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A systematic synthesis of evidence regarding relationship of physical activity and sports participation with trait self-control

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ABSTRACT

Individuals with low level of trait self-control exhibit several negative behaviors such as violence, addictive behaviors (drug addiction, technological addictions), suicide, unhealthy eating, and criminal behaviors. In contrast, high level of self-control thought to be associated with positive psychosocial and physical health related outcomes. Interventions contribute to boost self-control seems essential for individual with risk of low trait self-control.

The purpose of this study is to systematically evaluate the relationship between physical activity and trait self-control.

For this purpose, full-text articles were searched in research databases including Psych INFO, PubMed, Medline, The Cochrane Library, Wiley Library, Taylor & Francis, Science Direct, Springer, ERIC, JSTOR, Google scholar, and Sage Journals. Following screening for the study selection criteria and assessment of risk of bias, twenty one studies (13cross-sectional, 5 longitudinal and 3 interventions) with low or moderate risks of bias were finally selected for qualitative synthesis. Findings from all of the included studies consistently showed that there was a significantly positive relationship between physical activity and trait self-control. It is suggested that increasing self-efficacy, decreasing aggression, and improvement in positive and negative emotional states might be underlying mechanisms working for beneficial effects of physical activity on trait self-control.

These suggest that physical activity and exercise may serve as a potential means to enhance trait self-control. Practical implementation and recommendations for policy makers are put forward in this connection.

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1. Introduction

The construct of trait self-control is considered significantly critical while determining influential factors effecting human behaviors.In the existing literature, considerable discrepancies exist concerning its conceptualization, assessment tools and procedures, and even its name. However,in general, current theories agreed upon the view that trait self-control can be conceptualized as the capacity of an individual to regulate successfully emotions, feelings, immediate tendencies, impulses, and behaviors, or to control predominant dispositions in an attempt to attain long-term goals in the later life(D. T. De Ridder & Lensvelt-Mulders, 2018). In addition, trait self-control implies as the potential to exhibit consciously in wide range circumstance and situations that can be evaluated using self-reported questionnaires (Allom, Panetta, Mullan, & Hagger, 2016; Tangney, Baumeister, & Boone, 2004).

Research suggested that peoples varying with respect to their ability and level of trait self-control that resulting in exerting different impact oncertain behaviors, life style, attitudes and over all life of the individuals. For example, individuals with high trait self-control exhibit less criminal behavior (Bobbio, Arbach, & Vazsonyi, 2019), less alcohol and fast food consumption, and healthy eating (Martin S. Hagger et al.). Moreover, research also, demonstrated positive association of trait self-control with stable emotions, self-esteem, being open, perspective taking and negatively related with shyness, personal distress, and unconcern (Pilarska & Baumeister, 2018). Other studies indicated that individuals having higher level of self-control exhibited higher academic performance, good social relations, and higher psychological health(Tangney et al., 2004). In contrast,negative effects such as borderline personality symptoms (Hallquist, Hipwell, & Stepp, 2015), depression and loneliness (Özdemir, Kuzucu, & Ak, 2014), aggression and addictive behaviors (Kim, Namkoong, Ku, & Kim, 2008), gambling disorder (von Hammerstein et al., 2018), burnout (Seibert, May, Fitzgerald, & Fincham, 2016), loose temperament (Nęcka, Korona-Golec, Hlawacz, Nowak, & Gruszka-Gosiewska, 2018), obesity and eating disorders (Mackenbach et al., 2019), and suicidal behavior (Baer et al., 2018) appeared to be related with low level of self-control potentials. In the same line, Malouf et al. (2014) found that there was inverse association of trait self-control with maladaptive behaviors including suicidal behavior, unhealthy sex behavior, and substance dependency in a sample of jail inmates.

These findings suggest that the trait self-control is a multi-facets and complex construct that is related with wide range of behaviors, thoughts, and emotions. Therefore, professionals in psychology, therapeutic experts dealing with psychiatric diseases, sociologist, educationist, and criminologists are deeply concerned with the issues generated due to lack of trait self-control (Piquero, Jennings, Farrington, Diamond, & Gonzalez, 2016). In line with above discussions, it seems crucially important to identify the therapeutic interventions, and ways that could help improve self-control in wide range of populations. The experts have been showing great concern regarding therapeutic interventions to deal with issue of low self-control on their target populations. The interventions, approaches, and strategies focusing on developing the skills that regulate emotions, behaviors, cognition and promote problem solving and social skills have importance for considerations in this regard (Crick & Dodge, 1994; Elias, Zins, & Weissberg, 1997; Stein, Thurston, & Mather, 1997). Interventions such as mindfulness training (Rowland, Wenzel, & Kubiak, 2016), situational self-control strategies (Duckworth, Gendler, & Gross, 2016),cognitive-behavioral therapy (Scarpa & Reyes, 2011),relaxation training, cognitive coping strategies, video tape training/role playing interventions, and immediate/delayed rewards clinical interventions(Piquero et al., 2016), have been the main focus of previous research in an efforts to improve trait self-control. On the other hand, researchers are curious to explore more alternative approaches such as physical activity and exercise(Scully, Kremer, Meade, Graham, & Dudgeon, 1998).

