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Original

ASOCIACIONES ENTRE CONDICIÓN FÍSICA Y SALUD MENTAL ENTRE ADOLESCENTES ALEMANES

ASSOCIATIONS BETWEEN PHYSICAL FITNESS AND MENTAL HEALTH AMONG GERMAN ADOLESCENTS

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RESUMEN

El ejercicio físico conlleva beneficios en diversos aspectos fisiológicos y de salud mental. Se ha demostrado que la actividad física se relaciona con indicadores de salud mental tales como la depresión, ansiedad, trastorno de déficit de atención e hiperactividad (TDAH) o autoestima. Estudios recientes sugieren a la condición física, especialmente la condición cardiovascular, como un indicador promisorio para la depresión. Asimismo, la composición corporal parece estar asociada con la ansiedad y el TDAH. Con fin de replicar y por tanto verificar estos hallazgos iniciales en adolescentes, examinamos diversos parámetros de condición física (condición cardiovascular, niveles de fuerza y composición corporal) en conexión con la salud mental (síntomas depresivos, ansiedad y problemas de inatención e hiperactividad) en N = 511 adolescentes alemanes. Los resultados revelaron altos índices de ansiedad, así como de hiperactividad e inatención en adolescentes con bajos niveles de fuerza muscular. A pesar de la relativa juventud de la muestra, se encontraron relaciones entre la condición física (fuerza muscular) y parámetros de salud mental. Las investigaciones futuras podrían beneficiarse al estudiar la relación y los mecanismos subyacentes entre la condición física y la salud mental durante el desarrollo. Asimismo, monitorear estas asociaciones en adolescentes en crecimiento podría aportar información valiosa.

Palabras clave: fuerza, depresión, ansiedad, hiperactividad, condición cardiovascular, IMC.

ABSTRACT

Exercise has positive benefits for various physiological and mental health aspects. Physical activity has been demonstrated to be connected with mental health markers such as depression, anxiety, Attention-Deficit/Hyperactivity Disorder (ADHD) or self-worth. Recent studies have also shown fitness, specifically cardio vascular fitness, as a promising marker for depression. Furthermore, body composition seems to be associated with anxiety and ADHD. To replicate and therefore verify these first findings in adolescents, we examined physical fitness parameters (cardiovascular fitness, strength and body composition) regarding its connection to mental health (depressive symptoms, anxiety and inattention hyperactivity problems) among N = 511 German adolescents. Results revealed higher scores in anxiety as well as in hyperactivity inattention for adolescents with low levels in physical strength. Although the relatively young sample, relations between physical fitness (strength) and mental health parameters were found. Further research could benefit by focusing the relation and underlying, developmental mechanisms between fitness and mental health and monitoring of these associations over time in growing adolescents could yield important information.

Keywords: strength, depression, anxiety, hyperactivity, cardiovascular fitness, BMI.

