Physical exercise fosters recovery from negative stressors: The impact on sleep quality and mental health for trauma victims

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Foreword

Submitted in partial fulfillment of the requirements of the BSc Psychology degree, Reykjavik University, this thesis is presented in the style of an article for submission to a peer-reviewed journal.

This thesis was completed in the Spring of 2020 and may therefore have been significantly impacted by the COVID-19 pandemic. The thesis and its findings should be viewed in light of that.
Abstract
Most people experience a serious stressor which can entail a threat to their life and can subsequently affect mental health severely. Research has demonstrated that physical exercise has beneficial effects on mental health and that social support is a motivator in being physically active. It is crucial to shed more light on the beneficial impact physical exercise may have on the mental health of trauma victims. The purpose of the study was to evaluate the potential impact of these contributors to mental health following trauma exposure. The present study was based on prior data collected by the Icelandic Directorate of Health in 2017, comprised of an Icelandic sample of 6,776 participants. The findings indicated that physical exercise has beneficial effects on mental health and sleep quality, especially for trauma victims. However, social support did not have the expected effect of promoting greater physical exercise. Physical exercise partially mediates the relationship between traumatic experiences and mental health. Participation in physical exercise manifests in overall improved mental health following trauma. Thus, it is important to encourage physical exercise among this group.

Keywords: trauma, physical exercise, social support, sleep quality, mental health, anxiety, depression, PTSD.

Útdráttur

Lykilorð: Áföll, líkamleg hreyfing, félagslegur stuðningur, svefngæði, andleg heilsa, kvíði, þunglyndi, áfallastreituröskun.
Physical exercise can have beneficial effects on the physical and mental health of individuals (Hötting & Röder, 2013). Physical exercise is generally described as a repetitive, planned, structural form of physical exercise (Qiu et al., 2019) which can be categorized into several different types. Isotonic and isokinetic exercises involve the contractions of muscles with the following movement of the joints (Van Ark et al., 2016; Sin et al., 2014). Aerobic exercise however, involves an increase in oxygen level used by the body and is performed for extended periods, between 10-40 minutes (Knuttgen, 2007).

Regular physical exercise can lead to stress reduction, altered pain perception and improved mood both during physical exercise and afterwards (Boecker et al., 2010). For example, after participating in an aerobic exercise people feel less angry, anxious and depressed (Szabadi, 1988). Regular physical exercise is also protective against higher prevalence of anxiety and major depression (Goodwin, 2003) and can help individuals manage mental disorders (Have, Graaf, & Monshouwer, 2011). Physical exercise likewise improves emotions and can alter a response to emotional event. Bernstein and colleagues revealed that moderate aerobic exercise helped participants recoup from watching a sadness-inducing movie clip, suggesting that physical exercise helps with managing emotional stress (Bernstein & McNally, 2017).

The effects of physical exercise could possibly be accounted for by several biological changes. Individuals can experience a sense of euphoria and analgesia which refer to the “runner’s high”. The changes are a consequence of increased endogenous opioids named endorphins (Rot, Collins, & Fitterling, 2009). Aerobic exercise is related to significant increased amount of 5HT and 5HIAA serum levels (relating to a neurotransmitter called serotonin) during 20 weeks therapy sessions (Valin et al., 2013). The positive effects of physical exercise could
therefore be at least partly explained with serotonin, which relates to greater 5HT and 5HIAA serum levels (Valin et al., 2013).

**Mental health following trauma**

Most people experience a serious stressor at some point in their lives, which can entail a threat to their life. Such events affect brain functioning, other body systems and can subsequently place individuals at risk of developing mental disorders (O’Donovan, Neylan, Metzler, & Cohen, 2012). Traumatic events are diverse, can include experiencing or witnessing events such as serious injury, physical abuse, sexual abuse, emotional abuse or natural disasters (Reeves et al., 2017). In those circumstances, a person can experience a sense of apprehension, serious fear and even a sense of helplessness (Roberts, Gilman, Breslau, Breslau & Koenen, 2011). The effects of trauma can appear later in life and in many cases long after the trauma (McFarlane, 2010).