Certain level of physical activity and exercise is considered important to constitute several psychological, social, cognitive, and health related benefits that may contribute dealing with self-control concerns. In this connection, previous research showed that an optimal level of physical activity appeared to reduce obesity and poor eating (Fan & Jin, 2013), depression, anxiety, psychotic symptoms, and suicidal behavior(Tao et al., 2007). Moreover, sufficient amount of physical activity is suggested to promote good eating habits, fulfilling the commitments, emotional control, timely completing the household chores, financial spending control, improvement in study habit and reduced negative behaviors such as perceived stress, alcohol, smoking, emotional distress, and caffeine consumption (Oaten & Cheng, 2006).Exercise has also been suggested to foster self-confidence, self-esteem,self-worth, controlling deviant tendencies, problem solving ability, happiness, self-discipline, pleasant mood, and socialization(Lubans, Plotnikoff, & Lubans, 2012; Nieman, 2002).Previous research has also corroborated that athletes encounter various challenges that require utilization of self-control capacity.It is also known that positive psychological states (happiness, pleasant mood) can result in promoting self-control (D. De Ridder & Gillebaart,

2017; Isen & Reeve, 2005). In addition, involvement in physical activity improves characteristics and skills those are essential for self-control abilities. On the other hand, the negative psychological characteristics are related with low self-control can be improved through physical activity. Therefore, this discussion theoretically led to assume that physical activity may be an effective source to improve trait self-control.

Furthermore, lack of involvement in physical activity has become global health concern in recent decades. A large proportion of the people do not meet the basic requirement of participation level in physical activity in almost all of the countries of the world. This lead to prevalence of psychological disorders, physical diseases, social problems, and exerting extra load on nation's economies(Penedo & Dahn, 2005). In the same vein, if, in some way, self-control has some relationship with health related behaviors including physical activity or unhealthy behaviors such as sedentary behavior, as it has consistently been demonstrated in the past research (D. T. De Ridder & Lensvelt-Mulders, 2018). Then, plausibly it points to the assessment of the efficacy of this relationship. This would be useful for policy makers to make decisions regarding promotion of positive health and nullifying negative health behaviors in the communities. Therefore, the purpose of this review is to assess the relationship of physical activity, exercise, and sports participation with trait self-control. To date, as per our knowledge, no review has systematically presented findings from published work on this topic. This review essentially would add quality based knowledge to the policy makers, psychologist, educationists, and health related professional for making decisions based on evidence based recommendations.

2. Methodology

2.1 Study Inclusion and Exclusion Criteria

Inclusion criteria was as follows: 1) the studies with the objective of assessing relationship of physical activity, exercise, sports participation, sedentary behavior, physical fitness on self-control either as a primary focus or as a sub theme, 2) cross-sectional, cohort, longitudinal, experimental, case-control, randomized control trials,and intervention research studies, 3)studies involved all sample types including students, community and healthy or patient samples, 4) studies used participants with any age (e.g., children, adolescents , adults, and old)that have both male and female genders, 5) studies in English language and conducted in any country/nation, 6)studies included physical activity-related keywords (e.g., physical activity, exercise, sports participation, physical fitness, sedentary behavior, athletes or non-athletes) and the keyword of self-control either in titles or in abstracts, 7) studies measured trait-self-control, and 8) studies published in peer review journals. Studies were excluded if they failed to meet the following criteria: 1) full texts were not available, 2) studies did not measure physical activity, exercise, sports participation, sedentary behavior, physical fitness or self-control3) studies presented findings solely based on behavioral measures of self-control. However, study is included if it used combination of both self-reported and behavioral measures of self-control. There is less agreement among the researchers on the use of behavioral measures of self-control(Allom et al., 2016), 4) studies presented insufficient data regarding the objectives of this review, 5) unpublished studies, commentaries, letters to the editor, conference proceedings, books and book chapters, thesis and dissertations, 6) case-reports, published reviews, case-series, qualitative studies, pilot studies, 7) studies lacking sufficient methodological details, and 8)studies used self-regulation as synonyms to self-control. Since, the constructs of self-control and self-regulation have not been considering the same in research literature, therefore, we excluded the studies used self-regulation approach as synonym to the concept of self-control (Gillebaart, 2018; Mann, De Ridder, & Fujita, 2013).

2.2 Search Strategy

Systematic search was conducted (December 2018) in major research data bases including Psych INFO, PubMed, Medline, The Cochrane Library, Wiley Library, Taylor & Francis, Science Direct, Springer, ERIC, JSTOR, Google scholar, and Sage Journals. Search terms consisted of "physical activity" AND "self-control", "exercise" AND "self-control", "physical fitness" AND "self-control", "sedentary behavior" AND "self-control", "athletes versus non-athletes" AND "self-control", and "sports participation" AND "self-control". In addition, reference lists of the research articles on the topics related to sport, exercise, and physical activity on self-control were screened to search for additional articles.

2.3 Study Selection

Based on inclusion and exclusion criteria, two experts independently performed extensive review to select the studies for this review. The experts performed review in following two steps: firstly, they screened for titles and abstracts of the retrieved studies looking for information and data relevant to the objectives of this review. And secondly, full texts of the retrieved articles were also reviewed for potential relevancy. Three meetings were

conducted among experts to discuss and resolve any discrepancy regarding study selection. Differences of opinion regarding selection of studies were resolved through discussions between both experts. A third expert was consulted in case the disagreement still existed between the two experts. Figure 1 illustrates the full details of study selection procedure.