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INTRODUCTION

Physical activity has various potential benefits such as reduction of cardiovascular diseases or chronic diseases (Banzer, Knoll, & Bös, 1998; Lee et al., 2012). Even risk for mortality is associated with lower levels of regular physical activity (Kodama et al., 2013; Samitz, Egger, & Zwahlen, 2011). Unfortunately, levels of physical activity across the western civilization are alarming. A study with 11 - 15 year aged adolescents from the Health Behavior in School-aged Children (HBSC-Team) in Germany in cooperation with the World Health Organization (WHO) in 2009/2010 showed that over 42% of the girls and over 30% of the boys engaged themselves in sport related activity less than 2 hours a week (HBSC-Team Deutschland, 2011b). In addition, levels of activity seemed to decrease in older adolescents. At the same time, 35 – 40% used their computer over 2 hours a day (HBSC-Team Deutschland, 2011a). Internationally, in large areas across Europe only less than 10% of 15 year aged girls engage in at least 1-hour physical activity per day (Currie et al., 2012). Consequently, problems connected to physical inactivity and sedentary behavior are gaining importance, too. Obesity for example, which is largely connected to physical inactivity and sedentary behavior (e.g. Janssen et al., 2005), is a considerable disease even in adolescents with prevalence rates from 10 up to 30% in countries in Europe and northern America (Currie et al., 2012).
Research on mental health showed also important connections to physical activity. While looking into the field of mental health and physical activity, it is useful to distinguish between physical activity, exercise and fitness. Whereas physical activity is considered to be any muscular movement that increases energy expenditure, physical exercise rather refers to planned, structured, systematic and purposeful physical activity (cfr. Ortega, Ruiz, Castillo, & Sjostrom, 2008). Health related physical fitness reflects the capacity to perform physical activity and has different components such as cardiorespiratory fitness, flexibility, muscular strength and endurance or body composition (Corbin, Pangrazi, & Franks, 2000). Many studies have shown the positive effects of exercise or physical activity interventions on psychological outcomes. For treatment of depressive disorders physical exercise reaches effect sizes comparable to psychotherapy and antidepressants (Cooney et al., 2013; Krogh, Nordentoft, Sterne, & Lawlor, 2011). Although these effects tend to be smaller in adolescents they are still noteworthy (Brown, Pearson, Braithwaite, Brown, & Biddle, 2013; Rethorst, Wipfli, & Landers, 2009). Besides the antidepressant effect, positive effects of exercise can also be seen for neurotic problems such as anxiety and posttraumatic disorders (Diaz & Motta, 2008; Wipfli, Rethorst, & Landers, 2008). Particularly, positive effects have been demonstrated in cognitive functioning and self-esteem among adolescents (Biddle & Asare, 2011). An anti-anxious affect is also observed in adolescents (Bonhauser et al., 2005; Lindwall & Lindgren, 2005), although only few studies are to be found (Larun, Nordheim, Ekeland, Hagen, & Heian, 2006).

Regarding levels of physical activity, studies showed connections between level of activity in childhood and depression in adults (Jacka et al., 2011). In addition, connections between physical activity and depression, as well as for physical activity and anxiety have been found in adolescents (De Moor, Beem, Stubbe, Boomsma, & De Geus, 2006; Wang, Fu, Lu, Tao, & Hao, 2014). Furthermore, adolescents with more than 4 hours a week vigorous physical activity showed lower levels of depression and anxiety (Parfitt, Pavey, & Rowlands, 2009).

Following these findings, there is a need for physical activity promotion in youths. However, research on more stable markers compared to single activity interventions could improve knowledge on general associations between physical activity behavior and mental health. Therefore, fitness could function as an important marker of health. Studies have found fitness to be a relatively stable marker in connection to physical activity. For example, Lämmle, Jekauc, Woll, Tittlbach, and Bös (2014) showed that the level of physical activity predicts physical fitness over the next 18 years. Long termed engagement in physical activity behavior might be relevant for prevention of diseases and therefore important in the critical stage of adolescents. Psychological problems, such as depression, anxiety, Attention-Deficit/Hyperactivity Disorder (ADHD) are evolving during this period and associating effects seem to be stable across gender and age (De Moor et al., 2006). Thus, one might argue that it makes sense to investigate relatively stable markers such as fitness components. In addition, research on physical activity is mostly

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based on self-description (interview or questionnaire) and therefore easily biased. In contrast, fitness parameters can be assessed by physical markers and therefore provide multimodal opportunities for assessment in adolescents.

Whereas the relationship between physical activity and mental health is underpinned by empirical research (Hallal, Victora, Azevedo, & Wells, 2006), research on fitness and mental health in adolescents is rather little (Ortega et al., 2008). However, recent studies support the assumption of fitness as an important marker for mental health. Greenleaf, Petrie, and Martin (2010) showed that in female adolescents' cardiorespiratory fitness is connected to self-esteem, depression and body satisfaction. In male adolescents, cardiorespiratory fitness was positively associated with body satisfaction. Results for the mixed sample indicated an elevated risk for depressive syndromes in adolescents with low levels of cardiorespiratory fitness (Rieck, Jackson, Martin, Petrie, & Greenleaf, 2013). Findings regarding depression are supported by results from a large Swedish prospective study (Aberg et al., 2012). Here, lower cardiovascular fitness at age 18 was associated with increased risk for depression in adulthood. In obese adolescents, associations between cardiorespiratory fitness and depression were observed, too (Shomaker et al., 2012). Regarding body composition, connections between body mass index (BMI) and depression, as well as between BMI and anxiety have been found (Wang et al., 2014). Furthermore, there is a connection between obesity, measured by BMI, and ADHD (Cortese & Vincenzi, 2011) (Cortese et al., 2008). In addition, childhood ADHD is connected with obesity in adulthood (Cortese, Faraone, Bernardi, Wang, & Blanco, 2013). Verret, Guay, Berthiaume, Gardiner, and Beliveau (2012) showed that physical activity interventions in children with ADHD had positive effects on behavior and cognitive functioning. But associations between other fitness markers and ADHD are yet unknown.

