Exercise addiction in CrossFit: Prevalence and psychometric properties of the Exercise Addiction Inventory☆

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ABSTRACT

Introduction: CrossFit is a mix of aerobic and anaerobic exercise regimes with the stated goal of improving fitness and physical performance. It is growing in popularity and has a strong community known to motivate and push the participants to maximal performance. The negative consequences of these extreme exercise patterns have rarely been described. The prevalence of injuries in CrossFit is high but exercise addiction and harmful exercise attitudes have not yet been assessed. The aim of this study was to measure the prevalence of exercise addiction in CrossFit and to evaluate the reliability and validity of the Exercise Addiction Inventory (EAI) in a CrossFit population.
Methods: We invited crossfitters to participate in an online survey using Facebook groups. A total of 603 regular crossfitters completed the EAI and additional questions concerning exercise amounts and negative exercise attitudes and beliefs. We used principal component analyses and structural equation models to test the psychometric properties of the EAI and to describe the characteristics of the addicted crossfitters.
Results: We found that 5% of the crossfitters were addicted to exercise and that young males had a higher risk. The EAI had good internal reliability (0.73) and construct validity. Thus we found significant positive associations between exercise addiction and the tendency to exercise in spite of injury, feelings of guilt when unable to exercise, passion turning into obsession and taking medication to be able to exercise.
Conclusions: Exercise addiction is prevalent in CrossFit and needs further exploration. The EAI is recommended for research in CrossFit communities and applied settings.

1. Introduction

In the 1990s a new form of exercise emerged in the US (Belger, 2012). Greg Glasmann created a workout program called CrossFit that was founded as a fitness company in 2000. Promoted as both a physical exercise philosophy and also as a competitive fitness sport, CrossFit workouts incorporate elements from high-intensity interval training, Olympic weightlifting, plyometrics, powerlifting, gymnastics, calisthenics, indoor rowing, running and other exercises. It is a strength and conditioning program consisting of a mix of aerobic and anaerobic exercises with the stated goal of improving fitness and physical performance with specific attention to cardiovascular and respiratory endurance, strength, flexibility, power, speed, coordination, agility, and balance. Hour-long classes at affiliated gyms, or "boxes", typically include a warm-up, a skill development segment, the high-intensity "workout of the day" (or WOD), and a period of individual or group stretching. Some gyms also often have a strength-focused movement prior to the WOD. Performance on each WOD is scored to encourage competition and to track individual progress.

CrossFit programming is decentralized but its general methodology is used by thousands of private affiliated gyms, fire departments, law enforcement agencies, and military organizations (Belger, 2012). In just 15 years CrossFit has turned into a worldwide sport with several thousand affiliated gyms. See Fig. 1 (https://map.crossfit.com).

The community that spontaneously arises when people do these workouts together is known to be strong. In fact, the communal and social aspects of CrossFit are key components of its effectiveness (Murphy, 2012). The CrossFit community is known to use extreme catchphrases like: "*Strong is the new skinny*", "*Sweat is your fat crying*", "*Everyday is a chance to get better*" and "*Repeat after me: I can do this*". These statements flourish on CrossFit websites and social media and are thought to motivate and push people to put all of their efforts into every training session. With a community known to motivate and push the participants to maximal performance there could be negative consequences such as injuries, excessive exercise and addiction.

Hak et al. found that 73.5% of a population of crossfitters had sustained an injury during CrossFit training and 7% required surgical