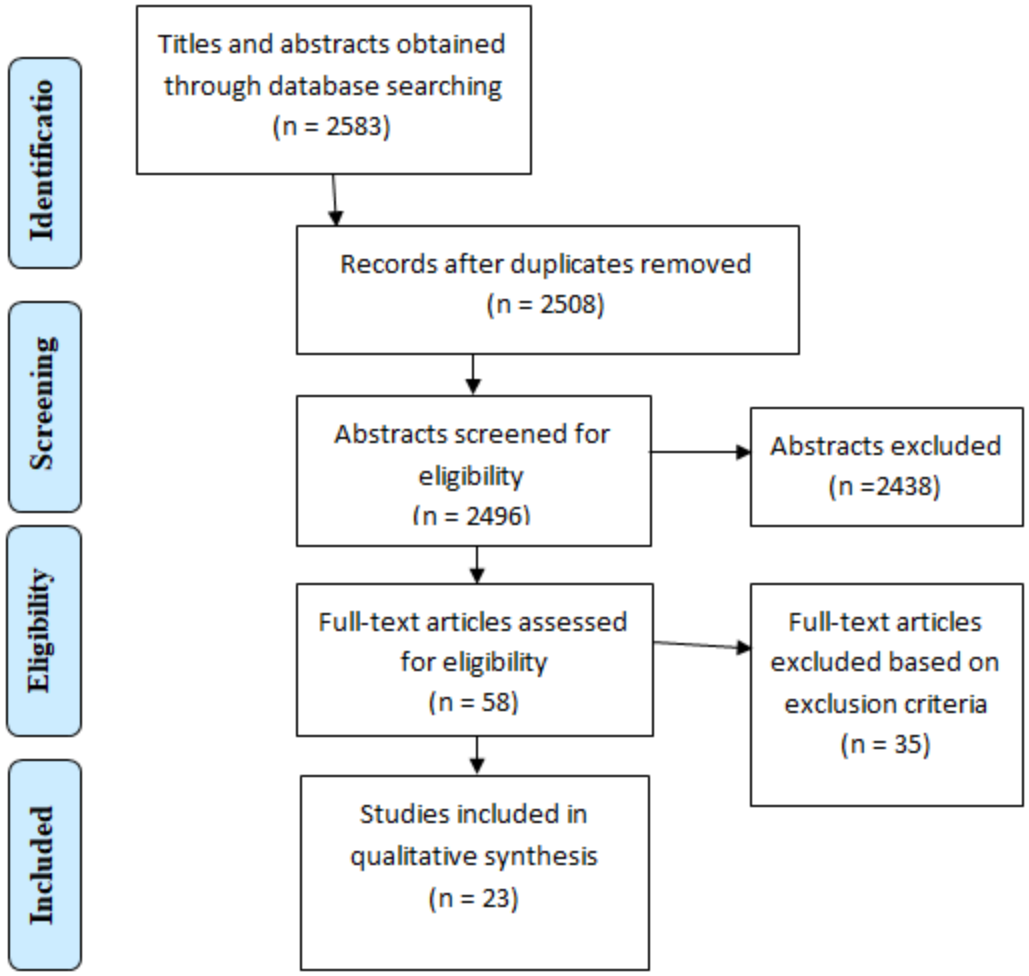

Figure 1. Search strategy and selection of studies

2.4 Assessment of Risk Of Bias

Two independent reviewers assessed the risk of bias for the studies met inclusion and exclusion criteria. Quality of the cross-sectional studies was evaluated using The Newcastle-Ottawa Scale (NOS) adapted for cross-sectional studies (Herzog et al., 2013).The Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies was used for appraisal of risk of bias of longitudinal and intervention studies (Project, 1998). This tool is considered valid and reliable for quality appraisal of cohort, longitudinal, randomized control trials, time series, control clinical design, and case-control studies and have been widely used in previous research(Armijo-Olivo, Stiles, Hagen, Biondo, & Cummings, 2012; Thomas, Ciliska, Dobbins, & Micucci, 2004). Quality ratings of the eligible studies were performed based on the scoring system prescribed by EPHPP reviewer's dictionary and manual. Based on the appraisal, the selected studies were classified as weak (two or more weak ratings), moderate (one weak rating), and strong (no weak ratings) categories. Discrepancies regarding the quality ratings for admissible publications was resolved through discussions between the two experts and agreement level was determined with a Kappa = .82.

3. Results

3.1 Study Selection

2496 titles and abstracts were carefully screened for admissibility. After removing ineligible abstracts and titles, 58 full text articles were retrieved and considered for further screening.35 studies were excluded due to not meeting

inclusion criteria for this review and finally 26 articles were selected for quality assessment in full text.Of these, 13 cross-sectional studies were categorized as very good, good or satisfactory. 5 longitudinal studies and 3 intervention studies having low or moderate risk of bias were selected for qualitative synthesis.