Taken together, these results indicate adolescent's fitness might be an important marker for mental health aspects. Especially cardiorespiratory fitness appears to be a potentially relevant factor for depression. Considering the results regarding physical activity in connection to anxiety and cognitive functioning, one might expect similar results between fitness and psychological factors. However, research on this matter is little. As obesity is related to ADHD on might assume that body composition in terms of fitness is related to ADHD, too. But here again, research focusing on this issue especially in adolescents is also scarce.

Our goal with this study is to further investigate fitness as a health related marker and therefore its possible connection to mental health. In detail, the goal is to replicate first findings for associations between fitness and mental health in a German sample and investigate further possible associations. In order to determine whether effects can be seen even in young people the study examined a sample of adolescents. It is hypothesized that fitness is associated with depression, anxiety and hyperactivity-inattention. For depression we expect primarily associations with cardiorespiratory fitness. For hyperactivity-inattention we expect primarily associations with body-composition. Due to the lack of research on anxiety, no specific assumption regarding anxiety is drawn.

METHODS

Participants

Participants were 279 female and 232 male students from various Bavarian schools within the region of Berchtesgadener Land ranging from grade 4 to grade 10. Girl's age was distributed with M_{age} = 12,51 years, *SD* = 2,26 years, range = 9-17 years. Boy's age was M_{age} = 11,67 years, *SD* = 2,02 years, range = 8-17 years. Due to the validity of the used assessment instruments and the cognitive capacity of young participants, not all psychological measurements were used in younger pupils. Cardiorespiratory fitness, strength, socioeconomic status and anxiety (Kinder Angst Test until the age of 15, Beck Angst Inventar above age 15) was assessed with all participants. Hyperactivity was assessed with all participants from age 11 on, and depression was assessed from age 13 on. This lead to 4 partially overlapping sub-samples: n*Depression* = 190 (54 male, 136 female). n*AnxietyI* = 464 (213 male, 251 female) n*AnxietyII* = 47 (19 male, 28 female), $n_{Hyperactivity\text{-}Inattention}$ = 381 (167 male, 214 female).

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Measures

Demographic and socioeconomic status. Participant's age, grade in school and gender was provided by parents and teacher. Socioeconomic status was assessed by the Family Affluence Scale as used in the National Health Studies by the HBSC in 2000/2001 (FAS II; Boyce, Torsheim, Currie, & Zambon, 2006; Currie et al., 2008). The FAS II uses material markers (family car, bedroom, holiday, and computer) in order to assess the family's status. Higher scores in the FAS indicate higher socio economic wealth of the children's family (Boyce et al., 2006).

Physical fitness. For assessment of the adolescent's fitness markers the FITNESSGRAM (Cooper Institute, 2007) was used. The FITNESSGRAM test battery provides measures of various markers such as body composition, aerobic capacity (i.e., cardiorespiratory fitness, CRF), strength and flexibility. All tests were implemented. However, for analysis in this study only the PACER (Progressive Aerobic Cardiovascular Endurance Run; CRF), curl-up test (strength) and body composition (Body-Mass Index, BMI) were used. The FITNESSGRAM uses zones (HF for High Fitness and LF for Low Fitness) to categorize fitness performance. The zones represent age- and gender-based minimum standards in fitness level that offer protection against diseases resulting from sedentary living behavior (Cooper Institute, 2007; Welk & Meredith, 2008). For the PACER, the minimum number of laps adolescents must complete to reach HF cardiorespiratory fitness is between 7 and 41 for females and between 23 and 61 for males. For the curl-ups, the minimum number of repetitions to reach HF strength is between 9 and 18 for females and between 9 and 24 for males. BMI scores to reach HF ranged between 14.1/18.3 (low level criteria) and 19.9/27.5 (high level criteria) for males and between 13.8/17.6 (low level criteria) and 20.0/27.2 (high level criteria) for females. The measures were shown to be reliable and valid measures of the fitness aspects they are capturing (Cooper Institute, 2007).