Trauma victims are at a greater risk of developing mental disorders than others (O’Donnell, Brynt, Creamer, & Carty, 2008), both in general (Jina et al., 2012) and for particular conditions, such as depression (O’Donnell et al., 2012) or suicidality (Jina et al., 2012). Post-traumatic stress disorder (PTSD) is the most frequent mental disorder occurring following a traumatic event (Shalev, Libezron & Marmar, 2017), symptoms include feelings of hyper-arousal, dissociation, avoidance and re-experiencing the traumatic event (Harvey & Bryant, 2002). Sleep disturbances are also common among trauma victims, including difficulty falling asleep, maintaining sleep and difficulty returning to sleep following awakening (Lande, 2012). The trauma could cause sleep disturbances by becoming associated with the sleeping environment with arousal and dissatisfaction. This association is maintained although the traumatic incident is no longer present (Hauri & Fisher, 1986). Poor sleep quality could precede
other debilitating complications of trauma such as substance dependence, depression and post-traumatic stress disorder (PTSD) (Sinha, 2016).

**Biological changes following stressors and trauma**

Psychological trauma can cause impairment of the neuroendocrine systems (Nunes, Watanabe, Morimoto, Moriya & Reiche, 2010). The hypothalamic-pituitary-adrenal axis (HPA axis) is the primary neuroendocrine stress response system (Twari & Gonzales, 2018), regulating stress hormones and stress reactivity (Twari & Gonzales, 2018). When responding to a stressor, a cascade of hormones is released through the body, including the stress hormone cortisol. It lessens sensitivity to pain and enhances immunity and memory (Twari & Gonzales, 2018).

There are two types of cortisol dysregulations which can emerge in the aftermath of a stressor: Inability to react vigorously to a stressor or hyper-reaction to the stressful event which in turn prolong the recovery (Reilly & Gunnar, 2019). Several studies suggest that there is enhanced suppression of cortisol among various trauma victims such as adult female survivors of childhood sexual abuse, combat veterans with PTSD and other individuals with PTSD (Ironson, Cruess & Kumar, 2007).

**Benefits of physical exercise for trauma victims**

Physical exercise can be beneficial to help individuals cope with trauma. A 5-year longitudinal study on adolescents found greater physical exercise among females who had experienced life stressors such as break-ups and getting a disease. One possible explanation for the increased activity was to help them cope with the events (Nader, Ward, Eltonsy & Bélanger, 2018). On a similar note, a systematic review of combat veterans showed that participating in physical exercise following trauma served as a coping mechanism, reduced PTSD symptoms and improved quality of life overall (Caddick & Smith, 2014). This suggest that physical exercise
possibly mediates the association between trauma and subsequent mental health (Caddick & Smith, 2014). A mediation analysis is when an intervention is being explored in how it leads to its effect (Kazdin & Nock, 2003). A mediator displays an important association between a phenomenon or an intervention and an outcome (Kazdin, 2007).

Social support for trauma victims is an important factor because some victims can become socially isolated following trauma exposure (Puri, Tamang & Shah, 2011). Nader and colleagues (2018) showed that social support from friends and parents was an important factor for adolescents, increasing their participation in organized physical exercise (Nader et al., 2018). Another study demonstrated similar results regarding female survivors of sexual abuse participating in integrative yoga group. Social factors seemed either to hinder or motivate physical exercise among the survivors. That is, exercising in small groups seemed motivating while exercising among men hindered their participation (Smith-Marek, Baptist, Lasley & Cless, 2018).

Sleep promotes various factors such as learning, memory (Stickgold, 2005) and psychological wellbeing (Hamilton, et al., 2007). Participating in physical exercise helps individuals fall asleep faster, sleep through the night, feeling well rested the following day and they are less likely to report sleep disorder (Loprinzi & Cardinal, 2011). Therefore, physical exercise could facilitate better sleep quality which in turn mediates the effect of physical exercise on mental health, indicating possible benefits for trauma victims (Lande, 2012; Kobayashi & Mellman, 2012).
Current study

The purpose of the current study was to investigate how physical exercise contributes to mental health following a traumatic event. If that is the case, physical exercise could be a valuable tool on trauma therapy. There were six hypotheses that the researcher examined; First, individuals with trauma history have worse mental health than non-trauma individuals. Second, individuals with trauma history who engage in physical exercise regularly have a better mental health and less likely to have mental disorders compared to trauma victims who do not engage in physical exercise. Third, individuals with trauma history who have social support are more likely to engage in physical exercise than trauma victims who have no social support. Fourth, regular physical exercise is associated with improved sleep. Fifth, trauma exposure is associated with disturbed sleep. Sixth, individuals with trauma history who engage in physical exercise regularly are less likely to suffer from sleep disturbances.