https://map.crossfit.com
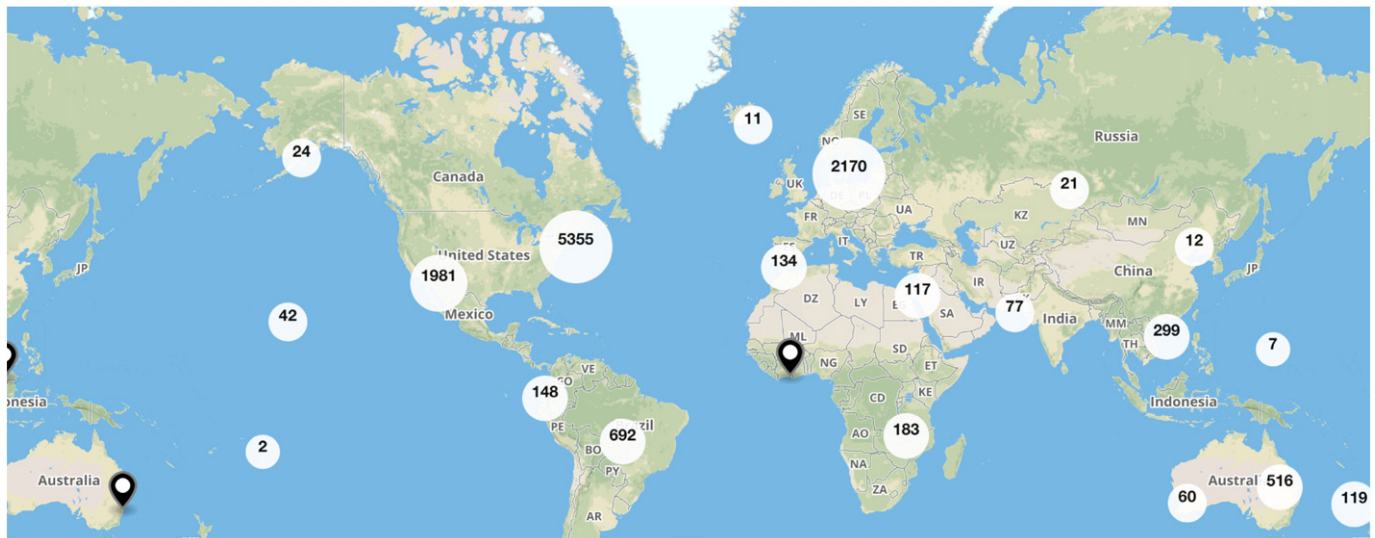
Fig. 1. Number of CrossFit centers worldwide.

intervention. Shoulder and spine injuries were the most common. This injury incidence was found to be similar to injury incidences in weight lifting and gymnastics (Hak, Hodzovic, & Hickey, 2013).

Despite the potential of losing control over exercise in sport settings with extreme exercise regimes, exercise addiction in CrossFit has not yet been explored. Exercise addiction has ben described since the 1970s and is characterized by increasing exercise amounts, tolerance, withdrawal symptoms and continuing exercise in spite of pain and injury (Adams & Kirkby, 2002; Berczik et al., 2012; Hausenblas & Downs, 2002a; Landolfi, 2013). Addiction to exercise belongs to the group of behavioral addictions where you get addicted to the benefits and rewards of your own activity (Brown, 1997; Griffiths, 1996). Exercise can lead to positive emotions, wellness, energy, enhanced self-esteem and identity, and thus the behavior may develop into an addictive pattern. It is not defined as a psychiatric disorder but has been observed in connection with mood disorders (Weinstein et al., 2015), eating disorders (Blaydon & Lindner, 2002; Bratland-Sanda et al., 2010) and other behavioral addictions (Muller, Loeber, Sochtig, Te Wildt, & De Zwaan, 2015; Villella et al., 2011).

Exercise addiction has been identified in runners (Chapman & De Castro, 1990; Zarauz & Ruiz-Juan, 2011), fitness exercisers (Lejoyeux, Guillot, Chalvin, Petit, & Lequen, 2012; Ogden, Veale, & Summers, 1997; Parastatidou, Georgios, Theodorakis, & Vlachopoulos, 2012; Sicilia & Gonzalez-Cutre, 2011), triathletes (Blaydon, Lindner, & Kerr, 2002; Youngman, 2014), sport students (Lindwall & Palmeira, 2009; Szabo & Griffiths, 2007) and football players (Lichtenstein, Larsen, Stõving & Bredahl, 2014). The prevalence of exercise addiction ranges from 3% to 29% in the different sport cultures. The prevalence rate in CrossFit needs to be investigated to clarify whether a problem of addiction exists in these communities. According to the philosophy, the community spirit and the high intensity exercise it could be expected that exercise addiction also exists in CrossFit settings and perhaps even has higher prevalence rates than in regular fitness exercisers.

Different measures have been used to identify symptoms of exercise addiction. The Exercise Addiction Inventory (EAI) is a quick self-report instrument that consists of 6 items that are directly related to the theoretical concepts of behavioral addictions (Griffiths, Szabo, & Terry, 2005; Terry, Szabo, & Griffiths, 2004). The scale has been used in different countries and sport settings and has demonstrated good reliability and validity (Griffiths et al., 2015; Lichtenstein, Christiansen, Bilenberg, & Stõving, 2014; Lichtenstein, Larsen, et al., 2014; Mónok et al., 2012). The psychometric properties of the EAI have not previously been tested

scientifically in a CrossFit-context. Thus we need to know if the inventory is useful to identify exercise addiction in crossfitters. It is important to explore if those with EAI-symptoms of addiction experience problematic attitudes and beliefs connected to their exercise regimes. The Obligatory Exercise Questionnaire (Thompson & Pasman, 1991) and the Exercise Dependence Scale (Hausenblas & Downs, 2002b) include items (missing in the EAI) related to feelings of guilt and obsession and they estimate the tendency to exercise in spite of pain and injury. Therefore, we added items related to these aspects of negative addiction. We also wanted to see if those with addiction were willing to take medication to be able to exercise, since this is a negative consequence of addiction.