Depression. For assessment of depressive symptoms, the widely used German version of the Center for Epidemiologic Studies Depression Scale (CES-D) from the National Institute of Mental Health (Hautzinger, Bailer, Hofmeister, & Keller, 2011; Radloff, 1977) was used. The CES-D is a short self-report scale designed to measure depressive symptoms in the general population. The 20 items include symptoms associated with depression and are assessed on a scale ranging from 0–3. The scale has been found to have very high internal consistency (α = .89) and an adequate test retest reliability of r = .58 (Hautzinger et al., 2011). Studies reported that the CES-D was also a reliable and valid measure of depression for adolescents from age 12 to 18 years (Fendrich, Weissman, & Warner, 1990; Hautzinger et al., 2011).

Anxiety. For assessment of anxiety the Kinder Angst Test (children anxiety test, KAT, (F. Thurner & Tewes, 1969)) was used. The KAT is a short self-report scale for measuring trait anxiety in children from age 9 to 15. The questionnaire includes 20 items covering anxiety sensitivity and anxiety reaction. Franz Thurner and Tewes (2000) report adequate internal consistency (α = .81) and a high retest reliability of r = .80. For participants with age 15 and older, anxiety was measured with the German version of the Beck Anxiety Inventory (Hewitt & Norton, 1993; Margraf & Ehlers, 2007). The self-report questionnaire includes 21 items. The scale is validated and showed an appropriate internal consistency of Cronbach's α = ,90 for clinical samples and between α = ,85 and α = ,90 for non-clinical samples.

Hyperactivity-Inattention. The hyperactivity-inattention subscale from the Strength and Difficulties Questionnaire (SDQ) as available in the German version from www.sdqinfo.org is a brief behavioral screening for hyperactivity in children. The self-report scale used in the present study consists of 5 questions regarding the child's behavior on a 3-point Likert-type scale ranging from 0 = "not true", 1 = "somewhat true" and 2 = "certainly true". The sum-score indicates possible difficulties in hyperactivity-inattention from score 8-10. The SDQ has been demonstrated to be a valid and reliable measurement in children and adolescents (Goodman, 2001; Woerner et al., 2002). It is proposed to use the self-report scale from the age 11 on, which was applied in this study accordingly.

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Procedure

Prior to testing the participant's parents were provided with information about the study. In addition, parent's agreement in using their children's data was obtained. All participants were recruited from a project called Sternstunden der Gesundheit, which took place in the area in Berchtesgadener Land, Germany. From October 2012 to June 2013, various school classes participated in the project, in which the students explanatively learned about health behavior (such as nutrition, sedentary behavior etc.). Students were divided in groups from 4 to 6 persons and run through the program provided by the project. In addition, the student-groups were tested with the psychological measures, with the FITNESSGRAM test battery and a medical examination, which data is not used in this study. The study has been conducted by Helsinki Declaration Ethical Rules (1975) and the study protocol was approved by the ethics commission of the Technische Universität München (5490/12), written informed consent was obtained from parents of all children as well as from children aged > 14 years.