Method

Participants

The present study was based on prior data from the questionnaire Health and Wellbeing of Icelanders conducted by the Icelandic Directorate of Health in 2017. The participants were Icelandic citizens born from 1938 (79 years of age) to 1999 (18 years of age), residing in Iceland and were divided into three samples; A, B and C. Sample A represented individuals who participated in 2007 (N=2,903) and sample B represented individuals who participated in 2012 (N=2,996). While sample C represented individuals, who were participating in 2017 (N=3,988). The total response rate of the questionnaire was 9.887 (68.5%), consisting of 4,671 males and
5.216 females. The participants were drawn from a random sample from the Icelandic population 
(Sigbjörnsdóttir, Guðlaugsson, & Jónsson, 2018).

Measures

**Gender.** Gender was tested on a three-point scale with the question “how do you define your gender?”: (1 = *male*, 2 = *female*).

**Trauma.** Trauma was examined on a three-point scale with the question “Have you experienced abuse?”: (1 = *no, never*, 2 = *yes in the last 12 months*, 3 = *yes, more than 12 months ago*). The sub-questions included physical abuse, sexual abuse and emotional abuse. The response “*No, never*” received value 0 and responses “*Yes, in the last 12 months*” and “*Yes, more than 12 months ago*” were aggregated receiving value 1 for data processing.

**Mental health.** Mental health was examined with few questions and some of them were measures of symptoms while others were diagnosis of mental disorders.

**Mental wellbeing.** Mental wellbeing was measured on a four-point Likert scale with the question “how do you rate your mental health?”: (1 = *very good*, 2 = *good*, 3 = *average* and 4 = *poor*). The 10-item Patient-Reported Outcomes Measurement Information System Global Health has demonstrated moderate internal reliability with a Cronbach’s alpha between 0.82–0.88 and good convergent validity (Katzan & Lapin, 2018).

**Depression diagnosis.** Participants were asked whether they had ever suffered from chronic depression. The response options were on a four-point Likert scale: (1 = *yes, have now*, 2 = *do not have now, although have had within 12 months*, 3 = *do not have now, although have had more than 12 months ago* and 4 = *no, never have*). DASS-21 is a valid subscale measurement of depression, anxiety and stress, exhibiting good discriminant and convergent
validity (Henry & Crawford, 2005). The scale’s measure of depression has shown satisfactory internal reliability (Cronbach’s $\alpha = 0.91$) (Lovibond & Lovibond, 1995).

**Anxiety diagnosis.** Participants were asked whether they had ever suffered from anxiety. The response options were on a four-point Likert scale: (1 = yes, have now, 2 = do not have now, although have had within 12 months, 3 = do not have now, although have had more than 12 months ago and 4 = no, never have). The DASS-21 scale’s measure of anxiety has demonstrated satisfactory internal reliability (Cronbach’s $\alpha = 0.84$) (Lovibond & Lovibond, 1995).

**Post-traumatic stress disorder (PTSD) diagnosis.** Participants were asked whether they had ever suffered from PTSD. The response options were on a four-point Likert scale: (1 = yes, have now, 2 = do not have now, although have had within 12 months, 3 = do not have now, although have had more than 12 months ago and 4 = no, never have). The Clinician-Administered PTSD scale has demonstrated high internal reliability (Cronbach’s $\alpha = 0.93$) and good convergent validity (Engelmann et al., 2018).