1.1. Aims

The aim of this study was to estimate the prevalence of exercise addiction in CrossFit settings and to characterize those with addiction. Further, we wanted to test the psychometric properties of the Exercise Addiction Inventory in a CrossFit population.

2. Materials and methods

2.1. Participants

By using Facebook we invited exercisers in ten CrossFit groups geographically spread in Denmark in both rural and urban areas. The participants were invited to respond to an online survey where they were informed about the purposes of the study. By participating in the study they gave permission for scientific use. Further they were informed that all participation was anonymous since we did not register any personal and confidential information about the participants.

All members of the CrossFit groups were invited to participate without any exclusion criteria. The data collection took place from 7th of October to 7th of November 2014. A total of 635 crossfitters participated in the survey. We excluded those who reported not performing CrossFit training (n = 32). The final number of participants was 603. The gender distribution consisted of 270 females (45%) and 328 males (55%).

2.2. Measurements

To measure exercise addiction we used the validated Danish version of the Exercise Addiction Inventory (EAI). The six EAI-items related to addiction are responded on a five-point Likert scale ranging from 1

(strongly disagree) to 5 (strongly agree). A total score is calculated and the scale has a range from 6–30. We used a cut-off of 24 to identify risk of exercise addiction. Exercise amounts were reported on a weekly basis in the categories: 0–2, 2–4, 4–6, 6–8, 8–10, 10 + h/week. Further, we had four additional items concerning extreme exercise attitudes and beliefs:

1. I exercise in spite of pain and injuries.
2. I often feel guilt when I do not exercise.
3. I am too driven to exercise and unable to differ between passion (want to exercise) and obsession (have to exercise).
4. I often take medication (e.g. analgesics) to be able to exercise.

Responses to these items were rated on the same 5-point Likert scale as the EAI-responses and were used to describe the participants with addiction and to test the validity of the EAI.

2.3. Statistics

Statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) Version 23. The first part of the study was analyzed using a descriptive statistical approach. Chi Square tests were used to describe the sub-groups with and without exercise addiction. The categorical variables were recoded into dichotomous values. To test the psychometric properties of the scale, we conducted a principal components analysis and structural equation models. The p-value was set to ≤0.05. Latent variable modeling was carried out in Mplus and Stata. Standard errors are robust to moderate non-normality. The full-information maximum likelihood estimator was used to handle cases with missing data.

3. Results

3.1. Prevalence and characteristics

The mean EAI-score was 17.4 (SD = 3.7) and the range was 6–30. The prevalence of exercise addiction (total EAI-score between 24 and 30) in CrossFit was 5.0% (n = 29). The group reporting high EAI-scores were overrepresented by young people, men and high weekly exercise amounts. Further, we found that more addicted crossfitters reported the presence of the four additional items related to negative exercise beliefs and attitudes. The results are depicted with Chi Square analyses in Table 1. According to the item concerning the use of medication the Chi Square test showed a significance level of 0.02. But the

number of observed outputs were less than five in the addiction group, so we conducted a Fischer's exact test.

There were 27 crossfitters (5%) that declined on the EAI-items. Regression analysis showed a significant positive relationship between these participants and age (B = 0.57, p = 0.04). No significant correlation between these participants and exercise amounts was detected (r = −0.02, p = 0.63).

3.2. Psychometric properties of the EAI

First, we tested reliability by using Cronbach's alpha and found an EAI-value: 0.73. When we expanded the scale and included the four additional items we found an EAI 10-value: 0.77.

Next, we conducted a principal component analysis (PCA) to test the structure and the consistency of the construct behind the EAI. The concepts of addiction and the EAI-items are represented according to factor-loading in Table 2. The eigenvalue was 2.5 and the six EAI-times explained 42.6% of the variance. All items had loadings above 0.5 at the first factor and a second factor was not proposed by the PCA-model. A second would only explain a further 14.5%. Thus we did not find evidence for expanding the number of factors explaining the structure of the scale.

Finally, we conducted a structural equation model (SEM) to further explore the psychometric properties of the EAI. The SEM-model gave new information about the internal reliability and the construct validity. See Fig. 2. The model was developed using modification indices to expand the simple relationships between the latent variable EAI and the observed covariates. This approach led to significant improvements in model fit by estimating a few direct relationships between the observed exogenous covariates and some of the six EAI-items.

