

Effect of sports and exercise on executive function: A Review Study

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Abstract: *The aim of the study was to elaborate the effect of sports and exercise on Executive Function through systematic survey of literature. The studies examined effect of various aspects of sports and variation of exercises on Executive Function and its various forms on adolescents and young adults accessed on open online journals published after 2000 A.D. were included in the study as an inclusion criteria; subjects on participants with neurocognitive disorder, older aged were excluded from the study as exclusion criteria. Studies prioritized computer based neurocognitive function task basis and modern technologies to assess various forms of executive function. Most of the studies revealed various forms of exercise in responding with intensity, moderation and forms enhancing executive function with fewer studies predicting contradictions. Externally paced open skill sports performed proficiencies in executive function and proposed as predictor of future sports performance. Attention, arousals, task specification, level of fitness are sited as dependant factors to elicit executive function. A meta analysis to reveal the effect size recommended to stabilize the effect of exercise on executive function recommended to highlight the facts.*

Key Words: *Executive Function, Inhibitory Control, Acute Exercise, Sports Performance, Physical Fitness.*

1. INTRODUCTION:

Sports and Exercises are worldwide evident to be effective measure of healthy and fit life with accumulating better and efficiency in organ and system health, mental and social aspects of life. Participation in sports adequately increases with the deviation of performance basis to recreational order. Sports emerged in various forms in terms of performance aspects; open skill, closed skill, self paced, externally paced, gross, fine, simple, complex skill etc. are involved in sports activities for achieving greater consequences of outcomes. Motor learning allows developing skills (Cullen & Mitchell, 2017) to achieve performance. Sportsman uses somatic reflection that influenced mainly on conscious focus on bodily movements and evidenced to improve skill after becoming expert (Toner & Moran, 2015) that implicit to be more active and efficient to productive life. Adolescent is stage of life consider different areas of development such as somatic, neurologic, cognitive, psychological function in an integrated and interdependent approach with a significant impact of sports participation (Brown, Patel, & Darmawan, 2017). Level maturation of adolescents is a covariant in talent development in respect with anthropometrics, Physical Characteristics, Physiological Attributes, and Sport-Specific Skills considerations to sports participation (Ziv & Lidor, 2014). Exercise defined by Casperson et al.(1985) as subset of Physical activity that is planned, structured and repetitive for the improvement or maintenance of Physical Fitness as a final or intermediate objective (Caspersen, Powell, & Christenson, 1985). American College of Sports Medicine(ACSM) quantified relative exercise intensity as Light intensity 57-63 percent of maximum Heart Rate (HR_{max} %); moderate 64-76 HR_{max} % and Vigorous 77-95 HR_{max} % (ACSM, 2010). Several scientific investigation revealed effect of exercise on different aspect of health, wellness with the emphasis of providing quality of life.

Executive Function is a cognitive process highly associated with neurocognitive functions. An integration of cognitive processes of thinking before taking action, meeting novel, unanticipated challenges, resisting temptations and staying focused (Diamond, 2013). Several definitions on Executive function denotes that Andersson (2002) it has principal elements included anticipation, goal selection, planning, initiation of activity, self regulation, mental flexibility, deployment of attention and utilization of feedback; Baron (2004) defined 'Executive Functioning skills allow an individual to perceived stimuli from his or her environment, respond adaptively, flexibly change direction, anticipate future goals, consider consequences and respond in an integrated or commonsense way; Best', Miller and Jones (2009) defined 'executive function serves as an umbrella term to encompass the goal oriented control functions of the Prefrontal cortex' (Goldstein & Naglieri, 2014). Executive Function helps to discriminate elite and non elite athletes of high performance sports (Krenn, Finkenzerler, Wuerth, & Amesberger, 2018).

2. METHOD:

The present study invested the source of different online open access journal with the keywords of sports and executive function, exercise and executive function, executive control, inhibitory control. The survey was integrating

the results and findings of the study with the thorough investigation of the methodology of the studies. The selection of the studies determine according to the inclusion and exclusion criteria for the study.

Inclusion Criteria:

The inclusion criteria of the study were

- Effect of exercise and its various forms in terms of intensity, duration, level of fitness, moderation(specification) on Executive function
- Published between 2000-2020 AD in any online open access journals
- Healthy adolescents and young adult male and female participants in the study.
- Meta analysis and review studies on effect of executive function sports and exercise on healthy young adults were included.
- Physically Disabled sports activities were included.

Exclusion Criteria:

The exclusion criteria of the study were

- Study on children and older adults were excluded.
- Participants with any Neurocognitive Disorders and Mental Trauma.
- Studies contented subjective measurements excluded.

3. DISCUSSION:

3.1. Sports and Executive Function:

Executive Function (EF) in static, interceptive, and strategic sports differ according to their sports and development of EF might have an influence in strategic sports (Krenn, Finkenzerler, Würth, & Amesberger, 2018) and it also seems that athletes found better in EF than non athletes where self paced athletes or internally paced athletes found better in inhibition task and externally paced athletes found better in problem solving tasks (Jacobson & Matthaeus, 2014). In soccer, EF both core (simple working memory capacity) and higher level (manipulation of information) has the proficiency to predict success in young players (Vestberg, Reinebo, Maurex, Ingvar, & Petrovic, 2017) and EF may depend upon level of participation and may related with performance (Vestberg, Gustafson, Maurex, Ingvar, & Petrovic, 2012). EF has also been reported as predictor of future success of tennis players in a follow-up study of eighteen months (Ishihara, Kuroda, & Mizuno, 2019) and EF may develop through competence and enjoyment based sports programs in junior tennis players (Ishihara & Mizuno, 2018). Open skill training can be beneficial for Inhibitory control, an executive function or dominant behavioral response to stimuli (Wang, et al., 2013). Studies supported that EF has well linked with Physical Fitness, Motor Fitness and Sport Proficiency (Marchetti, Forte, Borzacchini, Vazou, Tomporowski, & Pesce, 2015). Even in case of Disable open skill sports may have partial consequences of compensate executive control impairment by the fostering stability of motor responses and favoring response flexibility (Russo, 2010). Executive functions such as inhibition and planning improved at the end of the season for American Football Players (Rincón-Campos, Sanchez-Lopez, López-Walle, & Ortiz-Jiménez, 2019).