**Chronic fatigue diagnosis.** Participants were asked whether they had ever suffered from Chronic fatigue. The response options were on a four-point Likert scale: (1 = yes, have now, 2 = do not have now, although have had within 12 months, 3 = do not have now, although have had more than 12 months ago and 4 = no, never have). The Patient-Reported Outcomes Information System Sleep Disturbance has demonstrated good construct validity and internal reliability (Cronbach’s $\alpha = 0.96$) (Buysse et al., 2010).

**Sleep quality.** Sleep quality was examined with the question “How often have you experienced the following within the past three months?” containing four sub-questions such as “Have difficulty falling asleep?” and was measured on a five-point Likert scale ranging from 1 (never) to 5 (always, each night). The Patient-Reported Outcomes Information System Sleep
Disturbance has demonstrated good construct validity and reliability (Buysse et al., 2010). The questions were aggregated into one variable labeled *sleep quality* and valued from a minimum 4 to a maximum 20, demonstrating internal reliability of Cronbach’s α = 0.73.

**Social support.** Social support was examined with the question “How many hours a week, on average, do you spend on following tasks?” and on a thirteen-point scale ranging from 1 (zero hours) to (60 hours or more). Little social support has demonstrated moderate effects on stress, increasing life stress (Vilhjálmsen, 1993).

**Physical exercise.** Physical exercise was measured with two questions “For how many days within the last 7 days have you participated in a moderate physical exercise for 30 minutes or more?, consider all moderate exercise or intense exercise which persisted for at least 10 minutes each time to the extent of increasing heartrate and breathing”. The response was assessed on an eight-point scale: (1 = no day, 2 = one day, 3 = two days, 4 = three days, 5 = four days, 6 = five days, 7 = six days and 8 = each day). Physically exercising 2-3 times per week benefits mental health (Hassmén, Koivula & Uutela, 2000).

**Procedure**

The National Bioethics Committee granted permission for the study *Health and Wellbeing of Icelanders* in October 2017. The questionnaire was a confidential cross-sectional survey and drawn from a randomized sample of the population. For the first time since the initial study was conducted in 2007 the survey form was randomly divided into two segments, half of the participants received the survey in paper form while the other half received it electronically. On October the 2nd participants received one of four distinctive introduction letters determined by individuals’ participation, receiving the survey in paper form or electronically and whether they had been a prior participant in the study.
On October the 9th, participants received the questionnaire either by mail or by an email accompanying information of the composition. The email included the website www.HL17.is alongside a password for each participant receiving the survey electronically. A reminder was sent out on the 19th of October, thanking participant for their participation and reminding those individuals who had not participated. Those who represented the electronical sample received an email accompanying the website and the password for the second time. Individuals who had not participated in the survey earlier than November 13th of 2017, the paper form sample received a new form of the questionnaire, while the electronic sample received a phone call advising them to participate. The participants did not receive compensation of any form for their participation in the study (Sigbjörnsdóttir et al., 2018).

**Data analysis**

The 25th edition of the Statistical Package for Social Science (SPSS) software was used for processing the data. The first hypothesis which assessed whether there was a significant difference in mental health between trauma victims and non-victims, was examined using independent t-test and chi-square. The assumption of homogeneity of variance for the independent t-test was violated as the assumption of the chi-square.

The fourth hypothesis, assessing whether regular physical exercise was associated with improved sleep was examined using Spearman’s rho correlation. Spearman’s rho correlation was also conducted to examine the fifth hypothesis, which assessed whether trauma exposure was associated with disturbed sleep.

Mediation and moderation analyses were conducted to examine the other three hypotheses using the process tool by Andrew Hayes (Hayes, 2018). Mediation effect examined the second hypothesis and assessed whether individuals with trauma history who engage in
regular physical exercise have better mental health and less likely to have mental disorders than trauma victims who do not engage in physical exercise. Mediation effect also examined the sixth hypothesis, whether individuals with trauma history who engage in regular physical exercise are less likely to suffer from sleep disturbances than trauma victims who do not engage in physical exercise. Moderation analysis was conducted to examine the third hypothesis, whether individuals with trauma history who have social support are more likely to engage in physical exercise than trauma victims who have no social support. The linearity assumption between the independent variables and the dependent variable was violated. Neither the assumption of homogeneity nor the assumption for the normality of residuals were met.