3.2 Study Characteristics

3.2.1 Cross-Sectional Studies (N=13)

We found thirteen eligible cross-sectional studies that examined association or relationship of physical activity or physical fitness with trait self-control. The details about characteristics of the selected studies are presented in table 1.A. Study characteristics were extracted following careful reviewing of the selected studied by two experts. These characteristics included author name and year of publication, population, sample size, sample selection procedure, participant's ages and gender, physical activity and trait self-control measures, data analysis tests, and results and findings.

The total number of participants consisted of 7309 ranging from 134 to 2812 participants in these studies. Five studies were performed in adolescents from school, colleges, or university students and eight studies in adults. Five studies included both adolescents and adults participants. Participant's ages ranged from 12 to 65 years in these studies. Among thirteen admissible cross-sectional studies, two studies included only male participants whereas remaining eleven studies included both male and female participants.Majority of the studies used convenience sampling while a few studies used purposive (Tedesqui & Young, 2017) or cluster sampling (Chen, Li, Xie, Li, & Zhang, 2018; Chen et al., 2019)procedures. None of the studies used random or systematic sampling procedure for sample selection. The response rates of the participants were greater than 80% in Ten out of thirteen studies. Less than half of the studies (5/13) controlled for almost all of the important confounding factors, whereas, approximately half of the eligible studies (6/13) controlled for the most important confounding factors (e.g., age, sex), except two studies that did not report controlling of confounding variables.

In particular, three studies included professional athletes, one study selected participants from fitness gym, and one recruited participants from soldiers attending physical training. All of these studies used self-reported valid and reliable methods/ tools of measuring sports participation, physical activity, exercise, and trait self-control. However, only one study administered objective measures of physical activity. Majority of these studies(8/13) used either short or long version of self-control scale developed by Tangney et al. (2004). In these studies, three were conducted in Netherlands, two in USA, two in China, and one in each of the countries including Finland, Israel, Norway, Canada, South Korea, and UK. All of the thirteen cross-sectional studies were found to have significantly positive relationship or association of sports participation, physical activity, exercise, or physical fitness with trait-self-control.

3.2.2 Longitudinal (N=5) and Intervention Studies (N=3)

We found five longitudinal studies assessed association between physical activity and trait self-control. Table 1.B and C illustrates characteristics of the longitudinal and intervention studies included in this article. These studies consisted of 30 to 3993 participants and included 7153 participants in total. Three studies included participants from university student's population and two studies were conducted in general population. Participant's ages were ranged from 15 to 45 years, respectively. The follow up period varied from 2 weeks to 6 years across the five longitudinal studies. Only one study used random sampling approach while reaming four studies used convenience sampling procedures, however, they did justify the sample size. Four out of five studies used valid and reliable physical activity measures. All of the studies used valid and reliable trait self-control measures. These studies also did control for the most important confounding factors either in designs or in analysis. These studies were conducted in Germany (N=2), Netherlands (N=1), Finland (N=1), and Canada (N=1). All of these studies reported significantly positive relationship between physical activity and trait self-control.

We identified three studies with intervention research paradigms assessing association between physical activity and trait self-control. The major characteristics of the three intervention studies are described in Table 1.C.Of these, one study applied randomized control trials(Cecchini, Montero, Alonso, Izquierdo, & Contreras, 2007), one study controlled clinical trial(Shachar, Ronen-Rosenbaum, Rosenbaum, Orkibi, & Hamama, 2016) and one study had time series design(Will Crescioni et al., 2011). Participant's ages were ranged from 9 to 60 years in these studies. Participants of two studies consisted of school children and participants of one study were selected from university students and general population.These studies included 921 participants in total that ranged from 86 to 649 participants. The intervention period ranged from 5 to 24 weeks, respectively. Of the three intervention studies, two

used team sports as intervention strategy and one study used general physical exercise program (e.g., walking, jogging, aerobic dance, cycling, and swimming). All of the three studies measured trait self-control with valid and reliable tools. One study was conducted in USA, one in Israel, and one in Spain, respectively.All of the three studies had low risk of bias and had overall strong rating. Findings from the intervention studies consistently showed significantly positive relationship of sports participation, exercise, and trait self-control.

Table 1. A. characteristics of cross-sectional studies assessing relationship of physical activity and trait self-control

Author/ country	Population, sample, Participants ages	Male %	Response rate (%)	PA measure	Trait self-control measure	Analysis	Results/ findings
(Wills, et al,. 2007) USA	sample of 539 selected from three public high schools with mean age 14.6 years (SD 0.7)	52	83	Vigorous exercise, sports participation and sedentary behavior were measured through 4 items selected from valid and reliable measures	12 items from multiple measures of self-control driven from past research	confirmatory analysis, correlations, and structural equation modeling analysis	Trait self-control were positively related with consumption of healthy eating, spots participation, and negatively related with sedentary behavior. Poor trait self-control exhibited decreased vigorous exercise.

