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Psychological benefits of exercise in children and adolescents

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Introduction

It is commonly accepted that exercise can lead to a number of benefits. While the psychological aspects have been examined to some extent, the majority of research has been on the physiological effects. Within the psychological research that has been conducted, adult and clinical populations are the most common, leaving little research on the psychological benefits of healthy children and adolescent.

The first part of my thesis is a cross-sectional study investigating the long-term effects of adolescent exercise in terms of happiness and positive emotions in adulthood. This particular connection has to our knowledge never been investigated before. The most interesting finding in this study is that adolescent exercise is a significant predictor for positive moods in adulthood, even when controlling for current exercise. There is also a connection between adolescent exercise and happiness, although it appears to be that adolescent exercise predicts exercise in adult life, which in turn has a connection to happiness. As very few variables are known to cause changes in happiness, even the slight influence found from exercising is important. In the second part of my thesis I present a review of the research that has been conducted of the psychological benefits of healthy children and adolescent. The review focuses on the psychological aspects of cognition, self-esteem, emotions and moods, and on the effect that exercise and physical education has on academic performance.

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The influence of adolescent exercise on adult happiness and positive emotions

Abstract

The main research question for this paper was; does adolescent exercise predict happiness and positive moods in adult life? Data was collected through an online questionnaire (N = 438). The questionnaire included a measure of happiness (The Subjective Happiness Scale), moods (The Profile of Mood States) and questions on current and adolescent exercise. Adolescent exercise was a significant predictor for positive moods, even when controlling for current exercise. This is as far as we know the first study to find this connection. There is also a connection between adolescent exercise and happiness, although it appears to be that adolescent exercise predicts exercise in adult life, which in turn has a connection to happiness. Exercise was not a significant predictor of negative moods in adulthood.

In 1998, Martin E. P. Seligman urged psychologists to remember that psychology should not be limited to a focus on pathology, damage and weakness, but also to include strengths, virtues, and all the things that make our lives worth living. This new area of focus has become known as positive psychology (Compton, 2005). With growing interest in positive psychology since 1998 topics such as "how to increase happiness" and "what positive effects can good mood lead to" have received more attention. Another field that have received an increased amount of attention lately from both psychology and other fields are the positive effects of exercise in kids and adolescents. While this is not a new topic of research a recent increase has been seen following the dramatic increase in obesity, type 2 diabetes and other pathological dangers that have historically been connected to a lack of exercise.

In the present study we have changed the focus from obesity and type 2 diabetes to mood and happiness, and examined how adolescence exercise influence mood and happiness in adulthood. There is to our knowledge no existing research that connects these popular concepts. Our main research question is; does adolescent exercise predict happiness and positive moods in adult life?

Happiness

Happiness, also described as "subjective well-being" (Diner, 2000), refers to people's subjective evaluation of their own lives. Once the most material needs such as food, clothing and housing are met, people become concerned about self-fulfillment and happiness (Inglehart, 1990). Throughout the world people are rating happiness as one the most important aspects of their lives. In an international sample of 7.204 respondents from 42 countries, 69% rated happiness at the top of the importance scale, with only 6% rating money as more important (Diner, 2000). With importance and concern tied up to happiness an important question arises; how can we influence our happiness? Today people in the western world have more cars, electronics, brand-name clothing, and other things that are often bought to increase happiness; however studies show that such possessions do not provide lasting effects (Myers & Diener, 1995). Even winning the lottery seems to only increase happiness for a short while (Brickman, Coates & Janoff-Bulman, 1978).

One of the goals of positive psychology is to broaden the field of psychology to also include science and knowledge on how to increase happiness. Some interactions and interventions have already been examined (Seligman, Steen, Park & Peterson, 2005), but little seems to be known on how we can increase our own happiness (Sheldon & Lyubomirsky, 2006). A connection has already been made between adolescent exercise and adolescent happiness (Norris, Carroll, & Cochrane, 1992), as well as a connection between adult exercise and adult happiness (Fox, 1999; Stephens, 1988). How adolescent exercise can affect adult happiness has however not been examined. It is expected that adolescent exercise could have an effect on adult happiness, due to long-term effects of exercise, such as reduced stress and future job strain (Yang et al, 2010), lasting bone and muscle strength (McKay, Liu, Egeli, Boyd, & Burrows, 2011; Vicente-Rodríguez, 2006), reduced chance of coronary disease and a longer life (Paffenbarger et al, 1993) combined with the connection between exercise in early life and adulthood (Hallal, Victora, Azevedo, & Wells, 2006; Telama et al, 2005; Twisk, Kemper, & van Mechelen, 2000) and the results indicating that there is a correlation between exercise and happiness in both adults (Fox, 1999; Stephens, 1988) and adolescents (Norris, Carroll, & Cochrane, 1992).

Mood

Mood is by some considered one of the aspects of happiness, alongside emotions and satisfaction with different parts of life (Diner, 2000). This is supported by the finding that moods can affect scores of happiness scales (Schwarz & Strack, 1999). In psychology today there is no broad agreement on exactly how emotions are separated from moods, however there is agreement that moods are more global and persistent, while emotions are short-term and more intense (Compton, 2005, Morris, 1998). In this study we are looking for long-term lasting effects of adolescent exercise, and therefore moods were chosen instead of emotions. By choosing moods we can measure something that is less likely to be affected by recent events and more likely to represent something that is stabile in the individual.

Recent research has shown that positive mood have many advantages, including a significant impact on several psychological aspects such as memory, attention, experience of self, altruism, decision-making, creativity, aggression, interpersonal relationships, and job satisfaction (Compton, 2000, Isen, 2001). Positive moods appear not only to make us feel better, but actually

make us better. The advantages of positive moods gave us the incentive to explore one of the aspects that might affect mood, and how it can be improved. The relationship between exercise and mood has been explored in several studies; and whilst most of the focus has been on negative moods, often in connection with factors concerning depression and anxiety states (Berger & Motl, 2000, Prapavessis, 2000), the connection between present amount of exercise and present positive moods has been established in several studies (Scully, Kremer, Meade, Graham & Dudgeon, 1998). The long-term effects of adolescent exercise in terms of mood has however not been established.

Exercise

In recent exercise research Caspersen, Powell and Christiansen's (1985) definition of exercise has been used consistently. They define exercise as "a physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective" (p.128).

In this study we have only adult participants, giving us the opportunity to measure exercise in both adolescence and the present time. The inclusion of exercise at the present time has two advantages. It creates the possibility to separate the effects of present exercise and adolescent exercise, and second; it contributes to the already existing literature on the connection between adult exercise and mood and happiness.

Method

Subjects

438 participants were included in the data analysis. The original dataset included 561 respondents. 123 were excluded because of blank responses. The high amount of blank responses is believed to mainly be a result of respondents closing the questionnaire webpage without completing the questionnaire. If someone chose not to finish the questionnaire, or even just looked at it and chose not to participate in the study, a partial or blank response would be registered.

The data collection was done online through SelectSurvey, and respondents were recruited through facebook and Innsida (a part of the Norwegian University of Science and Technology's (NTNU) homepage). The questionnaire was available online for one week from 25.02.11 through 01.03.11.

The project was approved by Regionale komiteer for medisinsk og helsefaglig forskningsetikk, Midt-Norge (a regional committee of medicinal and health related research ethics).

Measurements

The Subjective Happiness Scale (Lyubomirsky & Lepper, 1999) (also known as the General Happiness Scale in Seligman's Authentic Happiness (2002)) was chosen to measure happiness. It has been used in several previous exercise studies (Sheldon & Lyubomirsky, 2006, Stubbe, de Moor, Boomsma & de Geus, 2007). The Subjective Happiness Scale contains four statements on a 7-point likert scale with descriptions at the end points (both one and seven). The statements are; 1. In general I consider myself (1- Not very happy, 7- A very happy person), 2. Compared to most of my peers, I consider myself (1- Less happy, 7- More happy), 3. Some people are generally very happy. They enjoy life regardless of what is going on getting the most out of everything. To what extent does this characterization describe you? (1- Not at all, 7- A great deal), 4. Some people are generally not very happy. Although they are not depressed, they never seem as happy as they might be. To what extent does this characterization describe you? (1- Not at all, 7- A great deal). In the original Subjective Happiness Scale the last statement had "A great deal" as the description of the lowest score on the likert scale and "Not at all" as the

highest, this was considered a potential source of misunderstanding and therefore the descriptions were switched and the scoring was reversed.