The model confirms that the six EAI-items are reliable and have high internal consistency related to the underlying concept supposed to be exercise addiction (EAI). The figure shows that gender and age are related to exercise addiction. The figure also emphasizes that exercise addiction is related to exercise amounts, exercise in spite of injury, feelings of guilt when not exercising, obsessive exercise and taking medication to be able to exercise. It further demonstrates that exercise amounts are especially linked to EAI-item 3 (exercise to change mood). Feelings of guilt have a special relationship to EAI-item 5 (feeling irritable when missing an exercise session). Finally we found that obsession with exercise was associated with EAI-item 2 (conflicts with family).

Table 1
Chi Square analyses of crossfitters with addiction versus no-addiction.

	EAI-addiction	EAI-no-addiction	p-Value
Gender (n = 572)			0.02
Males	75.9% (n = 22)	53.4% (n = 290)	
Females	24.1% (n = 7)	46.6% (n = 253)	
Age (n = 575)			0.00
−30 years	75.9% (n = 22)	49.9% (n = 268)	
31 + years	24.1% (n = 7)	50.9% (n = 278)	
Weekly exercise hours (n = 573)			0.00
1–8 h/week	29.7% (n = 6)	69.5% (n = 379)	
9 + h/week	79.3% (n = 23)	30.3% (n = 165)	
Exercise in spite of pain/injury (n = 574)			0.00
Yes	55.2% (n = 16)	29.7% (n = 162)	
No	44.8% (n = 13)	70.3% (n = 383)	
Feeling guilt when missing exercise (n = 576)			0.01
Yes	58.6% (n = 17)	35.5% (n = 194)	
No	41.4% (n = 12)	64.5% (n = 353)	
Obsessive exercise (n = 576)			0.00
Yes	27.6% (n = 8)	4.2% (n = 23)	
No	72.4% (n = 21)	95.8% (n = 524)	
Take medication to exercise (n = 575)			0.05 (Fischer's)
Yes	10.3% (n = 3)	2.6% (n = 14)	
No	89.7% (n = 26)	97.4% (n = 532)	

Table 2
Principal component analysis of the EAI-scale.

Addiction concept	EAI item	Loading on first component
Salience	EAI 1. Exercise is the most important thing in my life	0.63
Conflicts	EAI 2. Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do	0.59
Emotion regulation	EAI 3. I use exercise as a way of changing my mood	0.59
Tolerance and increase	EAI 4. Over time I have increased the amount of exercise I do in a day	0.68
Withdrawal symptoms	EAI 5. If I have to miss an exercise session I feel moody and irritable	0.70
Loss of control	EAI 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	0.72

4. Discussion

The prevalence of exercise addiction in CrossFit was 5% and was similar to the prevalence rates in other fitness settings in Denmark (Lichtenstein et al., 2014; Lichtenstein, Larsen, et al., 2014). In different sport populations the prevalence measured with the EAI varies from 1.8% to 29.6% (Griffiths et al., 2015). We conclude that exercise addiction also exists in CrossFit but the problem is probably not larger than in other sport environments. This is surprising due to the presence of a strong community and the constant focus on maximal performance. It could be hypothesized that crossfitters with problematic exercise attitudes tended not to report high EAI-score due to lack of realization or shame. But we found no relationship between those who declined to respond to the EAI-items and exercise amounts and we therefore assume that decliners were unrelated to excessive exercise attitudes.

We found that crossfitters with addiction were characterized by young age (below 30 years), more males and large exercise amounts. These findings are in line with previous studies about exercise addiction (Lichtenstein et al., 2014). We demonstrated that significantly more crossfitters with addiction experienced negative and harmful attitudes and beliefs related to their exercise. We can therefore characterize them as more distressed and at risk of negative consequences related to their exercise addiction such as injuries, illness and loss of social relations. Given that exercise addiction is often associated with mental disorders (e.g. eating disorders and other addictions) we recommend further assessment of related problems in CrossFit settings.

Our psychometric evaluation of the EAI in CrossFit showed good internal reliability (0.73). Also the scale appeared to be valid reflecting one underlying concept interpreted as "exercise addiction" since it correlated with high exercise amounts and problematic exercise attitudes. This interpretation was further supported by the fine details of the SEM showing that high exercise amounts were strongly related to the use of exercise as a way of regulating emotions. We assume that crossfitters who use exercise as their primary way to regulate emotions expel high volume exercise since regulating emotions is an on-going task for human beings. It is not surprising that "feelings of guilt when unable to exercise" is associated with withdrawal symptoms. Both items reflect the tendency to experience severe discomfort when an exercise session is missed. Finally, when CrossFit-passion turns into obsession it is related to conflicts with family or partners. Probably because exercise repeatedly is given priority over social activities. In a clinical or qualitative setting these fine distinctions and associations would be important to clarify, explore and discuss.

