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# Exercise caution: Over-exercise is associated with suicidality among individuals with disordered eating

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ABSTRACT

We conducted four studies to examine the relationship between over-exercise and suicidality. Study 1 investigated whether over-exercise predicted suicidal behavior after controlling for other eating disorder behaviors in a patient sample of 204 women (144 with Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) Bulimia Nervosa [BN]). Study 2 tested the prospective association between over-exercise and acquired capability for suicide (ACS) in a sample of 171 college students followed for 3–4 weeks. Study 3 investigated whether pain insensitivity accounted for the relationship between over-exercise and ACS in a new sample of 467 college students. Study 4 tested whether ACS accounted for the relationship between over-exercise and suicidal behavior in a sample of 512 college students. In Study 1, after controlling for key covariates, over-exercise was the only disordered eating variable that maintained a significant relationship with suicidal behavior. In Study 2, Time 1 over-exercise was the only disordered eating behavior that was associated with Time 2 ACS. In Study 3, pain insensitivity accounted for the relationship between over-exercise and ACS. In Study 4, ACS accounted for the relationship between over-exercise and suicidal behavior. Over-exercise appears to be associated with suicidal behavior, an association accounted for by pain insensitivity and the acquired capability for suicide; notably, this association was found across a series of four studies with different populations.



## 1. Introduction

Eating disorders convey a substantial mortality risk. Although the mortality rate for bulimia nervosa (BN) is lower than for anorexia nervosa (3.9% as compared to 10%, respectively; American Psychiatric Association, 2000; Crow et al., 2009), it is still elevated as compared to the general population. Further, suicide rates among individuals with BN are higher than in the general population (Preti et al., 2011). Specifically, in their recent meta-analysis, Preti et al. (2011) found that the standardized mortality rate (i.e., the ratio of the number of deaths observed in a sample compared with the number of deaths expected in the population) for individuals with BN was 7.5. Additionally, approximately one-third of women with BN attempt suicide at least once during their lifetime (e.g., Bulik et al., 1999; Corcos et al., 2002; Franko and Keel, 2006). This elevated rate of suicidal behavior within BN populations is notable given that the single best predictor of completed suicide is a previous attempt (e.g., Jenkins et al., 2002).

The interpersonal-psychological theory of suicide (IPTS) identifies three essential variables that must be in place before one can enact a lethal suicide attempt: thwarted belongingness,

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perceived burdensomeness, and the acquired capability for suicide (Joiner, 2005). Thwarted belongingness refers to feelings of loneliness and the perception that one does not have meaningful relationships. Perceived burdensomeness occurs when someone makes the miscalculation that his or her death is worth more to others than his or her life, and results from external factors—job loss, physical illness, and family conflict (Van Orden et al., 2010). The acquired capability for suicide refers to the ability to inflict potentially lethal self-harm and is attained by repeatedly subjecting the body to painful and provocative experiences. According to the theory, when individuals repeatedly experience pain and/or provocation, they habituate to physical pain and become less fearful of pain and death. They are then more readily able to inflict physical harm upon themselves, should they desire to do so (Joiner, 2005). As such, repeated engagement in self-injurious behavior may eventually lead to greater acquired capability for suicide. In combination with thwarted belongingness and perceived burdensomeness (the determinants of suicidal desire, according to the theory), having the acquired capability for suicide increases one's risk for death by suicide (Joiner, 2005; Joiner et al., 2009).

Thus far the IPTS has been investigated in past attempters (Van Orden et al., 2008), undergraduates (e.g., Davidson et al., 2011), military populations (e.g., Bryan and Anestis, 2011), and suicidal young adults (Joiner et al., 2009). Recently, one study tested a component of the IPTS, the acquired capability for suicide, in a population of women with anorexia nervosa (AN) (Selby et al., 2010). Across two studies, the authors found that dietary restraint was associated with suicidal behavior (i.e., number of previous attempts) among individuals with AN-restricting subtype. Provocative behaviors (e.g., binging, purging, self-injury, substance use), however, linked AN-binge/purge subtype to suicidal behavior.