For measuring mood the Profile of Mood States (POMS) was chosen. It has been applied to a wide range of populations and it has become one of the most reliable, valid, and frequently used measures on moods and mood states in sports and exercise research (Berger & Motl, 2000, Prapavessis, 2000). The POMS contains 65 adjectives, which are divided into seven mood categories developed though factor analysis (McNair & Heuchert, 2010). Both the Subjective Happiness Scale and the POMS was translated into Norwegian. For exercise no existing index was found that satisfied our requirements for this study. Questions were developed to measure current amount of exercise per week, as well as per week between the ages of 13-15 and 16-18.

Variable Creation

The Happiness variable was created from the average score of the items on The Subjective Happiness Scale (Lyubomirsky & Lepper, 1999). The Positive Moods variable was created from the mean score of the POMS factors from the principal component analysis which were considered to be positive, and the Negative Moods variable was created from the mean score of the negative. The exercise variables were the amount of hours currently spent exercising per week, between the ages of 13-15 and 16-18.

Analysis

A principal component analysis was used to find the underlying factors of the POMS. An oblique (direct oblimin) rotation was used as it was expected that the factors would be correlated. Factor extraction was done accordingly to the POMS manual (McNair & Heuchert, 2010), where six or seven factors are extracted. Whether six or seven factors are extracted is chosen by whether or not the Friendliness factor is found and included.

For analyzing the predictive power of exercise four separate regression analysis was used. A block-wise regression was chosen due to the connection and expected correlation between the exercise items based on existing literature where adolescent exercise predicts adult exercise (Hallal et al, 2006; Telama et al, 2005; Twisk et al, 2000). In the first regression analysis current exercise was set as the dependent variable. Control variables of gender, age and education were

placed in the first block, exercise between ages 13-15 in the second, and exercise between ages 16-18 in the third block. In the second regression analysis Happiness was set as the dependent variable. Control variables of gender, age and education were placed in the first block, exercise between ages 13-15 in the second, exercise between ages 16-18 in the third block, and current exercise in the fourth block. In the third regression analysis Positive Moods was set as the dependent variable. Control variables of gender, age and education were placed in the first block, exercise between ages 13-15 in the second, exercise between ages 16-18 in the third block, and current exercise in the fourth block. In the third regression analysis Negative Moods was set as the dependent variable. Control variables of gender, age and education were placed in the first block, exercise between ages 13-15 in the second, exercise between ages 16-18 in the third block, and current exercise in the fourth block.

Results

Table 1 describes the characteristics of the sample and the key variables in this study. The final sample consisted of 438 participants, 154 men (35%) and 283 women (65%), with one participant choosing not to select gender. Age ranged from 18 to 50 (which were set as the minimum and maximum age for participating in the study).

Correlations

All three exercise items had significant correlations. Although significant current exercise had weak correlations with both exercise between the ages of 13-15 (r = .23) and exercise between the ages of 16-18 (r = .29), while there was stronger correlation between the two measurements of adolescent exercise (r = .64).

Happiness had a significant positive although weak correlation with both current exercise (r = .14) and exercise between ages 16-18 (r = .12). Positive emotions also had a significant although weak correlation with both current exercise (r = .25) and exercise between the ages of 16-18 (r = .19). Negative emotions had no significant correlations with the exercise items, and a negative correlation with both Happiness (r = -.44) and Positive emotions (r = -.21). Happiness and Positive emotions were positively correlated (r = .51).

Table 1

Means, Standard Deviations and Intercorrelations.

Measure	M	SD	1	2	3	4	5	6	7	8	9
1. Gender	--	--	--								
2. Age	24.86	5.13	.07	--							
3. Education	4.45	2.46	.13**	.37**	--						
4. Current exercise	4.64	3.17	-.19**	-.04	-.05	--					
5. Exercise between 13-15	4.96	3.78	-.17**	-.06	-.09	.23**	--				
6. Exercise between 16-18	5.26	4.76	-.16**	-.11*	-.07	.29**	.64**	--			
7. Happiness	4.74	1.16	.03	.05	.06	.14**	.06	.12*	--		
8. Positive Moods	3.18	.55	-.13*	.07	.07	.25**	.10	.19**	.51**	--	
9. Negative Moods	1.80	.35	-.04	-.08	-.03	-.03	.07	.02	-.44**	-.21**	--

*p < .05. **p < .01

Factor Analysis

In creation and verification of the POMS a standard for extracting six or seven factors has been set. Whether six or seven factors are chosen is determined by whether or not the Friendliness factor is found in the sample. A factor analysis was performed with six extracted factors, where it was found that the Friendliness factor was clearly present in the data with all seven items form the Friendliness category significantly loading on the second factor. Therefore a new factor analysis was preformed extracting seven factors. An oblique (direct oblimin) rotation and a .30 requirement for significant factor loading were used in accordance with the original POMS manual (see Table 2) (McNair & Heuchert, 2010).

Table 2

Summary of Items and Factor Loadings for Direct Oblimin Seven-Factor Solution for the Profile of Mood States Questionnaire (N = 355)

	Factor loading							
Item	1	2	3	4	5	6	7	Communality
23. Unworthy	**.82**	-.09	-.11	.10	-.03	.06	.16	.69
58. Worthless	**.81**	-.05	.00	.00	-.07	.07	-.03	.67
35. Lonely	**.73**	-.08	.02	.01	-.01	-.13	.10	.55
14. Sad	**.67**	.04	.22	.11	-.04	-.26	.01	.71
5. Unhappy	**.67**	-.03	.13	.16	-.14	-.12	.03	.63
21.Hopeless	**.66**	-.01	.00	.13	.10	-.06	-.11	.62
36. Miserable	**.63**	-.03	.15	.10	-.01	.26	-.13	.73
64. Uncertain About Things	**.62**	-.02	.03	.12	.14	-.18	.00	.77
33. Resentful	**.62**	.06	.18	-.15	-.20	.17	.10	.45
18. Blue	**.61**	.03	.22	.19	-.09	-.11	-.02	.67
9. Sorry	**.60**	.03	-.02	.01	.09	-.05	-.02	.39
52. Deceived	**.60**	.02	.08	-.21	.04	.26	-.06	.45
39. Bitter	**.60**	-.04	.14	.07	-.07	.24	.06	.57
62. Guilty	**.59**	-.14	-.08	.09	.12	.27	.15	.53
41. Anxious	**.56**	.02	-.03	.05	**.34**	-.22	-.17	.60
44. Gloomy	**.51**	-.03	.16	.25	-.01	.04	-.11	.61
8. Confused	**.50**	.04	-.07	.06	.22	-.15	-.07	.38
45. Desperate	**.50**	.00	.09	.07	.07	**.32**	-.12	.53
26. Uneasy	**.49**	.01	.16	.17	.08	.08	-.13	.55
32. Discouraged	**.46**	.05	.19	.18	.01	.02	-.26	.58
48. Helpless	**.41**	-.01	.09	.15	.07	.18	-.26	.49
34. Nervous	**.39**	.07	.09	.18	**.36**	-.14	-.10	.54
43. Good Natured	.08	**.87**	-.04	.05	-.04	-.02	-.12	.69
13. Considerate	.08	**.84**	-.09	.12	-.11	-.10	.00	.65
25. Sympathetic	-.04	**.81**	.03	.08	-.07	.05	-.16	.58
30. Helpful	.01	**.79**	.01	-.01	.08	-.02	-.06	.63
55. Trusting	-.11	**.74**	.09	.07	.00	-.01	.01	.55
1. Friendly	.09	**.58**	**-.30**	-.04	.05	.06	.07	.52
38. Cheerful	-.20	**.48**	-.15	-.06	**.30**	.12	.24	.69
7. Lively	-.13	**.40**	.00	-.14	**.31**	.06	**.38**	.67
57. Bad-tempered	-.19	.04	**.81**	.05	.04	.22	.06	.64
3. Angry	.07	.02	**.80**	-.02	-.09	-.10	-.02	.66

(table continues)

Table 2 (continued)