(Junger,et al., 2010) Nather land	sample consisted of 201 adolescents using convenience sampling with ages between 15 and 20 years	50	100	2 times selected from valid and reliable Moderate-to-Vigorous Physical Activity measure	Tangney's SCS	Stepwise regression analysis, Pearson correlations, hierarchal regression analysis and a multivariate step-wise analysis	Trait self-control (β = .21) was positively related with physical activity but negatively related with BMI (β = -.17).
(Kinnunen, et al,. 2012) Finland	Sample sizes was 482 men ages ranged from 18-29 years (M = 20 yeras)	100	47	Height, weight, and waist circumference. Leisure Time Physical Activity, BMI, Cooper 12-Minutes Running Test. Muscle fitness tests included pull-ups, sit-ups, standing long jump push-ups, and a back-muscle test	Tangney's SCS	Linear regression analyses, and Sobel test.	Trait self-control was positively associated with leisure time physical activity, muscle fitness, aerobic fitness, and negatively related with BMI.
(Shachaf, et al., 2014) Isreal	Sample comprised of 491 10th-11th- and 12th grade Israeli high schools students. They were divided in to three comparison groups including 170 in sports group and 185 in non-sports but	44	100	Competitive sports group, physical fitness group, no activity group,	Rosenbaum,s SCS	One-way ANOVA	The participants in the sport group reported greater self-efficacy, attribution style, and self-control compared with the subjects in the no-activity and physical fitness conditions.

	fitness program group, and 106 in no activity group.						
(Toering, et al., 2015) Norway	639 male players from soccer teams took part in this study. Participants ages were ranged from 15 to 38 years (M = 23.6, SD = 4.8).	100	96	Soccer players were divided in to groups based on their performance and experience.	Tangney's SCS	chi-square statistic, confirmatory factor analysis, exploratory factor analysis, Multiple regression analyses, Pearson correlation	Players with higher performance and players spending more time in practice exhibited significantly higher trait self-control.
(Tedesqui, et al., 2017) Canada	Online survey study used , purposive sampling to select 244 athletes (M age =21.96 years, range = 12–43 years),	53	100	Athlete's level of skill and playing practice were assessed through valid and reliable 7 item valid tool.	Tangney's SCS	confirmatory factor analyses, Partial correlations, two separate one-way analyses of covariance.	Enhanced trait self-control was related with higher level of sport participation commitment and more time spending in sport practice.

(Chen, et al., 2018) China	210 national level Chinese boxers were recruited through cluster sampling. Participants' average age was 18.89 years while their average experience was 4.93 years.	36.2	91	Level and experience of boxers were measured through valid and reliable tool.	Self-control questionnaire for Chinese athletes	regression coefficients	The level of trait self-control was high in national boxers of china. Self-control was significantly greater as a function of athlete's level of competitions.
(Chen, et al., 2019) China	The sample size was 414 Chinese Professional boxers those were selected using cluster sampling. average age of the sample was 17.72 years.	58	92	Level and years of experience was measured through self-reported questions	Self-control Questionnaire for athletes	correlation analysis, variance analysis, regression analysis, Structural equation modeling,	Boxers with greater competition level exhibited higher self-efficacy and higher self-control. Aggression was negatively associated with self-control. Level of self-control was increased as a function of increasing years of training of boxing ($\beta = 0.202$, $p < 0.001$).
(Briki, w., 2016) USA	Sample consisted of 317 American adults (Mean age 32.97 years , SD age D11.30),	29.7	100	Self-reported regular exercise, BREQ-2	Tangney's SCS	Correlation Analyses, Structural model analysis	Motivation toward physical exercise (MPE) significantly enhanced trait self-control and trait self-control further enhanced subjective well-being in regular exercisers.

(Gille baart , at al., 2017) Nether land	online survey, The sample was 134 self-reported exercisers that were selected from fitness gyms. Participants ages ranged from 18-65 years, Mean age of 37.93 years (SD = 12.44.	38.8	100	Regular exercisers in gym. SRHI	Tangney ’s SCS	Spearman’s rank-order correlations, Pearson product-moment Correlations, regression analysis	Trait self-control was associated with increased duration of exercise (r = 0.33, p < 0.001) and strength of exercise habit (r =0.31, p<0.001).
(Park, et al., 2016) South Korea	Convenience sampling, 345 students were selected through convenience sampling from two middle and two high schools of south Korea. Participant’s ages were ranged from 15-18 years.	17.7	89	Sports participati on questionna ire	SCRS	Confirmator y Factor Analysis, Structural equation modeling, independent t-test and one way analysis of variance	Sports participation significantly and positively influenced self-control (β=.154, p < .05).
(Been ackers , et al., 2017) Nether land	2812 adults with ages ranged from 25–75 years were surveyed. Age mean and SD 48.8-14.9.	44.8	45. 5	SQUASH	Tangney ’s SCS	linear regression with a log-link function and generalized linear regression models,	High trait self-control was related with increased physical activity.

(Allom, et al., 2016) UK	Sample included 146 undergraduates university students with their ages ranged from 18-52 years (M age = 23.43, SD = 6.26).		99	PAQ	Tangney's SCS	Means, standard deviations and correlation coefficients, hierarchical regression analysis,	There was a positive relationship between physical activity and trait self-control. Trait self-control significantly predicted physical activity.

Table 1. B. Characteristics of longitudinal studies evaluated relationship between physical activity and trait self-control.

Author/ country	Population, sample size and ages, follow up period	Male%	Return rate %	PA measures	SC measures	Analysis	Findings
(Schondube, et al., 2017) Germany	One group pre-post longitudinal design using convenience sampling in which 63 university students ages ranged from 19 to 32 years (M= 23.5; SD =2.8) were participated. Selected variables were measured consecutively for 20 days.	33.3	83.3	Self-reported physical exercise participation for 20 days using single item valid tool.	Tangney's SCS	estimated multilevel models analysis	Reduction in physical activity was significantly lower in the participants showed higher trait self-control when compared with the participants exhibited lower trait self-control.