To our knowledge, no study has tested constructs of the IPTS in a sample of people with symptoms of BN, despite the fact that individuals with BN display increased rates of suicidal behavior compared to the general population (Bulik et al., 1999; Corcos et al., 2002; Franko and Keel, 2006; Preti et al., 2011). Various symptoms of BN may be both provocative and painful. Specifically, the use of self-induced vomiting, laxatives, and over-exercise may cause physical pain through esophagitis, abdominal cramping and exercise-induced injury (Mehler and Weiner, 1994). Given the recurrent nature of these behaviors in eating disorders, repeated exposure to pain during purging and non-purging episodes may contribute to the acquired capability for suicide. Using the IPTS framework, the present project examines whether acquired capability mediates the relationship between painful eating disorder behaviors and suicidal behavior. We were specifically interested at looking at the disordered eating behavior of over-exercise due to its noted association with pain tolerance (e.g., Ryan and Kovacic, 1966) and suicidality (e.g., Brown and Blanton, 2002), and because over-exercise often results in pain and injury (e.g., Veale, 1987; McKenzie, 1999). Behaviors such as vomiting and laxative abuse involve pain and bodily damage (e.g., erosion of dental enamel and cavities, abrasions to the back of the hand [Russell's sign], esophagitis and risk of esophageal tear, intense abdominal cramping, light headedness and headache, marked edema and fluid retention). Further, prolonged periods of restriction require one to overcome hunger pains and intense discomfort. However, we hypothesized that over-exercise would be a stronger predictor of acquired capability for suicide than other compensatory behaviors. We further predicted that the acquired capability for suicide would mediate the relationship between over-exercise and suicidality. For the current studies, "over-exercise" was defined as vigorous exercise engaged in as a means of controlling shape and weight.

Several lines of research implicate over-exercise as a potentially potent predictor of suicidal behavior, over and above other compensatory behaviors. First, over-exercise can result in serious physical damage (e.g., Veale, 1987; McKenzie, 1999), and one's history of experiences with pain is believed to be associated with increased levels of acquired capability for suicide (Joiner, 2005). Healthy exercise is extolled as beneficial for physical health and emotional wellbeing, and in fact has been found to decrease depression (e.g., Mota-Pereira et al., 2011). However, over-exercise is frequently associated with painful outcomes, including a pattern of symptoms called "overtraining syndrome." Overtraining syndrome is the result of intense workouts, which eventually lack any health benefit and lead to a host of problems including fatigue and increased rates of physical illness (Smith, 2003). Additionally, overuse injuries, such as stress fractures (Sidiropoulos, 2007), tendonitis, and apophysitis (or an inflammation of the growth plate in the heel) represent painful, and sometimes chronic injuries that occur during and after over-exercise (Committee on Sports Medicine and Fitness, 2000). Furthermore, some overuse injuries, like compartment syndrome, are characterized by pain that rarely subsides without surgical intervention (Reneman, 1975).

Second, over-exercise appears to lead to a degree of habituation to pain, or an increase in pain tolerance. In fact, athletes have been found to have greater pain tolerance than non-athletes. For example, Ryan and Kovacic (1966) found that athletes engaging in contact sports (e.g., football, wrestling) had greater pain tolerance than athletes who did not engage in contact sports (e.g., golf, tennis), and these non-contact athletes in turn had greater pain tolerance than non-athletes. Length of training among athletes has also been found to be related to pain tolerance; athletes with greater amounts of training have higher pain tolerance than athletes with less training (Paparizos et al., 2005). Such findings align well with the IPTS, in that the repeated exposure to pain as a result of over-exercise may increase one's acquired capability for suicide and thus increase risk of suicidal behavior.

Third, two lines of research suggest that over-exercise is related to suicidal behavior via its relationship with anxiety sensitivity (Broman-Fulks et al., 2004; Capron et al., 2012a, 2012b). Specifically, Capron et al. (2012a) found that low physical concerns (a component of anxiety sensitivity) were related to suicidal ideation and attempts. In another study, it was found that low physical concerns trended toward predicting suicidality in a sample of adults with HIV (Capron et al., 2012b). Importantly, Broman-Fulks et al. (2004) found that only high-intensity exercise (vs. low-intensity) reduced fear of anxiety-related physical concerns. Thus, by reducing anxiety-related body sensations, over-exercise may increase the risk for suicidal behavior.

Finally, research has found support for the association between over-exercise and suicidal behavior. Wade et al. (2006) used latent profile analysis in a community sample of 1002 twins to determine the number of distinct weight and eating profiles that emerged from their analysis. The authors found a clear five-class solution, with the fourth class displaying greater symptom severity compared to the other classes. The fourth class also displayed a greater likelihood of having lifetime major depression and suicidality. Notably, this fourth class, which had elevated suicidality, also had a higher likelihood of endorsing over-exercise than the other profile groups. Further, college women who engaged in frequent, vigorous exercise were two times more likely to engage in suicidal behavior as compared to women who did not exercise regularly (Brown and Blanton, 2002). Unger (1997) found that adolescent girls who exercised frequently (i.e., six to seven days per week) had higher rates of suicidal behavior as compared to girls who did not engage in physical activity. Additionally, even moderately active women were more