Item	Factor loading							Communality
	1	2	3	4	5	6	7	
16. On Edge	-.03	-.09	**.78**	.07	.16	-.08	.06	.70
31. Annoyed	.11	-.04	**.78**	.05	.00	.00	.07	.72
17. Grouchy	.01	-.14	**.74**	.07	.04	-.01	.06	.65
53. Furious	.18	.03	**.50**	-.08	-.08	**.49**	-.14	.61
12. Peeved	**.32**	-.01	**.40**	-.04	.06	-.08	-.06	.38
2. Tense	.23	.08	**.37**	.18	.11	**-.30**	-.16	.53
29. Fatigued	.00	.10	.11	**.80**	-.12	-.17	.05	.67
65. Bushed	.15	-.01	.10	**.79**	-.08	.00	.09	.77
4. Worn-Out	.07	.02	.21	**.73**	-.07	-.11	.16	.67
49. Weary	.16	.10	.02	**.63**	.04	.13	-.09	.59
40. Exhausted	.06	.06	.12	**.59**	**.33**	-.07	.18	.61
46. Sluggish	-.09	-.08	.03	**.59**	.06	.21	-.25	.52
59. Forgetful	.11	.07	-.05	**.41**	.20	.13	.15	.30
28. Unable To Concentrate	.13	.01	.09	**.39**	.20	-.11	**-.30**	.50
51. Alert	.18	**.34**	-.10	**-.38**	.08	.01	**.30**	.51
63. Vigorous	.00	.19	.01	**-.35**	-.26	.18	.27	.46
11. Listless	.20	-.08	.07	**.31**	.11	.17	**-.30**	.48
27. Restless	-.03	-.05	.11	-.06	**.61**	-.10	-.09	.37
42. Ready To Fight	-.05	.21	.01	-.16	**.48**	.01	.26	.48
19. Energetic	-.13	.29	.04	-.28	**.44**	-.06	**.33**	.70
56. Full of Pep	-.08	**.34**	.09	-.07	**.40**	.20	.20	.52
10. Shaky	.20	-.03	-.06	.20	**.38**	.04	-.01	.31
20. Panicky	.25	.07	.14	.10	**.38**	.02	-.24	.45
50. Bewildered	.21	-.01	.16	.16	**.36**	.17	**-.33**	.57
47. Rebellious	.01	-.07	.04	.18	**.35**	.20	.05	.24
22. Relaxed	-.10	**.31**	-.27	-.01	-.15	**.36**	.18	.47
60. Carefree	**-.33**	.13	-.13	-.09	.05	**.33**	.15	.40
37. Muddled	.15	.00	.05	.31	.23	**.32**	**-.30**	.53
61. Terrified	.29	.03	.12	.07	.11	**.31**	.10	.32
24. Spiteful	.16	-.17	.04	**.30**	.01	.04	**.62**	.43
6. Clear-Headed	-.07	**.40**	.01	-.08	-.09	.08	**.45**	.53
54. Efficient	-.16	**.35**	.15	-.17	.16	-.03	**.42**	.55
15. Active	-.03	.23	.08	**-.34**	**.34**	.02	**.36**	.57

Note. Boldface indicates a factor loading above .30

For further analysis a new variable was created based on each factor. The variables were created from the mean score of all the items that had a factor loading higher than .30 on the factor (see Table 2). Items with a negative loading have had their scores reversed. The variables were divided into positive and negative moods and used as dependent variables in further analysis.

Depression. The first factor (eigenvalue = 18.56, variance explained = 29%) contains 24 items with a factor loading higher than 0.30, including all 15 adjectives from the Depression-Dejection factor in the POMS. The factor loadings of all 15 items from the Depression-Dejection category are close what is found in other studies (McNair & Heuchert, 2010). The Depression variable (24 items, $\alpha = .95$) was considered a negative mood.

Friendliness. In an attempt to strengthen the Anger-Hostility factor, friendly adjectives where added to POMS. In some studies these do strengthen the Anger-Hostility factor with negative factor loadings, while other studies have found them clustering together as a Friendliness factor; often as a seventh weak factor that is often left out of extraction (McNair & Heuchert, 2010). In this study Friendliness is the second strongest factor (eigenvalue = 7.03, variance explained = 11%) with five factor loadings of over .70 and three factor loadings over .80. The Friendliness factor has loadings over 0.40 on all seven of the items which belong to the Friendliness category of the POMS (McNair & Heuchert, 2010). The Friendliness variable (13 items, $\alpha = .90$) was considered a positive mood.

Anger. The third strongest factor (eigenvalue = 2.79, variance explained = 4%) has resemblance to the Anger-Hostility factor in the original POMS factor extraction, with .30 or higher factor loadings on six of its twelve items. While not all twelve items from the original Anger-Hostility factor have loadings on this factor, the loading that were expected to be the strongest from previous studies (McNair & Heuchert, 2010), “angry” and “bad-tempered”, are the highest. The Anger variable (9 items, $\alpha = .85$) was considered a negative mood.

Fatigue. The Fatigue-Inertia factor is also clearly present in this study with all seven Fatigue-Inertia items loading higher than .30 on factor 4 (eigenvalue = 2.49, variance explained = 4%). In addition to the Fatigue-Inertia items, the Fatigue factor has negative loadings from “active” and “vigorous”, and loadings from “unable to concentrate” and “forgetful”. The Fatigue variable (13 items, $\alpha = .79$) was considered a negative mood.

Restless. With a combination of items from the Vigor category and the Tension category, the fifth factor (eigenvalue = 1.60, variance explained = 3%) appears to no longer fit the positive profile of the original Vigor factor in the POMS. “Restless” is the item with the highest loading on this factor, and several of the other items with a loading higher than .30 on this factor are related to how you feel when you are restless, such as; “lively”, “active”, “energetic”, “ready to fight”, and “shaky”. The restless variable (14 items, $\alpha = .76$) was considered a negative mood.

Factor six. The items included in the sixth factor (eigenvalue = 1.69, variance explained = 3%) did not give a clear picture of what this factor represents. The factor has loadings from items such as “relaxed” and “carefree” and a negative loading from “tense”, however it does include items which would not intuitively be in the same factor such as .49 loading from “furious” and a .30 loading from “desperate”. Factor six has not been included into the positive nor negative mood scales and is thereby removed from the rest of the study.

Focus. Factor seven (eigenvalue = 1.51, variance explained = 2%) has loadings form items from the Vigor category, “lively”, “active”, “energetic” and “alert”, and strong negative loadings from the Confusion-Bewilderment items; “unable to concentrate” and “muddled”, and the Fatigue-Inertia item; “listless”. This factor appears to be a combination between the positive profile of the Vigor factor and a reversed version of the Confusion-Bewilderment factor. The name Focus was chosen since it appeared to be a central theme in the items, and since Vigor and Not Confused failed to describe the items included in the variable. The Focus variable (11 items, $\alpha = .83$) was considered a positive mood.

Exercise

The hours of exercise per week reported for the age 13 to 15 ranged from 0 to 25 with a mean of 4.96 ($N = 438$, $SD = 3.78$), for the age 16 to 18 it ranged from 0 to 27 with a mean of 5.26 ($N = 434$, $SD = 4.76$), and for the present day it ranged from 0 to 23 with a mean of 4.64 in hours spent exercising (N = 436, SD = 3.17). A t-test showed that there was a significant gender difference in the sample (t (433) = 3.96, $p < .01$), with men reporting a mean of 5.42 ($N = 153$; $SD = 3.74$) hours of exercise versus women who reported 4.19 ($N = 282$; $SD = 2.72$). Men also reported significantly more hours of current exercise between the ages of 13-15 (t (435) = 3.64, $p < .01$) and 16-18 (t (431) = 3.28, $p < .01$). A one-way ANOVA showed that there were no age

group differences, (F (5, 430) = .41, p > .05), nor education difference (F (4, 431) = 1.01, p > .05) in terms of exercise in the sample. There were significant correlations between all three exercise items (see Table 1).

Predicting exercise. A block wise regression analysis was used to test the strength of the different predictors. Current exercise was set as the dependent variable and the control variables of age, sex and education were put in the first block, exercise between ages 13-15 in the second and exercise between ages 16-18 in the third block. The control variables explained 4% of the variance in current exercise. Gender was the only control variable with unique predictive power. Exercise between the ages 13-15 was significant after the second block was added to the regression analysis (β = .20; N =432; p < .01; R^2 *Change* = .04, p < .01), it was however not significant after the third block with exercise between the ages of 16-18 was added. Exercise between the ages of 16-18 was a significant predictor for current exercise (see Table 3).

Table 3

Blockwise Regression Analysis Summary for Adolescent Exercise Predicting Current Exercise (N = 432)

Variable	B	SEB	β	R^2	ΔR^2
Block 1				.04*	
Gender	-.94	.31	-.14*		
Age	.00	.03	.00		
Education	-.01	.06	-.01		
Block 2				.08*	.04*
Exercise 13-15	.04	.05	.05		
Block 3				.11*	.03*
Exercise 16-18	.16	.04	.24*		

*p < .01.