Data analysis

Based on the FITNESSGRAM reference norms the participant's performance on the PACER and the curl-ups were classified as either HF or LF. These factors (cardiorespiratory fitness, muscular strength, and body composition) were treated as independent variables. Dependent variables were the four psychological measures: Depression, Anxiety I, Anxiety II and Hyperactivity-Inattention. Although there is an overlap between the sub-samples, this overlap was too small to be able to conduct multivariate analysis. Therefore, analyses were conducted for each dependent variable separately. However, to account for the problem of family wise error rate alpha was set at .01. As the SES has been related to both mental health and physical fitness (Boone-Heinonen et al., 2011; Jacobi et al., 2004), it served as a covariate to control for its potential effects. Analyses of Covariance (ANCOVA) were conducted to compare differences in the mental health (dependent variables) by the different fitness measures (independent variables). Because gender is commonly related to mental health (e.g. Jacobi et al., 2004), effects of gender for psychological measures were tested by t-tests, with alpha set at .05. For non-significant variables data were collapsed across gender. In this case, ANCOVA with gender as a factor for controlling was conducted. For significant different variables, separate ANCOVAs were conducted.

RESULTS

The distribution across the fitness categories (LF or HF) showed more participants in HF categories for all three fitness measures. For cardiorespiratory fitness, n = 115 adolescents were considered to have low CRF, whereas n = 396 participants fell into category high CRF. For strength, n = 141 fell into category low fitness and n = 370 fell into category high fitness. Due to body composition, n = 82 had a BMI considered to have low fitness, whereas n = 429 participants had a BMI related to high fitness. Socioeconomic status was in average M = 5,64 (SD = 1,20), levels of depression were M = 13,85 (SD = 8,74), scores for anxiety I were M = 6,83 (SD = 3,69), anxiety II was in average M = 10,79 (SD = 9,14) and ADHD had a mean of M = 2,86 (SD = 1,50).

Depression

As scores in depression were significant higher in females than in males (M_{female} = 15,54, SD = 9,38; M_{male} = 9,23, SD = 4,05; $t(173)$ = 4,45, p < ,001), separate analyses were conducted and are illustrated in table 1.

Table 1. Cardiorespiratory fitness (CRF), physical strength, Body Mass Index (BMI) and the covariate SES with Depression

			Depression		ANCOVA	
			M	*SD*	*F*(1, 123)	*p*
Females	**CRF**	LF	19,33	10,38	6,25	,014
		HF	14,38	8,79		
	Strength	LF	15,88	10,20	0,05	,821
		HF	15,38	9,03		
	BMI	LF	15,53	10,35	0,69	,409
		HF	15,54	9,30		
	SES				3,58	,061
					F(1, 42)	*p*
Males	**CRF**	LF	8,67	4,38	0,25	,620
		HF	9,83	3,69		
	Strength	LF	9,50	3,60	0,54	,465
		HF	9,16	4,21		
	BMI	LF	8,22	3,99	0,25	,620
		HF	9,47	4,09		
	SES				2,06	,159

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For girls the ANCOVA showed no significant effects for neither of factors nor the covariate. Although descriptively girls with a low cardiovascular fitness showed a higher level in depression scores, the analysis showed no significant effect ($F(1, 123) = 6,25$, $p = ,014$). For boys ANCOVA showed no significant effects either of the covariate SES or of fitness factors (cardiorespiratory fitness or strength).

Anxiety I

For Anxiety in younger participants, girls did not differ from boys ($M_{female} = 6,71$, $SD = 3,68$; $M_{male} = 6,97$, $SD = 3,71$; $t(462) = 0,75$, $p = ,453$). Data was therefore collapsed across gender. The ANCOVA presented in table 2 showed a significant effect for the factor strength ($F(1, 458) = 7,74$, $p = ,006$), indicating higher scores for anxiety in the LF group. For cardiorespiratory fitness, as well as the covariate SES, no effects were found.

Table 2. Results for cardiorespiratory fitness (CRF), physical strength, Body Mass Index (BMI) and the covariate SES with Anxiety in younger adolescents.

