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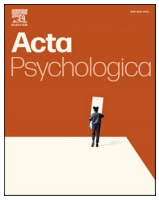

Do physical activity and virtues predict school grades?

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ABSTRACT

Many factors predict adolescents' school grades, two of which may be character strengths and physical activity. We investigated 339 adolescents (130 boys, 185 girls, two diverse, 22 missing data) between 10 and 21 years old (M = 14.92, SD = 2.28). They filled out questionnaires regarding their character strengths, extracurricular physical activity, math, language, and sports grades. The 24 character strengths were summarized into the virtues of wisdom, courage, humanity, justice, temperance, and transcendence. Math grades were positively predicted by the virtues of courage and temperance and negatively by age and justice. Girls and younger pupils reported better language grades. Sports grades were predicted by extracurricular physical activity and courage. Better sports grades were found in pupils who were members of a sports club and practiced their sports longer. In particular, courage, which consists of bravery, perseverance, honesty, and zest, is an essential predictor of adolescents' math and sports grades.

1. Introduction

Many factors are essential for success in school performance, such as cognitive factors like intelligence or working memory capacity. In terms of school success, often measured as test performance or school grade and termed achievement, it can be assumed that there is a prediction of intelligence on school achievement (Kriegbaum et al., 2018) - but this is only moderately pronounced. Spinath et al. (2006) showed that general intelligence and motivation are linked to school performance. In addition, area- or subject-specific self-perception plays a decisive role (Steinmayr & Spinath, 2009). In addition to intelligence, working memory capacity is a crucial factor. Even four to six-year-olds with a high working memory capacity achieve better school performance in all areas later on (Mähler et al., 2015). The researchers conclude that by assessing working memory capacity, phonological and numerical skills, socioeconomic status, and migration background in four-year-old children, 34 % of reading, 52 % of spelling, and 35 % of math performance can be predicted by the end of the first grade. Working memory improves academic performance by influencing reasoning and divergent thinking (creating unfamiliar possibilities) (Vock et al., 2011).

Next to those cognitive factors, one's gender seemed to be essential. In an analysis of all scientific studies on gender differences in school performance, a small but significant advantage was found for girls over boys when school success was measured in grades (Voyer & Voyer, 2014). This advantage was high for language subjects and lower for mathematics. Variables that influenced this result were the source of the assessment, nationality, ethnic composition, and gender composition of the sample. Incidentally, this result is not influenced by the year of publication. Stereotypes, i.e., generalizations about a group of people that can also be transferred to children, are assumed to be the reason for the better performance of girls. Research has shown that gender-relevant stereotypes about school performance are already evident in elementary schools (Hartley & Sutton, 2013).

Besides the aspects mentioned above, there are many other variables; in fact, Hattie (2008) mentioned 138 factors that are related to the school's performance, such as, for example, socioeconomic status (Langensee et al., 2024), motivation (Steinmayr et al., 2019), and the personality of the teacher (Hattie, 2008). Because socioeconomic status and the teacher's personality cannot be changed, it seemed worth investigating those factors that lie in the pupil. Relevant factors appeared to be physical activity and personality or character strengths or virtues:

It is well-known that physical activity and cognitive performance are related (Bidzan-Bluma & Lipowska, 2018), even though there is a lack of publications investigating which type of physical activity at which duration and frequency are related to which cognitive functions. Some reviews suggest that combat sports are related to visual-spatial abilities (Voyer & Jansen, 2017) and aerobic exercise to executive functions

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(Best, 2010). In a systematic review of studies on the relationship between physical activity and academic performance in children (Bidzan-Bluma & Lipowska, 2018), it was demonstrated that there is an association between physical activity and academic performance in school-aged children (63 % non-disabled, 37 % disabled) that was primarily positive or nonsignificant. If the physical activity was 90 min or longer and the intensity was moderate or vigorous, there was an improved academic performance. This effect holds for several types of sports. Next, studies demonstrate that adding physical activity to the school day may enhance children's mathematics performance or have at least no adverse effects on performance (Sneck et al., 2019). Furthermore, longitudinal change in fitness from grade six to nine predicted the grade in mathematics at grade nine (Sember et al., 2022). Furthermore, there was a statistically significant positive correlation between fitness and standardized test scores in Language Arts and Math and a statistically significant negative relationship with school absences in a study with school children in grades three to eight (Blom et al., 2011).