**Results**

**Participant characteristics and correlation analysis**

A total of 58.2% participants had experienced trauma of some kind (N = 3692). Thereof were, 36.3% (N = 1341) males and 63.7% (N = 2351) females excluding eight participants who did not identify their gender. Considering the distribution of trauma categories for those who identified their gender, there were 31.1% (N = 1148) participants who declared being physically abused, 22.8% (N = 840) had experienced sexual abuse while 46.1% (N = 1704) participants reported emotional abuse. Statistics for the distribution of trauma categories and gender are illustrated in table 1.
Table 1. *Statistics for trauma exposure divided into categories and gender*

<table>
<thead>
<tr>
<th>Trauma</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
<th>Exact Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical abuse</td>
<td>581 (9.1%)</td>
<td>567 (8.8%)</td>
<td>1148 (17.9%)</td>
<td>.001</td>
</tr>
<tr>
<td>Sexual abuse</td>
<td>143 (2.3%)</td>
<td>697 (11.1%)</td>
<td>840 (13.4%)</td>
<td>.000</td>
</tr>
<tr>
<td>Emotional abuse</td>
<td>617 (9.7%)</td>
<td>1087 (17.1%)</td>
<td>1704 (26.9%)</td>
<td>.000</td>
</tr>
<tr>
<td>Total</td>
<td>1341 (21.1%)</td>
<td>2351 (37.0%)</td>
<td>3692 (58.2%)</td>
<td>.000</td>
</tr>
</tbody>
</table>

*Note.* sig (2-tailed).

Chi square test demonstrated that emotional abuse was the most common type of trauma, and sexual abuse the least common type. Significant gender differences emerged, where men were more likely to experience physical abuse, but women were more likely to experience sexual and emotional abuse.

Descriptive statistics for three variables along with the dependent variable are illustrated in table 2.

Table 2. *Descriptive statistics for sleep quality, physical exercise, social support and mental health*

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep quality</td>
<td>6,475</td>
<td>4</td>
<td>11</td>
<td>6.54</td>
<td>0.48</td>
</tr>
<tr>
<td>Physical exercise</td>
<td>6,620</td>
<td>1</td>
<td>8</td>
<td>4.22</td>
<td>2.32</td>
</tr>
<tr>
<td>Social support</td>
<td>6,212</td>
<td>1</td>
<td>13</td>
<td>6.86</td>
<td>2.96</td>
</tr>
<tr>
<td>Mental health</td>
<td>6,695</td>
<td>1</td>
<td>4</td>
<td>3.11</td>
<td>0.77</td>
</tr>
</tbody>
</table>

*Note.* N = number; M = mean; SD = standard deviation.
On average, participants scored considerably high on mental health and considered it generally good ($M = 3.11$). While 942 (15.0%) participants had been diagnosed with anxiety and 658 (10.5%) individuals with depression, the diagnosis for PTSD was slightly lower since 389 (6.3%) participants had diagnosable PTSD. Participants were most likely to exercise three times per week ($M = 4.22$) and spent time with family and friends between 11-19 hours per week ($M = 6.86$).

Subsequent table (see table 3) demonstrates the Spearman’s rho correlation between trauma, mental disorders, sleep quality, physical exercise and social support.

Table 3. Spearman’s rho correlation between variables

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Trauma</td>
<td>1</td>
<td>-.16**</td>
<td>.19**</td>
<td>.26**</td>
<td>.33**</td>
<td>.27**</td>
<td>-.16**</td>
<td>-.04**</td>
<td>-.02**</td>
</tr>
<tr>
<td>2 Mental health</td>
<td>1</td>
<td>-.15**</td>
<td>-.33**</td>
<td>-.18**</td>
<td>-.34**</td>
<td>.25**</td>
<td>.12**</td>
<td>.11**</td>
<td></td>
</tr>
<tr>
<td>3 Chronic fatigue diagnosis</td>
<td>1</td>
<td>.24**</td>
<td>.24**</td>
<td>.21**</td>
<td>-.11**</td>
<td>-.02**</td>
<td>-.01**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Anxiety diagnosis</td>
<td>1</td>
<td>.38**</td>
<td>.56**</td>
<td>-.16**</td>
<td>-.06**</td>
<td>-.03**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 PTSD diagnosis</td>
<td>1</td>
<td>.33**</td>
<td>-.09**</td>
<td>-.01**</td>
<td>.00**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Depression diagnosis</td>
<td>1</td>
<td>-.15**</td>
<td>-.09**</td>
<td>-.04**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Sleep quality</td>
<td>1</td>
<td>.09**</td>
<td>.04**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Physical exercise</td>
<td>1</td>
<td>.02**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Social support</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* ** Correlation is significant at the 0.01 level sig (2-tailed).