		Anxiety I		ANCOVA	
		M	*SD*	*F*(1, 458)	*p*
CRF	LF	6,89	4,00	0,31	,581
	HF	6,82	3,62		
Strength	LF	7,63	3,62	7,74	,006
	HF	6,55	3,68		
BMI	LF	7,04	4,24	0	,971
	HF	6,79	3,58		
SES				2,09	,149
Gender	Female	6,71	3,68	1,03	,310
	Male	6,97	3,71		

Anxiety II

As scores in anxiety in older adolescents were significant higher in females than in males ($M_{female} = 13,00$, $SD = 9,60$; $M_{male} = 7,41$, $SD = 7,43$; $t(41) = 2,03$, $p = ,049$), separate analyses were conducted (see table 3). For girls ANCOVA showed no significant effects either of the covariate SES or of fitness (cardiorespiratory fitness or strength). For boys the factor strength showed a significant effect indicating higher scores for anxiety in the LF group ($F(1, 13) = 13,54$, $p = ,003$). For cardiorespiratory fitness, as well as the covariate SES, no effects were found.

Table 3. Results for cardiorespiratory fitness (CRF), physical strength, Body Mass Index (BMI) and the covariate SES with Anxiety in older adolescents.

			Anxiety II		ANCOVA	
			M	*SD*	*F*(1, 21)	*p*
Females	**CRF**	LF	15,62	10,74	1,97	,175
		HF	10,38	7,86		
	Strength	LF	12,92	9,03	0,00	,999
		HF	13,08	10,50		
	BMI	LF	15,80	9,60	0,58	,455
		HF	12,33	9,71		
	SES				2,82	,108
					F(1, 12)	*p*
Males	**CRF**	LF	7,36	5,66	0,19	,669
		HF	7,50	10,60		
	Strength	LF	15,40	8,29	13,54	,003
		HF	4,08	3,75		
	BMI	LF	7,67	7,51	1,56	,236
		HF	7,36	7,69		
	SES				0,00	,962

Hyperactivity-Inattention

The results in Table 4 showed for Hyperactivity-Inattention that girls did not differ from boys ($M_{female} = 2,93$, $SD = 1,41$; $M_{male} = 2,76$, $SD = 1,61$; $t(379) = 1,09$, $p = ,275$). Data was therefore collapsed across gender.

Table 4. Results for cardiorespiratory fitness (CRF), physical strength, Body Mass Index (BMI) and the covariate SES with Hyperactivity-Inattention (ADHD).

		ADHD		ANCOVA	
		M	*SD*	*F*(1, 375)	*p*
CRF	LF	2,73	1,45	1,10	,294
	HF	2,89	1,52		
Strength	LF	3,14	1,53	6,90	,009
	HF	2,75	1,48		
BMI	LF	2,70	1,52	1,12	,292
	HF	2,88	1,50		
SES				0,00	,987
Gender	Female	2,93	1,41	0,30	,587
	Male	2,76	1,61		

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The ANCOVA showed a significant effect for the factor strength ($F(1, 375) = 6{,}90$, $p = {,}009$) indicating higher scores in hyperactivity-inattention for the LF group. For cardiorespiratory fitness, as well as the covariate SES, no effects were found.

DISCUSSION

The present study assessed various markers of physical fitness (cardiorespiratory fitness, strength and body composition) to investigate its possible connection to depression, anxiety and hyperactivity-inattention in German adolescents. Results indicated connections between lower levels of physical strength with higher levels of anxiety and hyperactivity-inattention in both, males as well as in females. For depression, no significant effect was found. However, it seems to be noteworthy, that for females connections between cardiorespiratory fitness and depression only slightly failed significance. A hypothesized connection between hyperactivity-inattention and body composition could not be verified.

Regarding depression in adolescents, the present study could not find any significant effect in its connection to fitness. In detail, an expected association to cardiorespiratory fitness failed significance. In comparison to previous findings (e.g. Aberg et al., 2012; Greenleaf et al., 2010), the present study was not able to replicate these effect in German adolescents. Similar with general findings on depression the present sample showed differences between the genders. However, a connection between depression and the socio economic status also failed statistical significance. Possible reasons might be grounded in a general high socioeconomic status and low rates of adolescents with poor cardiorespiratory fitness in the present sample. Another considerable aspect that depressive syndromes are only evolving in adolescents. According to data from the German population, the onset of anxiety disorders is slightly earlier compared to depressive disorders (Jacobi et al., 2004). Thus, the range of presented symptoms in this young sample could be small for depressive symptoms and therefore effects cannot be observed. However, as this study was not conducted and therefore is not able to provide arguments against the possible connection between cardiorespiratory fitness and depression further research on this matter is needed.