The second relevant factor for school success might be personality or character strengths. Considering the Big Five personality traits, a meta-analysis found that conscientiousness and openness were strongly correlated with academic performance (Poropat, 2014). In high school students, the total grade is positively related to cognitive abilities, agreeableness, conscientiousness, and openness (Heaven & Ciarrochi, 2012). A study with eighth graders showed that self-discipline could better explain final grades than IQ (Duckworth & Seligman, 2005).

Character strengths can be seen as values in action (Park & Peterson, 2006). Character strengths are defined as "…positive traits reflected in thoughts, feelings, and behaviours "(Park et al., 2004, p. 603). Twenty-four character strengths can be classified into the following six virtues: Wisdom (e.g., creativity), courage (e.g., honesty), humanity (e.g., kindness), justice (e.g., fairness), temperance (e.g., forgiveness), and transcendence (e.g., hope). The strengths differ among individuals, and the most positive strength in an individual can be termed signature strength (Peterson & Seligman, 2004). A meta-analysis has demonstrated that character strength interventions can improve several outcomes, for example, positive affect or happiness or a decrease in depression (Schutte & Malouff, 2019).

One study investigated the relevance of character strengths at school regarding satisfaction with school experiences, academic self-efficacy, positive classroom behavior, and school grades (Weber & Ruch, 2012). This study operationalized school success by an average score in German and mathematics grades. It was shown that higher scores in mind-related character strengths (prudence, self-regulation, perseverance, and love of learning) were related to higher school success in the middle and the end of the year. Furthermore, the results hint that the relation of classroom-relevant character strengths (love of learning, prudence, and perseverance) on school success was meditated through positive classroom behavior, such as the fact that the child is motivated to perform. These character strengths can predict educational outcomes beyond other personality traits or cognitive abilities mentioned above (Wagner et al., 2020).

Two studies by Wagner and Ruch (2015) showed that character strengths positively affected children's school achievement. Love of learning, perspective, perseverance, zest, prudence, gratitude, and hope were positively correlated to the overall school achievement in fifth and sixth graders (Study 1) and seventh to ninth graders (Study 2). In these studies, school achievement was operationalized by teacher ratings for the younger sample in Study 1 and by an average score of all grades in the older pupils in Study 2. Another study with 10- to 17-year-old children and adolescents confirmed these results, except that zest did not affect school achievement (Weber & Harzer, 2022). In this study, school satisfaction was a significant mediator between some character strengths (e.g., bravery, prudence, teamwork) and school achievement. Shoshani and Slone (2013) allocated the 24-character strengths to four factors: temperance, intellectual, transcendence, and interpersonal strengths. Their study investigating middle school children showed that temperance (e.g., prudence, self-regulation) and intellectual strengths (e.g., love of learning, creativity) were associated with school achievement measured by an average of grades.

The studies above focused on school achievement as teacher ratings or average grades. The study presented here aims to individually identify character strengths associated with grades in math, language, or sports. Furthermore, the relationship between physical activity and grades will be investigated.

1.1. Hypotheses

1. Physical activity is assumed to predict children's and adolescents' math and sports grades. However, the relation between physical activity and language grades must be investigated exploratorily.
2. According to the studies by Wagner and Ruch (2015), Weber and Ruch (2012), and Weber and Harzer (2022), the virtues of temperance (including the character strengths of prudence and self-regulation), wisdom (with the character strength of love of learning), and courage (with the character strength of perseverance) are assumed to predict school grades.

Because of the well-known gender differences in grades (Voyer & Voyer, 2014), gender will be considered another predictor, as will age, because grades worsen (Hodis et al., 2011; Weber & Harzer, 2022).

2. Methods

2.1. Participants

The participants were 339 adolescents (130 boys, 185 girls, two diverse, 22 missing data) between 10 and 21 years old ($M = 14.92$, $SD = 2.28$) recruited in five different schools. For the calculations, we excluded participants who failed to report their age, gender, grade, or club sports (yes/no). The final sample included 215 students between 10 and 20 years old ($M = 14.73$, $SD = 2.25$; 93 boys and 122 girls). Table 1 gives an overview of the demographic data.

A G*Power (Faul et al., 2007) analysis for the regression analysis (fixed model, R^2, deviation from zero, with a small to medium effect size of $f^2 = 0.1$ ($\alpha = 0.0167$ (Bonferroni corrected), $1 - \beta = 0.80$, ten predictors) revealed a total sample size of 215 participants.