Trauma was positively correlated with chronic fatigue and diagnoses of anxiety, PTSD and depression, but negatively correlated with mental health, sleep quality, physical exercise and
social support. The correlation was positive between mental health, sleep quality, physical exercise and social support. Sleep quality and physical exercise were negatively associated with the mental disorders; chronic fatigue, anxiety, PTSD and depression. The same applied for social support except not being correlated with PTSD.

**Bivariate testing**

To examine the difference in mental health between trauma victims and non-trauma individuals, an independent-samples t-test was performed. Those who had experienced trauma reported worse mental health ($M = 2.73$, $SD = 0.85$) than non-victims ($M = 3.24$, $SD = 0.72$), $t(418.822) = 11.03$, $p < 0.001$. A chi-squared test also showed that trauma victims were more likely to be diagnosed with chronic fatigue (trauma: 60.2%, no trauma: 39.8%, $x^2 (1, 6174) = 96.420$, $p < .001$), anxiety (trauma: 59.2%, no trauma: 48.8%, $x^2 (1, 6192) = 278.186$, $p < .001$), PTSD (trauma: 73.2%, no trauma: 26.8%, $x^2 (1, 6112) = 264.818$, $p < .001$) and depression (trauma: 66.9%, no trauma: 33.1%, $x^2 (1, 6169) = 319.612$, $p < .001$).

**Mediation analysis**

Using the process tool by Andrew Hayes five types of regression mediation analysis were performed, four to assess whether the relationship between trauma, mental health and sleep quality was mediated by physical exercise. Another mediation analysis was performed to assess whether the relationship between trauma and mental health was mediated by sleep quality. The direct effect was significantly negative in the first two models (see figures 1 and 2), that trauma victims have worse mental health and worse sleep quality. It is additionally evident that trauma victims are less physically active and those who participate in physical exercise exhibit better mental health as well as better sleep quality. The indirect effect was significantly negative.
between trauma and mental health through physical exercise, \( b = -0.0141, BCa CI [-.5718, -.4167] \) (see figure 1) and between trauma and sleep quality through physical exercise, \( b = -0.0126, BCa CI [-.0239, -.0034] \) (see figure 2). The same applied to the third model in which a moderation of gender was assessed between the association of trauma and mental health through physical exercise. The indirect effect demonstrated significant negative effect between trauma and mental health through physical exercise for both genders although females were less active, \( b = -0.0172, BCa CI [-.0404, -.0049] \) for males (see figure 3) and \( b = -0.0116, BCa CI [-.0233, -.0008] \) for females (see figure 3). The models illustrate partial mediation effect of physical exercise. Physical exercise is an important factor, other factors are likewise important in explaining these associations.

*Figure 1. Mediation model with the mediation effect of physical exercise.*
Figure 2. Mediation model with the mediation effect of physical exercise.

Figure 3. Mediation model with the mediation effect of physical exercise and moderation effect of gender.
The fourth mediation model in which moderation effect of social support was assessed between the association of trauma and physical exercise demonstrated no significant indirect effect of social support, $b = -.0113$, $BCa CI [-.0258, .0018]$ (see figure 4.).

![Mediation model with the mediation effect of physical exercise and moderation effect of Social support.](image)

*Figure 4.* Mediation model with the mediation effect of physical exercise and moderation effect of Social support.

