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Physical Exercise Influences Academic Performance and Well-being in Children and Adolescents

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Physical exercise and other activity-promoting behaviors, including sports, hold incalculable benefits for children and adolescents besides physical and psychological health and quality of life [1]. A multitude factors contribute to increased brain and functional integrity [2,3] and optimal development [4,5] through exercise. Concurrently, a vast range of situations and techniques have demonstrated the marked cognitive [6], emotional [7,8] and neuroimmunological [9,10] functioning manifestations. Unsurprisingly, the influence of physical exercise upon school and academic performance is an issue of some magnitude [11-13]. In a systematic review of randomized control trials of school children, Lees and Hopkins [14] observed that there was a positive association between aerobic physical activity and cognition, academic achievement, behavior, and psychosocial functioning outcomes. Nevertheless, they indicated the necessity for more rigorous trials with adequate sample sizes assessing the impact of aerobic physical activity on children's cognitive abilities, psychosocial functioning, behavior, and academic achievement; standardized interventions, valid and reliable tools of measurement, and long-term follow-up for sustained cognitive and psychosocial outcomes were advanced as primary targets. Furthermore, Singh et al. [15] showed that physical exercise was linked positively to children's academic performance on the basis of two high-quality studies. In their turn, they called for the examination of dose-response relationships between extent of physical activity and academic performance. These avenues of consideration seem essential since poorer motor performance has been found to be related to inferior academic skills in school children, particularly among boys [16]. Their results beg the conclusion that early identification of children with poor motor/athletic prowess is of necessity and that actions aimed at improving these children's motor performance and academic skills during the first school years are important investments. Latham et al. [17] showed that provision of middle school students with a choice of performing the "FitnessGram" mile run in either traditional one-mile run or the treadmill one-mile format exerted positive influences on several measures of performance.

Affective status and personal attributes contribute both to academic and motor performance [18] as well as attitudes to physical exercise [19,20]. One prerequisite for compliance to exercise/activity schedules for children and adolescents (adults as well for that matter) requires that children's motivation ought to be founded upon enjoyment and the inherent satisfaction provided by physical activity is associated with their objectively-assessed physical activity; this type of motivation (activity)needs be associated positively with perceptions of psychological need satisfaction. The psychological factors implicated here represent potential flexible targets for interventions that elevate children's physical activity. Using structural equation modeling, Sebire et al. [21] showed the utility of a motivational model in which psychological need satisfaction was positively associated with intrinsic and identified motivation types and intrinsic motivation was associated positively with children's time spent in moderate-to-vigorous physical activity. Cognitive developmental trajectories contribute considerably to favorable strategies for optimizing such positive attributes as self-determination, internal locus of control, character and self-esteem [22,23] together with brain and central nervous system concomitants [24,25]. The successful implementation of these developmental programs places significant demands upon the caliber and professionalism of instructors and mentors. Myer et al. [26] have shown that regular, compliant training/coaching with structured and integrated modalities throughout the developmental years as a part of physical and psychosocial education improves both health and several performance variables. Physical exercise bestows a propensity for eventual manifestation of "redifferentiated" developmental trajectories that may equip even those developing individuals with a paucity of positive attributes, e.g. ADHD children, with a prognosis that is more adaptive functionally, independent of the applications of other therapeutic agents and treatments [27].

Children expressing higher life satisfaction were more connected with teachers, better engaged in schoolwork, and earned higher grades than those children who were less satisfied. In view of these transitional pressures that may affect health variables adversely, the associations between personal attributes, such as self-determination, anxiety and depression, stress, exercise propensity and academic performance amongst adolescents emerges with particular impact upon developmental trajectories. Using structural equation modeling with data from 750 secondary school pupils (mean age = 13.4 years), Hashim et al. [28] observed that greater levels of self-determination (intrinsic motivation) were linked positively with exercise habit behavior, with intensity of the exercise habit fostering academic performance and buffering individuals against the debilitating influences of stress, anxiety and depression in the absence of gender effects. The COPE (Creating Opportunities for Personal Empowerment), a cognitive-behavioral skills-building intervention, combined with TEEN (Thinking, Emotions, Exercise, Nutrition) program has been constructed to address public health problems affecting academic achievement in adolescents [29]. Melnyk et al. [30] studied 779 culturally-diverse adolescents in the US Southwest with COPE-TEEN+20 minutes physical exercise over 15 weeks. As a result of the intervention, they obtained significantly lower depression scores, lower mean BMI and higher health course grades both during the short-term and long-term testing.

In a recent unpublished study, we have discerned positive relations between academic performance, physical activity, well-being, and self-

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			Physical Activity		Well-Being		Self-regulation	
		Grade Point Average	Exercise Frequency	Exercise Intensity	Subjective Well-Being	Psychological Well-Being	Locomotion	Assessment
Physical Activity	Grade Point Average	-						
	Exercise Frequency	.10	-					
	Exercise Intensity	.26**	.50***	-				
Well-Being	Subjective Well-Being	.31***	.18*	.22**	-			
	Psychological Well-Being	.22**	.11	.13	.77***	-		
Self-regulation	Locomotion	.17*	,08	.23**	.48***	.59***	-	
	Assessment	.25**	.01	.15	-.23**	-.15	.09	-

Note: * p<.05, ** p< .01, *** p<.001.

Table 1: Correlations between grade point average, physical activity, well-being, and self-regulation among Swedish high school pupils (N=154).

regulation among Swedish high school pupils. We operationalized academic performance through high school pupils' final grades in Swedish, Mathematics, English, and Physical education. The courses take place during either one or two semesters or the grading scale ranges from A = pass with distinction to F = fail. Well-being was assessed as subjective well-being (Diener [31]; life satisfaction, positive and negative affect) and psychological well-being (Ryff [32]; personal growth, self-acceptance, environmental mastery, autonomy, positive relations with others, and meaning in life). Self-regulation is the procedure implemented by an individual striving to reach a goal [33]: identification and evaluation of different strategies to reach a goal (i.e, assessment) and then to take action and persist towards the goal (i.e. locomotiom). Academic performance, grade point average, is indeed positively associated to how intensely pupils exercise, well-being and to self-regulation; specially to assessment. Physical activity was also associated subjective well-being and to locomotion (Table 1).

In conclusion, the intervention of physical exercise holds real merit for engendering improved academic prowess. These observations are hardly surprising in view of the marked increases in neurotrophic factors, particularly brain-derived neurotrophic factor (BDNF), that have been obtained in association with cognitive and emotional benefits (Hopkins [34-36]. Indeed, exercise effects, mediated through BDNF, offer children and adolescents real epigenetic, permanent advantages [37]. Pareja-Galeano et al. [38] have showed that exercise training in adolescent boys (14 ± 2 years) elevated neuroplasticity-related proteins, BDNF and insulin-like growth factor-1 in comparison with sedentary boys. Moreover, physical activity might not only lead to better grades but also to enhanced well-being, specially subjective well-being or happiness, and to the ability to keep moving towards a goal and motivating the individual to take action and control of her/his life, that is, empowering the individual to become agentic.

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