Happiness

The Happiness variable was created from the items of the Subjective Happiness Scale (4 items, α = .86). Happiness had a mean score 4.74 (*SD* = 1.16, *N* = 433). A t-test showed that there were no gender difference ($t(430) = -.57$, $p > .05$), and ANOVA tests showed that there were no age group difference ($F(5, 427) = 1.73$, $p > .05$), nor education difference ($F(4, 428) = .83$, $p > .05$) in the sample in terms of Happiness.

Predicting Happiness. In a blockwise regression analysis control variables and exercise is found to explain 3% of the variance in Happiness. Control variables were found to explain less than 1% of the variance. Exercise between the ages of 13-15 was not found a significant predictor. Exercise between ages of 16-18 was found significant when added as the third block, but lost the significance when current exercise was added in the fourth and final block. Current exercise was found to be a significant predictor of Happiness (see Table 4).

Table 4

Blockwise Regression Analysis Summary for Exercise Predicting Happiness (N = 427)

Variable	B	SEB	β	R^2	ΔR^2
Block 1				.00	
Gender	.15	.12	.06		
Age	.01	.01	.04		
Education	.02	.02	.04		
Block 2				.01	.01
Exercise 13-15	.00	.02	-.01		
Block 3				.02	.01*
Exercise 16-18	.03	.02	.10		
Block 4				.03*	.01*
Current exercise	.05	.02	.12*		

*$p < .05$.

Positive Moods

A variable of Positive Moods was created from the mean score of the Friendliness and the Focus variable. The average score on Positive Moods was 3.18 (*SD* = .55, *N* = 405). A t-test showed that there were no gender difference ($t(402) = 2.59$, $p > .05$), and ANOVAs showed that no age difference ($F(5, 399) = 1.36$, $p > .05$), nor education difference ($F(4, 400) = 1.29$, $p > .05$) found in the sample in terms of Positive Moods.

Predicting Positive Moods. In a blockwise regression analysis control variables and exercise explained 10% of the variance in Positive Moods. Exercise explained 8% more of the variance than control variables alone. Exercise between the ages of 13-15 was not found to be a significant predictor. Exercise between ages of 16-18 and current exercise was found to be significant predictors of Positive Moods (see Table 5).

Table 5

Blockwise Regression Analysis Summary for Exercise Predicting Positive Moods (N = 400)

Variable	B	SEB	β	R^2	ΔR^2
Block 1				.02*	
Gender	-.10	.06	-.08		
Age	.01	.01	.08		
Education	.01	.01	.03		
Block 2				.03*	.01
Exercise 13-15	-.01	.01	.06		
Block 3				.06**	.03**
Exercise 16-18	.02	.01	.17**		
Block 4				.10**	.04**
Current exercise	.04	.01	.21**		

*p < .05, **p < .01.

Negative Moods

A variable of Negative Moods was created from the mean score of the Depression, Anger, Fatigue, and Restless factors. The average score on Negative Moods was 1.79 (*SD* = .35, *N* = 360). A t-test found no gender difference ($t(361) = .09$, $p > .05$), and ANOVAs found no age difference ($F(5, 357) = 1.26$, $p > .05$), nor education difference ($F(4, 358) = .06$, $p > .05$) in the sample in terms of Negative Moods.

Predicting Negative Moods. In a blockwise regression analysis control variables and exercise explained 2% of the variance in Negative Moods. Exercise explained 1% more of the variance than control variables alone. None of the control variables nor exercise items were significant predictors of Negative Moods (see Table 6).

Table 6

Blockwise Regression Analysis Summary for Exercise Predicting Positive Moods (N = 356)

Variable	B	SEB	B	R^2	ΔR^2
Block 1				.01	
Gender	-.03	.04	-.04		
Age	-.01	.00	-.08		
Education	-.00	.01	-.00		
Block 2				.01	.00
Exercise 13-15	.01	.01	.09		
Block 3				.01	.00
Exercise 16-18	-.00	.01	-.04		
Block 4				.02	.00
Current exercise	-.00	.01	-.04		

Discussion

Adolescent exercise is a significant predictor of positive emotions in adult life, even when controlled for present exercise. This is as far as we know the first study to find this connection. There is also a connection between adolescent exercise and happiness, although it appears to be that adolescent exercise predicts exercise in adult life, which in turn has a connection to happiness. This was expected based on previous research indicating that adolescent exercise predicts exercise later in life (Hallal et al, 2006; Telama et al, 2005; Twisk et al, 2000), and that present exercise has a connection with happiness (Fox, 1999; Stephens, 1988).

As expected there were gender differences in amount of exercise, with men reporting more exercise. There were also significant correlations between Happiness, Positive Moods and Negative Moods. While a certain correlation between these concepts is always expected, a strong correlation is not a given with several studies showing that neither happiness and negative moods, nor positive moods and negative moods are opposites (Costa & McCrae, 1980; Russell & Carroll, 1999). The correlation between Happiness and Positive Moods was also expected, as previous studies have found that mood influences scores on happiness scales (Schwarz & Strack, 1999), while they rarely have very high correlations as they are two different concepts (Diner, 2000).

Factor analysis. Several of the factors that were extracted from the POMS fit well with the categories that were set by the POMS manual, indicating that the sample in this study was close to what was seen in the original studies and that the translations of most of the items were accurate. Depression, Fatigue and Friendliness all had significant factor loadings from all items in one of the POMS categories. The Friendliness factor was far stronger than in any of the studies that the POMS questionnaire was based upon, with the second highest explained percentage and a significant loading on all of the items from the Friendliness category. The Anger factor only had a significant factor loading on half of the items of the Anger-Hostility category, perhaps indicating that the Norwegian population in this study is friendlier or perhaps just more comfortable with expressing positive moods than the moods associated with anger and hostility. With the questionnaire being announced through part of the university homepage, it is likely that many completed that questionnaire while at the university or working on something related to the university. This could in part have led to the last two included factors; Restless and Focus. Both the energetic restless feeling of wanting to do something else than studying, and the focused

"ready-to-work" feeling, could be imagined to be stronger in a student at a university than in the average population.

The connection between the only positive variable in the original POMS, Vigor, and exercise has been well established (Berger & Motl, 2000; Berger, Owen, 1983). By choosing to create our own variables in this study we increased the number of positive variables from one to two, and avoided exploring the well-established and intuitive link between exercise and vigor. The positive variables created in this study, Friendliness and Focus, do not represent qualities that are contradictory to exercise, but they do not have the same intuitive connection as vigor does.

Exercise as a predictor. The most interesting finding in this study is that exercise between the ages of 16 to 18 was a significant predictor for positive moods, even when controlled for current exercise. This is as far as we know the first study to find this connection and much more research is needed to verify and fully understand this connection. As expected, and consistent with previous studies (Hallal et al, 2006; Telama et al, 2005; Twisk et al, 2000) exercise in adolescence is a significant predictor for how much exercising one does as an adult. This could indicate that encouraging adolescents to exercise would be a good long-term plan to increase exercise performed by adults in the future. Encouraging and creating possibilities would probably be a key aspect as studies show that forcing kids to exercise will lead to negative attitudes towards exercising (Taylor, Blair, Cummings, Wun & Melina, 1999).

Current exercise was a significant predictor for Happiness. When looking at exercise between the ages 16-18 alone, it appeared to be a significant predictor, the significance was however lost when controlled for current exercise. This is not to say that adolescent exercise is unrelated to Happiness, there is a significant positive correlation, although the effect seems to be that adolescent exercise leads to current exercise, which is correlated with Happiness. While this does not imply a strong connection between exercise and happiness, it is an important connection. With so many rating happiness as the most important aspect of their lives, and so few known predictors (Sheldon & Lyubomirsky, 2006), even a slight influence is of importance.

Exercise was not a good predictor for Negative moods, with none of the exercise items having significant predictive power. This is a common result in studies that are measuring negative emotions, negative moods or depression in a healthy sample. Many of these scales, including the POMS that was used in this study, is created in a way that they are applicable to

both a healthy population and a patient population (McNair & Heuchert, 2010). This often leads to a difficulty in finding differences in scores of negative moods, emotions or depression, due to almost all healthy participant getting minimum or close to minimum scores.

While the results in this study are early indications that adolescent exercise can contribute to positive moods in adult life, and contribute to the growing amount of positive psychological results from exercise, it does not suggest how, how much, and what type of exercise that would get the best results. These aspects should be prioritized areas of research in order for results like this to become applicable. As this study is just an early indication of the connection between adolescent exercise, happiness and positive emotions in adult life, more research is needed to confirm these connections.