The fifth mediation model in which mediation effect of sleep quality was assessed between the association of trauma and mental health demonstrated significant negative direct effect, that trauma victims have worse mental health. Additionally, trauma victims have poorer sleep quality and those that have better sleep quality exhibit better mental health. The indirect effect of sleep quality was significantly negative, $b = -.0942$, $BCa CI [-.1175, -.0729]$ (see figure 5.).
Moderation analysis

Using the process tool five types of moderation analysis were performed. The first analysis was conducted to assess whether the association between trauma and mental health was moderated by social support and sleep quality. Neither interactive effects were significant, $b = -0.0291$, $BCa CI [-0.1187, 0.0606]$; $b = 0.0281$, $BCa CI [-0.2307, 0.2668]$ (see figure 6). Indicating similarly that the physical exercise is the important factor in explaining these associations.
The second moderation analysis was conducted to examine whether the relationship between trauma and mental health was moderated by both physical exercise and social support. Neither interactive effects were significant, $b = .0055$, BCa CI [-.0287, .0397]; $b = .0064$, BCa CI [-.0217, .0344] (see figure 7). The model demonstrates that physical exercise as a mediator is the important factor in explaining the association between trauma and mental health, not social support.
The third moderation analysis assessed whether the relationship between trauma and mental health was moderated by both physical exercise and sleep quality. Neither interactive effects were significant, $b = .0036, BCa CI [-.0294, .0367]; b = .0430, BCa CI [-.0359, .1219]$ (see figure 8) were significant. Indicating no effect on mental health.
The fourth moderation analysis was conducted to assess whether the association between trauma and anxiety diagnosis was moderated by physical exercise and social support. Neither interactive effects were significant, $b = .0592, BCa CI [-.0465, .1649]$; $b = .0158, BCa CI [-.1013, .0697]$ (see figure 9).

The last moderation analysis examined whether the association between trauma and PTSD diagnosis was moderated by physical exercise and sleep quality. The interaction effect of physical exercise was significantly positive, $b = .1389, BCa CI [.0033, .2746]$ (see figure 10). However, the interaction effect of sleep quality demonstrated no significance, $b = -.0106, BCa CI [-.3344, .3132]$ (see figure 10). Representing that only the moderator of physical exercise does effect whether trauma victims have PTSD diagnosis.

Figure 8. Moderation model with the moderation effects of physical exercise and sleep quality.
Figure 9. Moderation model with the moderation effects of physical exercise and social support.

Figure 10. Moderation model with the moderation effects of physical exercise and social support.
Discussion

The purpose of the present study was to evaluate the potential impact of physical exercise and social support on mental health following trauma exposure. The findings indicate that physical exercise is generally beneficial on mental health, especially on trauma victims and that social support does not play an important role in whether they participate in physical exercise. However, participation in physical exercise manifests in overall better mental health following trauma. Thus, being a crucial determinant of mental health outcomes in the aftermath of traumatic event(s).

Trauma exposure is common in the sample, as more than half the sample reported of abuse of some type. This is consistent with prior research showing that most individuals experience trauma at some point in their lives (O’Donovan et al., 2012). Additionally, the current study is in accordance with prior research concerning the impact of trauma and the consequences that may follow considerably later (McFarlane, 2010). Trauma experiences relate to detrimental consequences and declining mental health (Lande, 2012; O’Donnell et al., 2008). Although non-trauma victims can certainly develop various mental disorders, current findings demonstrated that more trauma-victims were diagnosed with mental disorders. Those mental disorders that were most common among trauma participants were PTSD and depression which is in accordance with O’Donnell and colleagues’ study (2012).

As previously mentioned, the second hypothesis, that trauma victims who engage in regular physical exercise have a better mental health and are less likely to have mental disorders was supported and is in line with prior research. Previous findings have found both that victims may use physical exercise to cope with the consequences of trauma (Nader et al, 2018) and physical exercise results in declines in mental disorders and overall improved quality of life.
(Caddick & Smith, 2013). This suggests that individuals can become aware of the beneficial effects of physical exercise and with time when experiencing adversity individuals may become motivated to utilize it as a form of therapy. However current findings demonstrated that trauma victims are less physically active compared to the general public which might indicate that the mental health outcomes restrict their daily lives to a considerable degree. For that reason, trauma victims may benefit from social encouragement to take the initiative in improving their wellbeing.