3.2. Exercise and Executive Function:

Several Meta-Analyses revealed Acute Physical Exercise enhances Executive Function (Verburgh L, Königs M, Scherder EJA, 2014; Greeff, Bosker, Oosterlaan, Visscher, & Hartman, 2018). In an investigation of Soga et al. (2015) moderate intensity exercises affects executive function of adolescents (Soga, Shishido, & Nagatomi, 2015). In case of bout of cardiovascular exercise, the mechanism of neuroelectric processes affected that underlying executive function that modules cognitive processing and stimulus classification speed (Hillman, Snook, & Jerome, 2003), female irrespective of age with fitness on cardio respiratory functions are proficient in better executive function and cognition as well (Dupuy, Gauthier, Fraser, & Desjardins-Crépeau, 2015). For improving students' executive attention, duration of sports program might be decisive as aerobic endurance exercise-based physical education program can leads to maintenance of on-task attention (Beddoes, Castelli, & Barcelona, 2020). A Functional Near Infrared Spectroscopy (fNIRS) neuroimaging study revealed acute mild exercise can improve executive task performance and also positively related with increased arousal level (Byun, Hyodo, Suwabe, Fukuie, & Soya, 2016), High Intensity Exercise also found to be beneficial as acute High Intensity Exercise improves executive function of young adults (Kujach, et al., 2018). Moderate intensity of resistance and aerobic exercises session of male and female physical education students found incremental effect on executive function (Tsuk, et al., 2019) whereas participants with the age of 52±7 years showed marginal significance on executive function after program of resistance exercise (Dunsky, Abu-Rukun, Tsuk, Dwolatzky, Carasso, & Netz, 2017). In healthy women both aerobic and strength exercises positively improve executive function mainly task and executive function dependant (Alves, et al., 2012). In respect with the limited and task specification of acute resistance exercise can influence on executive functions of healthy young adults (Brush, Olson,

Ehmann, Osovsky, & Alderman, 2016). An exercise on cycle ergometer of ten minutes proposed to be beneficial for executive function and its effect observed in also continuum of moderate to very heavy intensities (Heath, Petrella, Blazevic, Lim, Pelletier, & Belfry, 2018), also reported of increasing executive related oculomotor control and also attributed attention, arousal and task specific activity of brain to exercise based increase (Samani & Heath, 2018). An intense effect of aerobic exercise on inhibitory response note but does not last 30 minutes following a recovery period in middle aged healthy active adult females (Netz, et al., 2016). Between high to moderate and light intensity acute aerobic exercise inhibitory control performed not significant in young adults (Ciria, Perakakis, Luque-Casado, & Sanabria, 2018), even in moderate intensity aerobic cycling and passive motor driven cycling sessions fails to elicit inhibitory control (Weng, Pierce, Darling, & Voss, 2015). In a meta analysis of forty experimental studies confirmed small effect of aerobic exercise on time dependant measures and accuracy in executive function tasks (Ludyga, Gerber, Brand, Holsboer-Trachsler, & Pühse, 2016). Despite of acute Exercise, Game based activity of Basketball and Sprint Based activity found to be effective for executive function in fit adolescents (Cooper, Dring, Morris, Sunderland, Bandelow, & Nevill, 2018; Cooper, et al., 2016).

A perspective of negative influence of environmental condition profound, moderate exercise under normobaric hypoxic condition has negative effect on executive function (Ochi, et al., 2018). The effect of acute yogic exercises outperform aerobic exercise on executive function elicit contradiction (Gothe, Pontifex, Hillman, & McAuley, 2013). A contradictory study sought acute bout of cardiovascular exercise can momentarily alter executive function of young adult participants and shifting attention of task and error rates increase as of intensity increased (Labelle, Bosquet, Mekary, & Bherer, 2013). On an another study of Labelle et al. (2014) reported momentarily impairment on executive function due increase intensity of acute exercise to younger adults also revealed individuals fitness level moderate this relation with executive function (Labelle V. , Bosquet, Mekary, Vu, Smilovitch, & Bherer, 2014). Newson and Kemps (2008) reported no significance of executive function among the high and low fitness groups young adults rather proposed relationship between fitness and cognitive ageing is domain specific (Newson & Kemps, 2008) whereas physically active young adults demonstrated a better efficiency in executive function than the sedentary groups (Kamijo & Takeda, 2010) due to the influence of behavioral and neuroelectric indices of action monitoring (Themanson, Hillman, & Curtin, 2006).

4. CONCLUSION:

The study prescribes vigorous aspects of effect of exercise and sports on executive function through the systematic survey of scientific literatures. On the basis of collected literature, Sports performances in terms various skill acquisitions lead to provide proficiency on executive function that provide a prediction of successful players. Exercise mostly moderate intensities influence Executive function that of increasing attention, arousal and task specific activities. Aerobic and resistance exercises showed evidence on influencing executive function with a greater implementation on increasing intensities of moderate to high. Very fewer contradictory findings, evident of impairment of executive function were surveyed.

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