Conclusion

The most interesting finding in this study is that adolescent exercise is a significant predictor for positive moods, even when controlling for current exercise. This is as far as we know the first study to find this connection and more research is needed to verify and fully understand this connection. There is also a connection between adolescent exercise and happiness, although it appears to be that adolescent exercise predicts exercise in adult life, which in turn has a connection to happiness. This is important because adolescent exercise increases the chance of continued exercise in adulthood, which again can lead to greater happiness. As very few variables are known to cause changes in happiness, even the slight influence found from exercising is important. These results could be considered an additional incentive for both adolescent and adult exercise.

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II

Martin Rasmussen

The psychological benefits of exercise in healthy children and adolescents

Abstract

This review examines the psychological benefits exercise lead to in healthy children and adolescents. Studies on the effect of exercise on cognition, self-esteem, emotions and mood, and academic performance were examined. Exercise seems to have a positive effect on several aspects of cognition and self-esteem in healthy children and adolescents. There is not sufficient evidence to conclude that there are benefits from exercise in emotions, mood and academic performance.

The connection between a physically active body and an intellectual mind was an established part in the knowledgebase of the ancient Greeks. Since then science and research have changed how we view the world and many of the connections in it. The connection between a physically active body and an intellectual mind has however withstood these changes. Benefits of exercise have been shown in all age groups from early childhood (Alpert, Field, Goldstein, & Perry, 1990) to old age (Taylor et al, 2004). If someone were to wait until adulthood or old age before they adopted an active lifestyle, many benefits could still be obtained (Paffenbarger et al, 1993). Not all effects would however still be available (Hallal, Victora, Azevedo, & Wells, 2006; Sallis, Patterson, Buono, & Nader, 1988) and those who are active in their childhood and adolescent are those who are the most likely to continue exercising and reaping the benefits of exercise thoughout their lives (Hallal et al, 2006, Telama et al, 2005; Twisk, Kemper, & van Mechelen, 2000). While the physiological benefits of exercise has been thoroughly examined research on the psychological benefits of healthy children and adolescents has been sparse.

Research on the connection between exercise and academic effects, including connected aspects such as cognition and self-esteem, became popular in the 1950s and 1960s in what was likely an attempt to justify exercise and PE in schools from an academic standpoint (Sibley & Etnier, 2003). This incentive was however removed when criticism towards PE was reduced in the 1970s, as it became widely accepted that PE was needed for its physical health benefits (Sibley & Etnier, 2003). This acceptance did however start to fade in the 1990s with some parents even criticizing PE as harmful for the education and a waste of time and money (Shepard, 1997). Another theory on what caused the changes in popularity in PE and exercise studies is that the incentive originated from anecdotal observations of overly excited children in classes following PE or breaks with games or playing. The overly excited children would then lack concentration and have worse behavior in class, leading to reduced academic performance. This led to studies with the intent of clarifying whether or not PE did in fact have this effect on children. As the studies failed to show any impairment to academic performance the incentive for research was reduced and the popularity sank (Tomporowski, 2003).

Many different disciplines have been involved in the research of the psychological benefits of exercise resulting in many different approaches. While there will always be difficulties when comparing results from different disciplines, it has been made easier in exercise research by the consistent use of Caspersen, Powell, and Christiansen's (1985) definition of

exercise: “Exercise is a physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective” (p.128). Thereby clarifying it as a subset to the broader term of physical activity which is defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” (p.126).

This review will examine; what psychological benefits can exercise lead to in healthy children and adolescents? The psychological benefits which were chosen for this review were cognition, self-esteem, emotions and mood. The review will also examine the existing literature on how exercise influences academic performance, a real life measure which has been found to have connections to cognition, self-esteem, emotions and mood.

This review will focus on the psychological benefits of healthy children and adolescents. For reviews on the alleviating effects of exercise on clinical diagnosis see Stathopoulou, Powers, Berry, Smits, & Otto (2006) and effects of exercise on learning disabilities see Pope and Whiteley (2003).

The studies reviewed in this review have been divided into which benefit of exercise they measured. The effects of exercise on cognition will be presented first, followed by self-esteem, emotions and moods and finally academic performance. Many of the studies that describe themselves as studies of the effects of exercise on cognition have chosen to use academic performance as a measurement. In this review the cognitive studies that have used academic performance as measurement have been included in the section of academic performance and not cognition.

Cognition

Cognition is a broad term that covers many different aspects of mental functioning, including thought processing, memory, attention, concentration and creativity. Since cognitive processes are underlying every aspect of life several different approaches to measuring and researching cognition exists. Research from a variety of disciplines, including developmental psychology, sports psychology, biopsychology, kinesiology, and cognitive neuroscience has contributed to our understanding of the role exercise plays in the development and functioning of cognition in children and adolescents. The effects of exercise on child and adolescent cognitions have been detected both from a single session of exercise in short-term experiments (Budde,

Voelcker-Rehage, Pietrabyk-Kendziorra, Ribeiro and Tidow, 2008) and from habitual exercise in long-term experiments (Hinkle, Tuckman, & Sampson, 1993). While some longitudinal studies have been performed, most experimental studies to this date on the effects of exercise on cognition have been short-term and based on performance during or shortly after exercise. While longitudinal studies should give a better indication of whether or not children and adolescents will experience real-life benefits from exercise, it is often hindered by the increased economic costs and the increased time-consumption from both the researcher and the participants.

Longitudinal studies. Several of the longitudinal studies of cognitive benefits in children and adolescents have chosen to measure the effects in an academic setting to find results that are close to those experienced in real life. They will be discussed in the section on the effect of exercise on academic performance. Some studies have however chosen measurements of cognition that are not closely related to academic performance.

A longitudinal study of 154 children from the 4th, 5th, and 6th grade studied the effects of 30 minutes of running three times a week on creativity and self-concept (Tuckman & Hinkle, 1986). The students were separated into a running group and a control group. There were no significant differences between the exercise group and the control group in terms of self-concept measured by the Piers-Harris Children's Self-Concept Scale. A significant difference was however found between the groups in creativity measured by the Alternative Uses Test. A following study on 85 8th grade children, with a similar aerobic running program also found an increase in creativity (Hinkle et al, 1993). 30 minute running session was preformed five times a week and creativity was measured though the Torrance Test of Creative Thinking.

Short-Term Experiments. In contrasts to the longitudinal studies the short-term experiments on exercise effects on cognition have not had the possibilities to choose academic performance as a measurement, as academic performance often is a long-term concept measured by grades at the end of a term or after a certain amount of curriculum is finished. Some have however chosen to measure cognitive aspects that are important in academic performance although not directly measured though academic test, such as memory, creativity and concentration.

An experiment with 177 children Caterino and Polak (1999) from the 2nd, 3rd and 4th grade studied the effect of 15 minutes of walking on concentration. Concentration was measured through the Woodcock-Johnson Test of Concentration. There was only found a significant effect

in concentration in 4th graders, with no significant results in 2nd and 3rd graders, perhaps indicating that only some age groups benefit from exercise in terms of concentration (Caterino & Polak, 1999). The short duration and low-intensity of the exercise, and the small differences in age between the groups does make it hard to generalize the results from this experiment towards the general effect of exercise in children or towards that only some age groups benefit from exercise in terms of concentration. Another experiment that also used a very short exercise session was an experiment with 115 adolescents (aged 13-16) found that participants performed better on cognitive tasks measuring concentration and attention following 10 minutes of exercise that required both skill and endurance, though ball control, balance and reaction, than adolescents who did a simple and repetitive, while equally exhausting, form of exercise (Budde et al, 2008). This could imply that exercise that has a cognitive aspect is beneficiary or perhaps necessary for an increase on a cognitive task. Pesce, Crova, Cereatti, Casella and Bellucci (2009) further investigated the role of cognitive work in immediate cognitive benefits from a single session of exercise. 52 students (aged 11-12) were tested on three separate occasions in memory performance following aerobic circuit training which had a focus on having cognitive requirements, team games and a baseline session with no exercise. The children performed significantly better in both of the exercise sessions than in the control condition, and had the best performance in the team games session (Pesce et al, 2009). This could indicate that the cognitive requirements in cooperation and adopting your play and movement on the basis of your opponents could further increase the cognitive benefits of exercise.

