: Prevalences and validation of the Exercise Addiction Inventory. *Addiction Research and Theory*, 22(5), 431–437. doi:10.3109/16066359.2013.875537
- Lindwall, M., & Palmeira, A. (2009). Factorial validity and invariance testing of the Exercise Dependence Scale-Revised in Swedish and Portuguese exercisers. *Measurement in Physical Education and Exercise Science*, 13(3), 166–179. doi:10.1080/10913670903050313
- Littleton, H. L., & Ollendick, T. (2003). Negative body image and disordered eating behavior in children and adolescents: What places youth at risk and how can these problems be prevented? *Clinical Child and Family Psychology Review*, 6(1), 51–66. doi:10.1023/A:1022266017046
- Loumidis, K., & Wells, A. (1998). Assessment of beliefs in exercise dependence: The development and preliminary validation of the Exercise Beliefs Questionnaire. *Personality and Individual Differences*, 25(3), 553–567. doi:10.1016/S0191-8869(98)00103-2
- Muro-Sans, P., Amador-Campos, J. A., & Morgan, J. F. (2008). The SCOFF-c: Psychometric properties of the Catalan version in a Spanish adolescent sample. *Journal of Psychosomatic Research*, 64(1), 81–86. doi:10.1016/j.jpsychores.2007.06.011
- Ogden, J., Veale, D., & Summers, Z. (1997). The development and validation of the Exercise Dependence Questionnaire. *Addiction Research*, 5(4), 343–355. doi:10.3109/16066359709004348
- Pontes, H. M., Macur, M., & Griffiths, M. D. (2016). Internet gaming disorder among Slovenian primary schoolchildren: Findings from a nationally representative sample of adolescents. *Journal of Behavioral Addictions*, 5(2), 304–310. doi:10.1556/2006.5.2016.042
- Ross, H. E., & Ivis, F. (1999). Binge eating and substance use among male and female adolescents. *International Journal of Eating Disorders*, 26(3), 245–260. doi:10.1002/(SICI)1098-108X(199911)26:3<245::AID-EAT2>3.0.CO;2-R
- Rueda, G. E., Diaz, L. A., Campo, A., Barros, J. A., Avila, G. C., Oróstegui, L. T., Osorio, B. C., & Cadena Ldel, P. (2005). Validation of the SCOFF Questionnaire for screening of eating disorders in university women. *Biomedica*, 25(2), 196–202. doi:10.7705/biomedica.v25i2.1342
- Terry, A., Szabo, A., & Griffiths, M. (2004). The Exercise Addiction Inventory: A new brief screening tool. *Addiction Research and Theory*, 12(5), 489–499. doi:10.1080/16066350310001637363
- Thompson, J. K., & Pasmán, L. (1991). The Obligatory Exercise Questionnaire. *Behavioural Assessment Review*, 14, 137.
- Tsai, J., Huh, J., Idrisov, B., Galimov, A., Espada, J. P., González, M. T., & Sussman, S. (2017). Prevalence and co-occurrence of addictive behaviors among Russian and Spanish youth. *Journal of Drug Education: Substance Abuse Research and Prevention*, 46(1–2), 32–46. doi:10.1177/0047237917704635
- Villella, C., Martinotti, G., Di Nicola, M., Cassano, M., La Torre, G., Gliubizzi, M. D., Messeri, I., Petrucelli, F., Brià, P., Janiri, L., & Conte, G. (2011). Behavioural addictions in adolescents and young adults: Results from a prevalence study. *Journal of Gambling Studies*, 27(2), 203–214. doi:10.1007/s10899-010-9206-0
- World Health Organization. (2016). *Growing up unequal: Gender and socioeconomic differences in young people’s health and well-being*. Geneva, Switzerland: World Health Organization.
- Zeulner, B., Ziemanz, H., Beyer, C., Hammon, M., & Janka, R. (2016). Disordered eating and exercise dependence in endurance athletes. *Advances in Physical Education*, 6(2), 76–87. doi:10.4236/ape.2016.62009

APPENDIX: ITEMS IN THE YOUTH VERSION OF EXERCISE ADDICTION INVENTORY (EAI-Y)
COMPARED WITH THE ADULT EAI VERSION (IN ITALICS)

-
1. Exercise is the most important thing in my life.
 - 1. Exercise is the most important thing in my life.*
 2. I have conflicts with family or friends because I exercise so much.
 - 2. Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do.*
 3. I use exercise to change my mood (e.g., to feel happier or forget about problems).
 - 3. I use exercise as a way of changing my mood (e.g., to get a buzz, to escape, etc.).*
 4. Over the last year, I have increased the amount of daily exercise that I do.
 - 4. Over time I have increased the amount of exercise I do in a day.*
 5. If I don't exercise every day, I get restless, upset, or sad.
 - 5. If I have to miss an exercise session I feel moody and irritable.*
 6. I have tried to reduce the amount of exercise I do but end up exercising as much as I did before.
 - 6. If I cut down the amount of exercise I do, and then start again, I always end up exercising as often as I did before.*
-