We recommend the EAI for scientific and clinical use in CrossFit settings. The scale is useful for identification of exercise addiction symptoms. To support the assessment of exercise addiction we suggest to
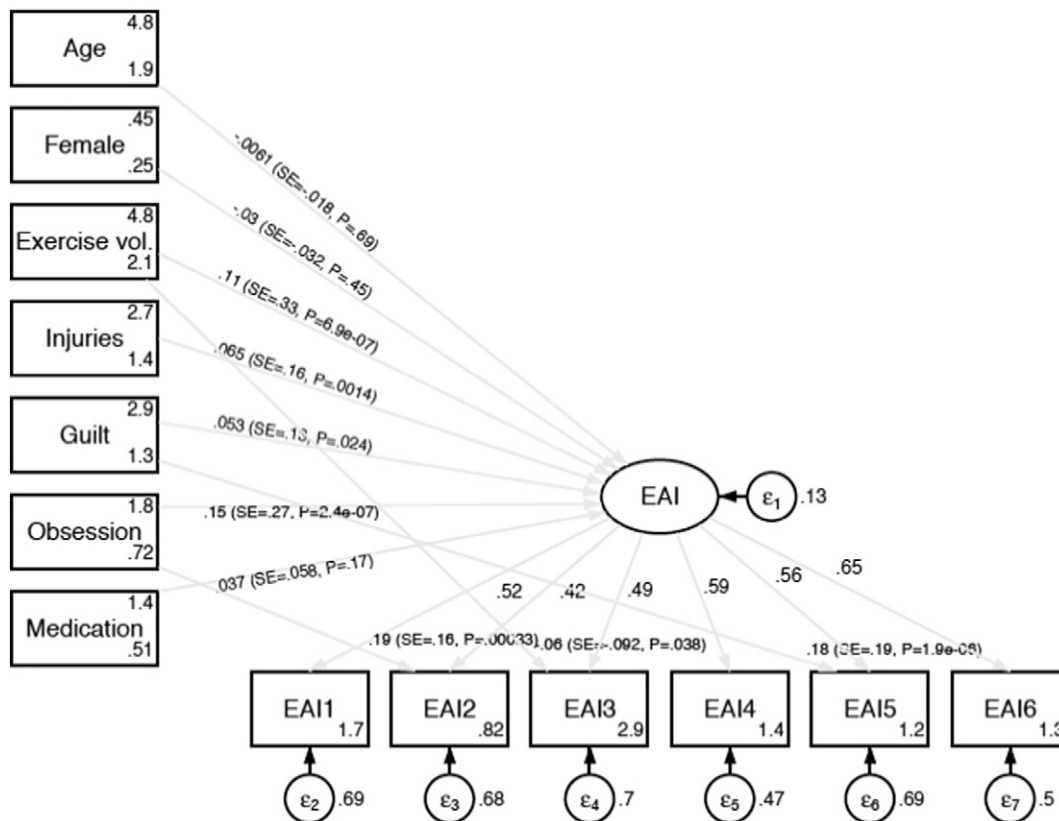

Fig. 2. Structural equation model of the EAI-scale and descriptive variables.

add the four questions of negative exercise attitudes and beliefs concerning exercise in spite of injury, feelings of guilt when unable to exercise, obsessive exercise and taking medication to be able to exercise. These items are related to exercise addiction and could complement the description of the addicted exerciser's level of distress.

4.1. Limitations and strengths

This study is based on self-report data, which is vulnerable to response bias, denial and inaccurate reporting. Advertisement on Facebook might influence respondents' age and their personal interest in the topic. Selection bias could occur when addicted exercisers are confronted with the questions related to exercise addiction. In this type of study the true number of potential participants and decliners are impossible to determine.

The strength of the study is the high number of participants that provides a solid starting point for psychometric analyses. Further it is the first study concerning exercise addiction in CrossFit. We expect future research to further explore problematic exercise behavior in this sport community.

5. Conclusions

This study found a prevalence of exercise addiction of 5% in CrossFit. Exercise addiction is more prevalent in young crossfitters (below 30 years) and in males. It is associated with high exercise volumes and negative exercise attitudes that might lead to negative consequences such as injuries and loss of social relations. The EAI can be used to detect exercise addiction in CrossFit and is recommended in research and applied settings.

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