If a certain degree of cognitive stimuli is necessary for a single session of exercise to result in an immediate effect on cognitive functions, than repetitive and simple exercise should yield little or no difference in measures performed soon after the exercise ended. Support for this idea has been found in some studies. A study 35 healthy adolescents (aged 13-15) on stationary bikes (Stroth, Kubesch, Dieterle, Ruchsow, Heim, & Kiefer, 2009) found no effect of exercise in a battery of cognitive tests. A study of 69 overweight children (aged 7-11) on treadmills (Tomporowski, Davis, Lambourne, Gregoski, & Tkacz, 2008) found no effect of exercise in a visual task-switching-task. The lack of effect by found by Tomporowski et al (2008) and Stroth et al (2009) could be due to a threshold effect of cognitive benefits of exercise. Tomporowski et al's (2008) had participants complete an exercise session of 23 minutes, while Stroth et al (2009) used a 20 minute session. Gabbard and Barton (1979) found a significant improvement on a math test

in 6th grade children following 50 minutes of vigorous physical activity, however this effect was not found after 20, 30 or 40 minutes. Contradictory to these results Hillman et al (2009), found that 20 minutes of treadmill walking had an effect on cognition in children using a similar test used in study of healthy adolescents on stationary bikes by Stroth el al (2008).

Since exercise that requires a certain amount of cognitive effort (Budde et al, 2008) and exercise based on interaction with teammates and opponents (Pesce et al, 2009) seem to benefit the cognition of children and adolescents the most, perhaps games that require no physical activity but have complex cognitive requirements and interaction will create the same cognitive benefit. This is supported by that computerized games that are specifically developed to train different cognitive aspects appear to be effective in both children (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005; Thorell, Lindqvist, Bergman, Bohlin, & Klingberg, 2009) and adolescents (Klingberg et al, 2005; Klingberg, Forssberg, & Westerberg, 2002). It is further supported by that the effect is also seen from games which are not specifically developed with this intent (Green, & Bavelier, 2003) and that people who play video games often outperform non-gamers in attention and some cognitive performance measures (Boot, Kramer, Simons, Fabiani, & Gratton, 2008). Others have however not found this connection and attribute the casual relationship between video games and cognitive skill to group differences (Boot et al, 2008; Owen et al, 2010). Further support for that the cognitive stimuli alone is not enough to create the cognitive benefits seen in exercise comes from Ellemberg and St. Louis-Deschênes (2010) experiment of 72 children divided into a group of watching an age appropriate television show while exercising on a stationary bikes and a group watching the same show while not exercising. The exercise group outperformed the non-exercise group in a reaction time task.

The connection between exercise and cognitive benefits is not found in all studies. There are several short-term studies that have found no connection between exercise and cognition. In addition to those already mentioned (Stroth et al, 2009; Tomporowski et al 2008), Raviv and Low's (1990) experiment of 96 children (aged 11-12), found no difference in the quality and level of concentration after a PE class and a science class in children. Concentration was measured through the completion speed of a letter-cancellation test.

Self-Concept and Self-Esteem

While several slightly different definitions exist, researchers seem to agree that self-concept is at least close to Rosenberg's (1979) definition, where self-concept is the "totality of the individual's thoughts and feelings having reference to himself as an object" (p. 7). Self-Esteem is often described as the discrepancy how a person evaluates themself (their self-image), and how they wish they were (their ideal self-image) (Sirgy, 1982). Where a person with a self-image close to his or hers ideal self-image, has a high self-esteem, while a person with a large degree of discrepancy between his or hers self-image and ideal self-image has a low self-esteem.

An early review of the psychological effects of exercise found that self-esteem was the only psychological aspect that was shown to benefit from exercise in existing literature at the time (Hughes, 1984). This was also found in an early meta-analysis (Gruber, 1986). This effect was however not clear as the participants in three of the four studies examined in the early review were boys with low self-esteem (McGowan, Jarman, & Pedersen, 1974), youthful offenders (Hilyer et al, 1982), and alcoholics (Gary & Guthrie, 1972). The fourth study, using college students, found that only those with low self-esteem benefitted from exercise (Hilyer & Mitchell, 1979). This focus has also been seen in studies on children and adolescents. Of the studies published on self-esteem, self-image and self-concept the majority have used children and adolescents with self-esteem or behavior problems as participants (Basile, Motta, & Allison, 1995; MacMahon & Gross, 1988), but there have been some studies of healthy children and adolescents.

The study with the youngest participants in this review is an 8-week longitudinal study with children aged 3-5 (Alpert et al, 1990). 24 children were divided into a free play group and an aerobic exercise group. The exercise sessions were administrated on every weekday and lasted for 30 minutes (including 5 minutes of warming up and 5 minutes of cooling down). The aerobic exercise group session consisted of games and activities developed specifically to raise preschoolers' heart rate to 60% to 80%. The children's heart rates where measured every 10 minutes. Self-esteem was measured through the Thomas Self-Concept Values Test, a 14-items scale with items such as happy, smart, strong, good looking and other qualities related to self-concept or self-esteem. Each child was shown a picture of themself, and would then answer verbally to questions asked by a research assistant to if the person in the picture was happy, smart, strong and so on. After the 8-week program the aerobic exercise group performed better on

self-esteem compared with both their baseline results and the free play group. The aerobic exercise group also had better results on tests of heart rate and agility. There were no significant changes in the free play group during the 8 weeks. A similar result was found in a sample of 30 5th and 6th grade children divided in a seven week running program or control condition (Percy, Dziuban, & Martin, 1981). Self-Esteem was measured with the Coopersmith Self-Esteem Inventory before and after the period. Self-esteem had an increase in the running program condition. Caution needs to have with generalizing these results, as the sample in both studies is small and due to the children in the first study being at an age where they are likely to be very susceptible to bias from the research assistants during the verbal assessment of self-esteem.

A cross-sectional study of 988 German students (Kirkcaldy, Shephard and Siefen, 2002) found that regular involvement in endurance sports or activities was connected to a better self-image and better psychological well-being than their less active counterparts. The study did not include any measurement that was specifically designed to measure self-esteem, although the authors concluded that the favorable self-image could be generalized to an improvement in self-esteem. All measurements were done though self-report questionnaires which included several socio-demographic control variables (i.e. gender, age, education, family situation). While the control variables do help to clarify the connection between exercise and self-image or self-esteem, the cross-sectional nature of the study limits the possibilities for a causal conclusion.

A three year longitudinal study was conducted in Sweden between 2000 and 2003, were a significant connection was found between physical self-esteem and exercise in girls and physical self-esteem and body mass index (BMI) in boys (Raustorp, Mattsson, Svensson, & Ståhle, 2006). Physical activity and fitness was measured trough daily pedometer steps, BMI and bioelectrical impedance (body fat percent). Self-esteem was measured through the Children and Youth Self-Perception Profile, a 36 item self-report questionnaire. 871 children (aged 7-14) participated in 2000, and 375 adolescents (15-18) participated in 2003. 97 of the children who participated in 2000 also participated in 2003, allowing the authors to use a follow-up design on parts of the population. The authors concluded that physical self-esteem in girls and weight control in body leads to exercise and a healthy life style. While the majority of research has suggested a causal link in the other direction, this study exemplifies the causality difficulties in research on exercise and psychological aspects where causality in either direction is often both possible and plausible.

As part of a 10 year longitudinal study 197 non-Hispanic white American girls' participation in physical activity and their self-esteem were assessed at ages 9, 11 and 13 (Schmalz, Deane, Birch, & Davison, 2007). Physical activity and physical fitness was measured though a questionnaire on general tendency or inclination toward physical activity, a checklist of which activities they were active in, and an endurance test consisting of running at progressively higher speeds. A positive connection between physical activity and self-esteem was found. There was also a lagged effect of physical activity in terms of self-esteem, were physical activity at ages 9 and 11 predicted self-esteem at ages 11 and 13, even when controlled for covariates. This lagged effect was not seen the other way around, as self-esteem did not significantly predict future exercise. This could be interpreted as evidence towards that the main causal relationship between exercise or physical activity and self-esteem is that exercise or physical activity leads to a better self-esteem. While the longitudinal design of the study does provide a good measure of development in both individual participants and the sample, there are limitations due to the sample of only non-Hispanic white American female participants.