Regarding anxiety in adolescents, the present results indicate connections between the fitness component strength and higher levels of anxiety. Interestingly, only strength was associated with anxiety whereas neither cardiorespiratory fitness nor body composition showed such effect. Based on previous research, strength was not highlighted as important fitness component for its relation to mental health. Results regarding fitness were mostly based on effects with cardiorespiratory fitness (Aberg et al., 2012; Shomaker et al., 2012). Thus, these findings might lead to forthcoming research to consider strength as a factor in relation to anxiety. Moreover, strength could also be considered for other mental health aspects as the present study indicated associations between strength and ADHD. Therefore, high levels in strength were associated with low levels in ADHD. This was surprising as the hypothesized connection between ADHD and BMI as previously found by Cortese and colleagues in different studies (Cortese et al., 2008; Cortese & Vincenzi, 2011) could not be supported by the data. However, as strength was an important factor for adolescent's mental health and especially male adolescents showed this connection in the present sample further considerations in this regard might be useful.

Whereas the relation between PA and mental health has been established, underlying mechanisms are hardly known. Lubans et al. (2016) pointed that there is potential hypothesis on neurobiological, psychosocial and behavioural mechanisms but evidence is rather scarce. They further argue however, that "participation in physical activity can improve physical self-perceptions and enhance self-esteem in young people" (p.10, Lubans et al., 2016). Strength can be considered an important physical component for physical self-pereption, especially in male adolescents. The attributes of imposing body composition and physical strength can be important to the identity of a young male role and gain even importance in regards to the domain of sport and physical education (Klomsten, Marsh, & Skaalvik, 2005). Thus, fulfilling this role expectation could bear some possible positive consequences, such as positive reinforcements, higher self-efficacy and positive self-esteem (Spence, Helmreich, & Stapp, 1975). These positive associations are also vital for mental health and research has already shown that for

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example self-esteem is connected to physical fitness (Biddle & Asare, 2011; Greenleaf et al., 2010) and physical activity can improve physical self-perceptions (Dale, Vanderloo, Moore, & Faulkner, 2019). Therefore, physically strong males could have higher confidence in their own abilities as well as a higher confidence regarding coping with and handling adversity. Thus, it seems likely that less experiences of anxiety are associated with strength in young males. However, there is certainly more research needed in order to first replicate this finding and further test this assumption on how these factors are connected or mediated.

Limitations

The present study is cross-sectional and therefor only provides insights into the existing associations between physical fitness and psychological measures. Causal relations should therefore further investigated by appropriate designs. In order to account for the relatively young age for assessing psychological variables, we decided to split samples according to age recommendations for the applied measurements. This however resulted in differences for the subsample in age and sample size. Thus, comparison of the results should be treated with caution and sample size should be considered for every results. Especially results for the relatively small sample tested with the BAI (n = 47) have to be interpreted with care. However, in order to enhance overall knowledge we decided to report these findings. Nevertheless, future research should first replicate and further explore these findings.

CONCLUSIONS

Summarizing the present results, fitness components were associated with mental health aspects, even in a relatively young sample of adolescents. Especially strength, which was associated with anxiety and ADHD, supported the expected association. However, hypothesized connections between mental health and cardiorespiratory fitness as well as between mental health and body composition have not been supported by the study. Besides the effect regarding the fitness component strength, it seems noteworthy that the present study focused on young adolescents. Therefore, the found effect indicates a relatively early connection between psychological and physical aspects. Thus, focusing on youths regarding physical intervention programs seems promising. Anti-depressive effects of exercise, for example, are promising for clinical samples and there are many studies to be found on this matter (Cooney et al., 2013; Krogh et al., 2011; Schuch et al., 2016). However, prevention in an early stage of development of clinical disorders would be beneficial. Thus, research might focus on early associations in general populations as well and further research is urgently needed in order to replicate findings in youth adolescents and to further analyze mechanisms between fitness and mental health. In this regard, monitoring over longer periods of time of early associations between fitness and mental health in growing adolescents could bare useful information and could be addressed in future research.

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