(Droomers, et al., 2001) Nather land	Longitudinal study between 1991 and 1997 with pre-post observations in which 3993 participants (ages 15-74 years) were selected through random sampling from the population of 27000 those were Followed up after six years.	N/R	85	Three items concerning Physical activity during leisure time from valid measure	RLCS	Logistic Regression, Explanatory Analyses,	Individuals with lower self-control reported reduced physical activity at follow up measures.
(Pfeffer, et al., 2017) Grmany	Longitudinal prospective design with 2 weeks interval, 118 participants. Convenience sampling, (age: M= 23.18 [SD = 2.57] years; range: 18–30).Sample size was statistically estimated and justified.	46.6	95	Single item vigorous physical activity. Validity was determined.	Tangney's SCS	regression analysis	High trait self-control predicted higher physical activity behavior.
(Hagger, et al., 2018) Finland	Correlational two-wave Prospective study design, Total samples size 3,249. Sample one comprised Finnish males military men (N = 679) from Finland. Sample 2 included 1072 university students from the Spain (N =282), UK (N = 258), Luxembourg (N = 172) and Philippines (N = 114). Samples Three and four consisted of university students from the Australia (N = 254) and United Kingdom (N = 150). Sample 5 included 235 students from two public schools of Finland. And 280 undergraduate students from 5 universities in Australia were selected for Sample 6.	Both male and females with varied ratio in sub samples	3.09 to 59.62	Self-reported participation in physical activity, walking and physical activity done after school hours	Tangney's SCS	MANOVA, chi-square tests, independent t-tests, regression analyses, the comparative fit index (CFI), the Tucker-Lewis index, RMSEA	Results from the samples of school and university students revealed that there was positive relation between physical activity and trait self-control.

	Mean ages of the total sample ranged from 13 to 21 years. Follow-up period was 2,4 and 8 weeks.						
(Stork , et al., 2016) Canada	online survey with pre-post prospective study design with 4 weeks period, sample 30 university under graduate students, mean age of 18.17 years, sample size was justified through power calculations,	23	98	IPAQ-S	Tangney's SCS	Multiple one-tailed Pearson's correlation coefficient, Spearman 's correlation coefficient, regression analyses	Physical activity was predicted by trait self-control (rs = 0.34, p = 0.04). Students with higher trait self-control engaged in exercise for longer durations than that of participants depicted lower trait self-control.

Table 1. C. characteristics of intervention studies examined relation between physical activity and trait self-control.

Author/ country	Population, sample size and ages, study design, group conditions	Male %	Return rate %	PA measures/PA interventions	Self-control measures	Analysis	Findings
(Cecchini, et al,. 2007) Spain	Randomized control trial study design, Population was 250,000. Total sample size was 186 middle school students with ages 13.6 mean years. The sample was randomly divided into three age and gender matched groups including experimental group A, experimental group B, and a control group.	49	100	Playing soccer for 5 weeks. Group A provided with beginners' five-a-side soccer five level, Group B provided level four, and control group did not participated soccer playing.	CASCQ	Univariate analysis	Experimental group A exhibited significant improvements in delayed gratification, trait self-control, and process self-regulation as a result five weeks of playing soccer than control group.
(Shachar, et al., 2016) Isreal	Controlled clinical trial design, 649 Israeli school children (ages = 9-11 years) equally divided into sports intervention group and no sports intervention control group.	Experimental group= 82, Control group= 70	90	experimental group provided with a total of 120 hours of sports activities after school hours for 24 weeks. Sports included soccer, basketball, volleyball, and mini-football whereas Control group received no sport activity.	Tangney's SCS	Pearson correlations, three-way multivariate analysis of covariance (MANCOVA), linear regression, two-way MANCOVA, and structural	Subjects in the sports intervention condition showed significantly greater improvement in self-control, significant reduction in aggression, negative emotions, and hostile thoughts in comparison with participants in control group.

						equation modeling (SEM).	
(Crescioni, et al., 2011) USA	12 weak time series single group design, 86 participants (ages, M = 26.56, SD = 10.77) participated in weight loss program for 12 weeks those required to record exercise daily for12 weeks and trait self-control once in every two weeks. The program focused on reducing weight through gradually adapting healthy food and increased physical activity. Exercises included walking, jogging, aerobic dance, cycling, and swimming.	29.1	62.31	BMI, Five questions regarding physical activity drawn from previous research	Tangney's SCS	Regression analysis, Multilevel modeling	At baseline, participants exhibited higher trait self-control appeared to engage in more physical activity compared with subjects yielded lower trait self-control. Subjects demonstrated greater trait self-control significantly increased amount of exercise more during 12 weeks of intervention period as compared with subjects exhibited lower trait self-control.