One possible explanation for why exercise or sports participation would increase self-esteem is the increase in skill that follows participation in a specific activity or sport. In a 10-week longitudinal study 288 students aged 12-14 and 16-18 were divided into groups of field hockey (96 participants), athletics (96 participants divided into discuss throw (32 participants), long jump (32 participants), and sprinting (32 participants)) and a control group (96 participants) (Salokun, 1994). Sports skill and self-esteem were measured prior and after the 10-week period. Both the field hockey and the athletics group had improvements in self-esteem and in sports skill. There was also a correlation between self-esteem and sports skill. The study concluded that the results support inclusion of success-oriented sports in the high school curriculum. As an increase in sports skill is natural to find in any sport that is practiced, it could be unrelated to the positive effect in self-esteem, which is also seen in studies where the form of exercise is not success-oriented. There is however additional support for self-esteem benefits of skill acquiring during sports or exercise. In a 12-day summer camp swimming program participated by 65 boys (aged 7-15), an improvement in self-concept was found in boys who learned to swim (Koocher, 1971). The 30 boys who already knew how to swim spent the swimming classes swimming on their own. There was no change in the self-concept of the children who failed to learn how to swim, or the children who already knew how to swim, despite being the group that swam the most during

the period. The children who failed to learn to swim did not have a negative change in self-concept. Self-concept was measured with the Index of Adjustments and Values modified for use with school-age children, a 35-item questionnaire assessing the boys' description of themselves, their satisfaction with themselves and their ideal self. Swimming ability was measured by whether or not the participant could swim 25-meters unassisted. Since swimming ability was determined in this fashion, the improvement in swimming skills amount the boys who already knew how to swim was not recorded. It was not reported how much time the any of groups spent swimming during the period.

The only study found where exercise did not have an effect on self-esteem, self-image, or self-concept was the previously mentioned study by Tuckman & Hinkle (1986). 154 children from grades 4th to 6th had no improvement in self-concept measured though the Piers-Harris Children's Self-Concept Scale from a 30-minute run. Exercise was however found to have a positive effect on creativity measured though the Alternative Uses Test.

Emotion and mood

The benefits of exercise in terms of emotions and mood have been researched and discussed thoroughly in adults and in several child and adolescent populations such as children or adolescents with delinquent behavior (MacMahon & Gross, 1988), youthful offenders (Hilyer et al, 1982), and a variety of clinical diagnosis. The research on healthy children and adolescents is however sparse, and is mostly limited to the protective factors exercise has towards depression. Studies that have only included measures of clinical diagnosis of depression or depression symptoms have not been included in this review. Only a few studies with other or additional measures than depression have been conducted.

A cross-sectional study of 5061 16-year old British adolescents found that exercise had a positive association with emotional wellbeing, even when social class and physical health was controlled for (Steptoe & Butler, 1996). Emotional well-being was measured through a general health questionnaire, which is designed to measure a variety of physiological and psychological health aspects.

Norris, Carroll, and Cochrane (1992) conducted both a cross-sectional study and an experiment. In the cross-sectional study 147 adolescents (age 13-17) completed self-reports of exercise, stress and psychological well-being. Stress and psychological well-being were

measured though a battery of tests consisting of the Life Events Questionnaire, the Seriousness of Illness Rating Scale, the Perceived Stress Scale, and the Multiple Affect Adjective Checklist. Exercise was measured though both "yes or no" questions on whether or not the participant exercised or played sports regularly as well as through a question of how many hours the participant spent exercising per week. Exercise was found to have a negative correlation to both stress and depression. In the following experiment 80 adolescents (mean age 16.7) were divided into four groups; moderate intensity aerobic exercise, high intensity aerobic exercise, flexibility training, and a control group. The experiment used same measurements for stress and psychological well-being as the cross-sectional study. The groups met twice a week for 25-30 minutes of exercise. The high intensity aerobic exercise group had significantly lower scores on both depression and stress, than the other three groups. No significant difference where found between the moderate intensity aerobic exercise group, the flexibility training group and the control group.

Academic Performance

Academic performance is a real-life measurement influenced by a wide range of variables. Several of those variables are psychological, including the aspects examined in this review. The relation between exercise and academic performance is of special concern with most countries today having some sort of physical education required in their national school system (Hardman, 2004). Although health benefits alone could justify physical education in schools, advocates for keeping or increasing physical education are often met by arguments that it is a waste of time and money or harmful to the academic process (Armour & Jones, 1998; DCMS/Strategy United, 2002; Shepard, 1997). While the majority of research published in English language journals is concerning the state of PE in the United States, Great Britain and Australia, PE is considered to be threatened in all regions of the world in a 2004 report from the World Health Organization (Hardman, 2004). The most common reason to why PE is not offered is economic (Hardman, 2004). With PE usually having higher costs than a normal academic subject for the school, due to additional cost such as gym maintenance and sports equipment, it is often the first subject to be reduced or cut when schools struggle with their budgets (Hardman, 2004; Sibley & Etnier, 2003). Another common reason why part of the child and adolescent population are not given PE in schools are cultural and religious reasons. Several countries,

particularly in Africa and Asia only provide PE for boys, or discourage girls to participate due to it not being accepted in their culture or religion (Hardman, 2004). Free playing time during recess is even being cut in several American schools due to liability issues associated with the risks of someone being injured while at school (Donnelly & Coakley, 2002).

Short term experiments and cross-sectional studies. Since academic performance often is measured by grades at the end of a term, a test after a certain amount of curriculum is gone through in class or other long-term aspects the possibilities for short-term studies are few. Correlations between academic performance and exercise, athletic performance, participation in academic programs at school and physical fitness has been found in cross-sectional studies dating all the way back to the 1930s (Shepard, 1997). While a positive effect is often found in these studies it's hard to determine any causality. It is likely that confounding variables such as intelligence, personality, genetic disposition or teacher bias towards those who perform the best in sports could be the reason for this effect, and not necessarily that the exercise or physical activity influenced academic performance (Shepard, 1997). Due to the weak nature of cross-sectional studies in determining the effects of exercise on academic performance this review will focus on longitudinal studies in terms of exercise and academic performance.

Longitudinal studies. Even though longitudinal studies seem like the only way to determine the effect of PE or exercise on academic performance relatively few studies have been conducted.

The earliest study was in 1950 in Vanves, France, were students at a selected experimental school had their timetables modified for their last year of primary education. The school week was increased from 32 to 41.5 hours, two half-hour breaks were introduced, academic instruction was limited to mornings and was reduced by 26%, a wide range of required physical activities was done in the afternoons and students received regular vitamin supplements. Students were described as more calm and attentive, number of average sick days was reduced and academic results remained close to what was found in control classes despite the 26% reduction of time spent normal education classes (Shepard, 1997). The Vanves study has been described as "an almost legdendary study" (Sallis et al. 1999, p.128). The status of almost legendary is partly due to the amount of attention the study has received, but also from all the uncertainties surrounding it. The study has never received publication in an English-langue journal, and the original French descriptions lack information about whether or not confounding

variables, such as class size and socioeconomic status, was controlled for (Shepard, 1997). Generalization is made further difficult from that both of the other introductions, additional breaks and vitamin supplements, are plausible to have an effect on academic performance.

In, Trois Rivieres, Quebec, in the mid 1970 a large longitudinal study was conducted. Students in 1st through 6th grade received more PE and spent less time on academic subjects. The results were compared with students at the same schools that preceded or followed the experiment (Sallis et al, 1999, Shepard 1997). Students in the year of the experiment ended up with significantly higher grades than both students that presided and followed them in most subjects with math being the subject that benefitted the most after a year of increased PE. The students did however score significantly lower in the categories English and "overall intelligence" on a province wide multiple-choice examination. This has been suggested to be due to the fact that students had a chance to practice on similar exams in classes before the actual exam, giving an advantage to the students with the most time spent in classrooms (Shepard 1997).

In 1978, the School Health, Academic Performance and Exercise (SHAPE) study was conducted in Adelaide, Australia. 519 fifth grade (10-year old) children from seven schools participated (Dwyer, Coonan, Worsley, & Leitch, 1979). Classes from the seven schools were divided into a fitness, skill or control group and observed for 14 weeks. Both the skill and the fitness group had 15 minutes of PE in the early mornings and 60 minutes during normal class hours. The skill group spent most of the time on activities or sports that required a high amount of technique, while the fitness group spent most of the time on endurance activities and endurance sports. The skill and fitness group both performed significantly better than the control group on teacher rated classroom behavior. There were no significant differences of academic performance between the groups. A follow-up study two years later found that the classes that had implemented and kept the schedules from the fitness or skill groups in the two-years following the original study outperformed the control classes in math, reading and teacher ratings of classroom behavior (Dwyer, Coonan, Leitch, Hetzel, & Baghurst, 1983). The study has been criticized for both the lack of standardized tests (Sallis et al, 1999) and possible bias from the teachers giving the ratings of classroom behavior (Shepard, 1997).