The third hypothesis, that individuals with trauma history who have social support are more likely to engage in physical exercise was not supported. The findings demonstrated that social support does not have a moderated effect on whether trauma victims participate in physical exercise, having no effect on improving overall mental health. This is inconsistent with prior findings which have found that social support plays an important factor, motivating physical exercise among trauma survivors (Nader et al., 2018; Smith-Marek et al., 2018). The discrepancy between findings could be a result of number of things. Firstly, there may be a variety of aspects that are considered to involve social support and thus researchers may include distinctive aspects of social support in their study, in which they consider important to examine. Another component that needs to be considered is individual differences and everyone might need different amounts of social support in different aspects of life. Some individuals might not need social support to participate in physical exercise while others do. Additionally, the measure of social support may not have been as satisfying as initially was thought.

The findings of the present study supported the fourth hypothesis that regular physical exercise is associated with improved sleep. The current study found a positive association between participation in physical exercise and sleep quality. That is, individuals who physically
exercise regularly exhibit better sleep quality which is in line with prior research. Previous findings have demonstrated that physical exercise facilitates better sleep quality by reducing sleep disruption patterns such as increasing sleep duration and feeling well rested the following day (Loprinzi & Cardinal, 2011). These findings encompass that physical exercise not only contributes to improvements in mental health but also other components that impact overall mental health.

Furthermore, the fifth hypothesis, that trauma exposure is associated with disturbed sleep was supported. As aforementioned findings demonstrated that trauma victims are prone to have worse mental health than non-victims and more likely to have mental disorders (O'Donnell et al., 2013; Puri et al., 2011), it is not unforeseen that they encounter sleep disruption as well since it contributes to wellbeing as prior research has shown (Hamilton et al., 2007). This suggests that trauma victims’ poor mental health is a continuum which is maintained firstly by traumatic events which could cause poor sleep quality and in turn maintains unimproved mental health. For that reason, it could be beneficial to implement proper sleeping patterns in psychotherapy for trauma survivors.

The last hypothesis, that individuals with trauma history who engage in physical exercise regularly are less likely to suffer from sleep disturbances was supported. As previously mentioned regarding the fourth hypothesis the current findings found that physical exercise improves sleep quality and additionally, demonstrated that physical exercise is an important factor in improving sleep quality among trauma victims. This is consistent with prior research, indicating that physical exercise promotes sleep patterns which possibly benefits trauma victims (Lande, 2012; Kobayashi & Mellman, 2012).
The current study is the first to examine the impact of physical exercise as a contributor on mental health following traumatic event(s) on an Icelandic sample. The study’s leading strength was the large sample size and age groups which enhances generalizability. It demonstrated high response rate which can be strengthening quality since large number of participants cooperated in reporting trauma history. The questionnaire consisted of standardized measures and satisfactory psychometric properties. Furthermore, the current findings reveal the importance of administrating other contributing factors into psychotherapy following trauma. Physical exercise could be a valuable tool for trauma victims to be implemented in the psychotherapy. It would require patients to participate in a certain amount of physical exercise and thereby promote their mental health. Serving the purpose of reducing the negative consequences that trauma exposure may entail by alleviating sleep disruption and various mental disorders such as anxiety, depression and PTSD ((Loprinzi & Cardinal, 2011; Manger & Motta, 2005). Although, the current study was not without limitations. The questionnaire was a self-reporting survey which consisted of 95 questions. Thus, the participants might not have comprehended or responded faithfully to every question. Additionally, the length might have resulted in some bias regarding the results. Since this is a quantitative correlational study, causation cannot be determined. Lastly, the measures that were used were not as satisfying as they could have been.

Overall research concerning the association between physical exercise following trauma and its effectiveness for trauma victims seems scarce. Hence, future research should examine more diverse traumas when assessing the impact of physical exercise on mental health which could demonstrate additional knowledge, since only three types of abuse were examined. Future research should also examine the association between trauma, physical exercise and mental
health in diverse cultures to assess whether any distinctive features emerge. Lastly, it would be interesting to explore whether trauma victims obtain improved mental health more rapidly when integrating both physical exercise and sleeping patterns in psychotherapy contiguous to traditional psychotherapy.

Resources
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