Abbreviations: PA = physical activity; BMI= body mass index; LTP = leisure time physical activity; BREQ-2 = The Behavioral Regulation Exercise Questionnaire-2; SRHI = Self-Report Habit Index; SQUASH =Short-Questionnaire to Assess Health-enhancing physical activity; PAQ = physical activity questionnaire; IPAQ-S = International Physical Activity Questionnaire, Short Form; SC= self-control; SCS = Tangney Self-Control Scale; SRQ = Self-Regulation Questionnaire; NEO-C = self-discipline; Rosenbaum,s SCS = Rosenbaum,s Self-Control Scale; SCRS = Self-Control Rating Scale; RLCS = Rotter's locus of Control Scale; CASCQ = The child and adolescent self-control questionnaire;

3.3 Quality of the Studies

3.3.1 Cross-Sectional Studies (N=13)

In this review, 13 cross-sectional studies were identified that were classified as good (N= 8) or satisfactory (N=5) quality rating (See table 2. A. for details). All of the cross-sectional studies included in this review selected the participants using convenience sampling approach. Among 13 selected studies, seven studies were classified as good quality rating. These studies used self-reported valid and reliable physical activity and trait self-control measures, controlled for at least most important confounding factors, reported sufficient response rate except two(Beenackers, Oude Groeniger, van Lenthe, & Kamphuis, 2017; Kinnunen, Suihko, Hankonen, Absetz, & Jallinoja, 2012) studies, sufficiently representative sample, satisfactory sample size with the exception of three(Chen et al., 2018; Gillebaart & Adriaanse, 2017; Toering & Jordet, 2015) studies, and applied appropriate statistical tests for analysis. Five of the selected cross-sectional studies were rated as satisfactory level of study quality(Allom et al., 2016; Briki, 2016; Junger & van Kampen, 2010; Park et al., 2016; Shachaf & Katz, 2014; Wills, Isasi, Mendoza, & Ainette, 2007). These studies had insufficient representativeness of samples and

unsatisfactory sample sizes. However, these studies did use valid and reliable physical activity and trait self-control measures, controlled the most important confounding factors, had sufficient level of participant's response rate and used appropriate statistical tests for analysis.

Table 2. A. Quality assessment of the cross-sectional included studies based on The Newcastle-Ottawa Scale (NOS) adapted for cross-sectional studies.

Study	Selection				Comparability	Outcome			
	1	2	3	4	5	6	7		
	Representativeness of the sample *	Sample size *	Non-respondents *	Ascertainment of the exposure **	Confounding factors are controlled **	Assessment of the outcome **	Statistical test *	Quality score out of 10	Quality rating
Wills, et al,. 2007	-	-	*	**	*	-	*	5	Satisfactory
Junger, et al., 2010	-	-	*	**	**	-	*	6	Satisfactory
Kinnunen, et al,. (2012)	*	*	-	**	*	*	*	7	Good
Shachaf, et al., 2014	-	-	*	**	-	*	*	5	Satisfactory
Toering, et al., 2015	*	-	*	**	**	*	*	8	Good
Park, et al., 2016	-	-	*	**	-	*	*	5	Satisfactory
Tedesqui, et al., (2017)	*	*	*	**	*	*	*	8	Good
Chen, et al., (2018)	*	-	*	**	**	*	*	8	Good
Chen, et al., 2019	*	*	*	**	*	*	*	8	Good
Briki, w., (2016)	-	-	*	**	**	-	*	6	Satisfactory
Gillebaart , at al., 2017	*	-	*	**	*	*	*	7	Good
Beenackers, et al., 2017	*	*	-	**	**	*	*	8	Good
Allom, et al., 2016	-	-	*	**	*	*	*	6	Satisfactory

Quality Rating procedure:

Very Good Studies: 9-10 points
Good Studies: 7-8 points
Satisfactory Studies: 5-6 points
Unsatisfactory Studies: 0 to 4 points

3.3.2 Longitudinal (N=5) and Intervention Studies (N=3

Out of five admissible longitudinal studies, one study is categorized in strong rating having low risk of bias with no weak rating in any of the component of quality assessment tool (Stork, Graham, Bray, & Martin Ginis, 2017).The details regarding quality ratings are depicted in Table. 2. B and C respectively.In addition, four out of five longitudinal studies were classified in moderate quality ratings (Droomers, Schrijvers, & Mackenbach, 2001; Martin S Hagger et al., 2018; Pfeffer & Strobach, 2017;Schöndube, Bertrams, Sudeck, & Fuchs, 2017). These

studies were characterized by following limitations: weak rating in selection bias 2/5 (Pfeffer & Strobach, 2017; Schöndube et al., 2017) and lower response rate (2/5) (Droomers et al., 2001; Martin S Hagger et al., 2018).

With regard to quality of the intervention studies, we identified three studies with over all strong quality rating (Cecchini et al., 2007; Shachar et al., 2016; Will Crescioni et al., 2011). These studies adequately minimized the selection bias in study samples (2/3) (Cecchini et al., 2007; Shachar et al., 2016), used strong study designs(2/3 (Cecchini et al., 2007; Will Crescioni et al., 2011), controlled for the major confounding factors (2/3)(Shachar et al., 2016; Will Crescioni et al., 2011), used valid and reliable physical activity and trait self-control measures (3/3)(Cecchini et al., 2007; Shachar et al., 2016; Will Crescioni et al., 2011), and had low withdrawal rates (2/3) (Cecchini et al., 2007; Shachar et al., 2016). None of the intervention studies admissible to this article had weak rating in any of the component of quality assessment criteria.