The Sports, Play, and Active Recreation for Kids (SPARK) program was a two year program, in a suburb in Southern California, in 1990 to 1991 (Sallis et al. 1999). 1,538 students

from the fourth and fifth grade were divided into three conditions; a specialist condition, where PE was conducted by a certified physical education specialist, a trained teacher condition were the research staff trained classroom teachers on how to implement the SPARK program in PE, and a control condition that would receive the usual PE program. The specialist and the trained teacher conditions both spent more time on PE and spent, 76 and 57 hours less on academic subjects per year. A small advantage over control groups in academic performance was found, and while the advantage was small, the results reinforce previous findings that an increase in PE does not interfere or harm academic performance (Sallis et al. 1999).

A recent study of 214 sixth grade students from a public school in Michigan, did not find any significant connection between introducing daily PE classes and academic performance (Coe, Pivarnik, Womack, Reeves, & Malina, 2006). The children had 55 minutes of PE every week day, while the students who were not part of the experiment had alternative exploratory classes such as arts or computer science. The lack of results from the PE could be due to average amount of vigorous or moderate activity only being 19 minutes per 55 minute session (Coe et al, 2006), which could be beneath the threshold for how much exercise is needed before benefits are seen. The study also measured the amount of exercise outside of school and found that students with the highest amount of vigorous activity had significantly better grades than those who did not.

Another Australian longitudinal study, the lifestyle of our kids (LOOK) project, ended in 2009; however no publication has yet included the results. A short report outlining the methods of the project has been published (Telford et al, 2009).

Discussion

The research question for this review was; what psychological benefits can exercise lead to in healthy children and adolescents? Studies on the effect of exercise on cognition, self-esteem, emotions and mood, and academic performance were examined. Findings from each of these topics will be summarized and discussed separately followed by a general discussion on the doses of exercise in the studies.

Cognition

In the studies reviewed cognition has been measured through creativity, concentration, attention and memory. Benefits of exercise were found in both long-term studies where a certain amount of exercise is performed per week and in short-term experiments where cognition is measured shortly after a single session of exercise. Exercise that is considered not to have cognitive demands, such as running and working-out on a stationary bike, have been found to have cognitive effects when the exercise is performed through several weeks. There is little evidence for an immediate cognitive benefit from a single session of exercise that does not have a cognitive demand. Exercise that requires a cognitive aspect such as timing, balance, dexterity, strategy and particularly team based games or sports that in addition require cooperation or adapting your play to opponents does seem to give the greatest cognitive benefits. This effect is seen both in long-term studies and shortly after a single session of exercise. The effects of cognitive demands in exercise have led to theories on that the cognitive demands alone are responsible for the cognitive benefits and that benefits could be obtained without the physical exhaustion. Evidence towards activities such as video-games that require all the cognitive aspects seen in team sports without physical exhaustion generally point towards that they do not have the same effect as team games or sports that do required physical exhaustion.

Self-Esteem

Self-esteem was in an early review (Hughes, 1984) concluded to being the only psychological aspect that benefitted from exercise in adults. This benefit is also found in children and adolescents with seven out of the eight studies in this review finding a positive effect on self-image, self-concept or self-esteem. While the measurements of self-concept, self-esteem, and self-image used in the studies reviewed in this review are based upon similar understandings of

the concepts, none of the experiments in this review have used the same index for measuring these concepts. The terms and concepts are also used interchangeably with studies using scales which are meant for measuring self-concept, self-perception and self-image in measurement of self-esteem (Alpert et al, 1990; Kirkcaldy et al, 2002; Raustorp, 2006). All of the studies in this review have measured self-esteem though questionnaires, or verbal administration of questionnaires to children who were too young to read. While modifications were made in many studies to better suit the questionnaires to children, additional methods such as structured interviews could in future studies provide a more in-depth understanding of children's self-esteem and how exercise affects it. Self-esteem is important as it has been found be to influence mental health, well-being (Fox, 2000) and happiness (Diener, & Diener, 1995).

Emotions and Mood

The benefits of exercise in terms of emotions and mood have been researched and discussed thoroughly in adults and in several clinical child and adolescent populations. The research on healthy children and adolescents is however sparse, and is mostly limited to the protective factors exercise has towards depression and anxiety. Interestingly there seems to be an almost complete lack of studies on the relationship between exercise and positive emotions or positive moods in children and adolescents. While a positive trend is seen in terms of exercise benefitting emotional well-being, not enough evidence is available to make any conclusions.

Academic Performance

The results from the longitudinal studies with increased PE in schools were generally positive either in terms of classroom behavior or through obtaining the same academic results from less time spent in classrooms. There is however not sufficient evidence to conclude that PE has a positive effect on academic performance. Caution should also be had when generalizing the results from the longitudinal studies of PE and academic performance due to weaknesses in the design of the studies. Only the SPARK and Trois Rivières study used standardized tests, increasing the possibilities of bias interfering with the results. In both the Vanves study and the SHAPE study found their positive effects through teacher evaluations of behavior, an effect that could be affected by the teachers having positive attitudes to the project. In the Trois Rivières study the students had the largest advantage in grades assigned by their homeroom teachers

(Shepard, 1997). During the study 80% of the teachers were positive towards the project, with the remaining 20% being neutral towards it (Shepard, 1997). In Trois Rivières, Vanves and SHAPE teachers had a daily one-hour break while the students had PE, this could have led the teachers to be fresher and better prepared during classes (Shepard, 1997) and may have led the teachers to over-evaluate both the program and the students' in class behavior and performance.

Although there were weaknesses in the studies and that PE wasn't found to greatly improve academic performance, there were very few indications that it would hurt academic performance, even when other traditional academic subjects were replaced. The general trend seemed to be a slight improvement in learning efficiency in other subjects through an increase in PE. The physiological and psychological benefits unrelated to academic performance, in addition to increased chance of continued exercising though life are all aspects that might not be of great importance to academic institutions, but would be a great bonus to the students.

Low doses

Most of the studies reviewed in this review have used a relatively low dose of exercise. Out of the 26 studies reviewed in this review, thirteen included an exercise intervention. In only two of those (Dwyer et al, 1979; Gabbard & Barton, 1979) participants performed more than 30 minutes of exercise per exercise session. One of those two studies included 20, 30, 40 and 50 minute groups, only finding significant results between the control group and the 50 minute group (Gabbard & Barton, 1979). With some studies only finding a significant difference between the high-dose group and the control group, while there is no difference between the low-dose group and the control group (Gabbard & Barton, 1979), it seems likely that there is a threshold effect in the benefits of exercise in terms of both intensity and duration. It is likely that many studies would have seen larger effect if the intensity or duration or exercise had been increased.

Measurements of Exercise

In research on the psychological benefits of exercise in children and adolescent many difficulties in measurement are met. Exercise is a term which is clearly defined based on the physical activity pattern of an adult, were the physical activity is done intentionally to improve or maintain physical form (Caspersen et al, 1985). This fits well with the modern adult life where

moderate or intense physical activity often is only performed with this intention. It does however not fit well with a young child's life where a large part of the activity is through unregulated play, quickly shifting levels of activity, and probably with little thought of consequences in terms of physical form. As children have a different natural way of performing physical activity than adults, perhaps different measurement and experiments should be developed to find the cognitive effects in children.

Future Studies

Future studies should several different levels of intensity and duration of exercise to determine whether or not there is a threshold effect in exercise. A more rigid and scientific design should be applied to future studies of exercise or PE in schools to better determine whether or not an increase in PE could increase academic performance. More research is needed on the emotional and mood effects of exercise. Particularly in positive emotions were there seems to be a complete lack of research.

Conclusion

Exercise seems to have a positive effect on several aspects of cognition and self-esteem in healthy children and adolescents. Few studies have been conducted on the benefits of emotions or mood from exercise. While a positive trend is seen from the few studies that have been conducted on mood and emotion there is not enough evidence to conclude whether or not a benefit can be seen from exercise. There is need for studies on the effects of exercise on positive emotions and positive mood of healthy children and adolescents. The results from the longitudinal studies with increased PE in schools were generally positive either in terms of classroom behavior or through obtaining the same academic results from less time spent in classrooms, but there is not sufficient evidence to conclude that PE has a positive effect on academic performance. The results in this review provide evidence for psychological benefits from exercise. These benefits are experienced during youth, and should work better as incentives for children and adolescent to exercise than long-term effects such as reducing the chances of cardiovascular problems a long time into the future, something very few children or adolescents are likely to worry about.

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