Table 2.B. Quality assessment of longitudinal studies based on Effective Public Health Practice Project (EPHPP) Quality Assessment Tool

Study	Selection bias	B Study Design	C Confounders	D Blinding	E Data collection methods	F Withdrawal	G Intervention integrity	H Analysis	Overall rating
Schondube, et al., (2017)	w	m	m	m	s	s	n/a	y	moderate
Droomers, et al., 2001	s	s	s	m	s	w	n/a	y	moderate
Pfeffer, et al., 2017	w	m	m	m	s	s	n/a	y	moderate
Stork, et al., 2016	m	m	m	m	s	s	n/a	y	strong
Hagger, et al., 2018	m	s	m	m	s	w	n/a	y	moderate
Table. 2. C. Quality assessment of intervention studies									
Shachar, et al., (2016)	s	m	s	m	m	s	y	y	strong
Cecchini, et al,. 2007	s	s	m	m	s	s	y	y	Strong
Crescioni, et al., 2011	m	s	s	m	s	m	y	y	strong
Rating scale: Strong = S, Moderate = M, Weak = W Criteria for overall rating of the study Strong= No weak rating Moderate = One weak rating Weak = Two or more weak rating									

4. Discussions

Lack of self-control constitute the likelihood of increased aggression, violent behavior, crimes and delinquencies, sedentary behavior, addictive tendencies, and inactivity that may increase wide range of social and health related

problems. In this connection, interventional strategies are crucially needed that may improve self-control in individuals with low level of self-control. Therefore, this study sought to systematically analyze the efficacy of physical activity, sports participation, and exercise to enhance self-control potentials. As per our knowledge, this is the first article that synthesized the findings from studies with sufficient quality and methodological rigor that tried to present findings on the said area of research. Thirteen cross-sectional studies with good (7/13) or satisfactory (6/13) quality ratings, five longitudinal studies with strong (1/5) or moderate (4/5) quality ratings, and three intervention studies with strong overall quality ratings presented findings in support of significantly positive relationship of physical activity, exercise , and sports participation with trait self-control and the vice versa.The consistency in findings from cross-sectional, longitudinal, and intervention studies provide sufficient evidence in favor of positive relation between physical activity and trait self-control. No study found inverse relation among these variables. Based on these findings, it can be suggested that participation in exercise and sports activities may be considered as a therapeutic mean to enhance self-control in individuals with low trait self-control and vice versa.

These findings are congruent with previous research indicating that participation in sports and physical activities foster positive psychological traits(Shachaf & Katz, 2014), and emotional well-being (Donaldson & Ronan, 2006).Some studies included in this review proposed the mechanismsthat might account for the positive relationship between physical activity and trait self-control. For example, findings from an intervention study conducted by Shachar et al. (2016), proposed that improvement in positive and negative emotions, and reduction in physical aggression as a result of participation in sport activities likely to foster self-control. Other studies suggested that participation in physical activities likely to increase self- efficacy, decrease aggression (Chen et al., 2019),and constitute positive habits (Gillebaart & Adriaanse, 2017) that in return might contribute improving trait self-control.

5. Strengths and Limitations of this Study

This study performed systematic literature search in the major research databases and presented well-structured and extensive synthesis of evidence. We evaluated the studies using valid, reliable and extensively used study quality assessment tools that were more appropriate for cross-sectional, longitudinal and intervention studies. Three intervention studies and one longitudinal study with strong methodologies and lower risk of biases added strength to the findings of this study. However, this study had some following limitations. For example, some of the included cross-sectional and longitudinal studies had moderate level of methodological quality that had risk of biased findings.

5.1 Future Research

Randomized control trial research design is considered as the gold standard design with respect to methodological quality. Experimental studies with randomized controlled trial (RCT) are limited on this topic as we could identify only one high quality study that used RCT design. Further research should focus on high quality studies with these research designs. Cross-sectional studies with larger sample sizes using systematic sampling techniques are also needed. Previous research heavily relied on using self-reported physical activity measures. Future research should use objective measures of physical activity while assessing relationship of physical activity and the ability of self-control. The link between type and form of physical activity and trait self-control can be another important venue of research that should be taken into consideration in the future.

6. Conclusion and Practical Implications

Individuals with criminal record have shown low level of trait self-control, hence, Policy makers should consider planning of exercise programs in jails for prisoners to engage them in sporting and exercise programs to enhance self-control levels in these individuals that could further reduce the tendency of criminology. Moreover, in current years, involvement in violent, bullying, aggressive and wide range of addictive behaviors has increased significantly among youth in education institutions. This posed a serious threat to peaceful learning environment of these institutions. Youth with these negative tendencies can be treated by offering special intervention programs including physical activities. This may help to improve self-control that further tends to reduce these negative behaviors among youth. On the other hand, dealing with the problem of inactivity or low level of physical activity has become major concern across the world. Since, higher level of trait self-control is related with increased physical activity, therapeutic intervention that could foster self-control can be helpful to increase level of physical activity in peoples with sedentary behavior. In sum, physical activity can be suggested as a potential medium of improving trait self-control. These recommendations have important implication for the professionals related with

criminology, health, psychology, and education. Policy makers can consider these guidelines while making decisions in these areas.

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