2.2. Material

2.2.1. Character strength

We used the German version of the Character Strengths Questionnaire VIA-Youth-96 (Park & Peterson, 2006). It consists of 96 items to measure the 24 character strengths. Each item is answered on a 5-point answering scale ranging from 1 = *does not apply at all* to 5 = *fully applies*. Each character strength is measured with four items; three to five strengths are summarized as a virtue. Because the reliabilities of the single character strengths were low, we investigated the virtues: The virtue of wisdom contains creativity, curiosity, judgment, love of learning, and perspective; courage is summarized as bravery, perseverance, honesty, and zest, and the virtue of humanity consists of love,

Table 1
Demographic data.

Age	*N*	Gender (in %)		Sports club (% yes)	Years sports	Sports per week (h)	Team sport (% Individual sport)
		males	females				
10–11	29	55.2	44.8	93.1	3.79	3.48	37.9
12–13	28	32.1	67.9	100.0	5.32	3.93	25.0
14–15	82	47.6	52.4	81.7	6.57	4.80	46.3
16–17	53	43.4	56.6	69.8	7.05	4.89	58.5
18–20	23	26.1	73.9	69.6	8.22	7.61	56.5

kindness, and social intelligence. The virtue of justice contains teamwork, fairness, and leadership; temperance includes forgiveness, humility, prudence, and self-regulation, and transcendence is summarized as appreciation of beauty & excellence, gratitude, hope, humor, and spirituality. Internal consistencies for the six virtues were acceptable or good: wisdom (Cronbach's alpha = 0.85), courage (Cronbach's alpha = 0.82), humanity (Cronbach's alpha = 0.80), justice (Cronbach's alpha = 0.71), temperance (Cronbach's alpha = 0.75), and transcendence (Cronbach's alpha = 0.83). We computed mean scores for the six virtues.

2.2.2. Demographic questionnaire

We asked the children and adolescents about their age (in years), gender (male, female, diverse), and last grades in mathematics, language (German), and sports. Grades were collected using a scale from 0 (worst grade) to 15 (best grade) for all age groups. All grades were from pupils' latest school report cards, given about three months before the data collection.

Furthermore, they answered questions about their sports behavior (club sport (yes/no), kind of sport, years of sport, and hours per week).

2.3. Procedure

This study investigated children and adolescents in secondary education in German public schools. In Germany, that refers to grades 5 to 13. Pupils are usually between 10 and 19 years old. They could be older if they started school later or stayed in school longer. After parents of children under 14 and adolescents above 14 gave informed consent, all participants filled out the questionnaires in the classes. It consisted of the VIA-Youth-96 (Park & Peterson, 2006) and questions about their gender, age, grades, and sports behavior. One parent of each child under 14 and all adolescents above 14 gave their written informed consent. Students were included in the study if written informed consent was given. The study was conducted according to the ethical guidelines of the Helsinki Declaration and was also approved by the University's Ethic Research Board (no. 22-3059_1-101).

2.4. Statistical analyses

Three regression analyses using the Enter method were calculated for each grade (math, language, sports) with the possible ten predictors of the six virtues, age, gender, sports club (yes/no), and years of sports.

3. Results

Table 2 provides descriptive statistics for grades and character strengths by age group.

3.1. Math grades

The regression analysis using the Enter method for the criterion math was significant, $F(10, 204) = 5.73, p < .001$. The R^2 for the overall model was 0.22 (adjusted $R^2 = 0.18$), indicative of a moderate to high goodness-of-fit according to Cohen (1988). Significant positive predictors were courage and temperance, whereas age and justice negatively predicted math grades (Table 3).

3.2. Language grades

The regression analysis using the Enter method for the criterion language was significant, $F(10, 204) = 4.23, p < .001$. The R^2 for the overall model was 0.17 (adjusted $R^2 = 0.13$), indicative of a moderate goodness-of-fit according to Cohen (1988). A significant negative predictor was age, and a significant positive predictor was gender, indicative that girls had better grades (Table 4).

3.3. Sports grades

The regression analysis using the Enter method for the criterion sports was significant, $F(10, 198) = 4.08, p < .001$. The R^2 for the overall model was 0.17 (adjusted $R^2 = 0.13$), indicative of a moderate - high goodness-of-fit according to Cohen (1988). Significant positive predictors were courage and sports in years, whereas sports clubs (yes/no) negatively predicted the sports grade. This means that children and youth who joined a sports club had better grades in sports (Table 5).

4. Discussion

The results only partly confirmed our hypotheses: Courage and temperance positively predicted math grades but not language grades. Justice and age had a negative influence on math grades. Language grades were also negatively predicted by age, and girls had better grades than boys. Better sports grades were found in participants who showed a higher level of physical activity, measured by the years of practice and attendance to sports clubs. This aligns with our first hypotheses; however, no such effect could be found concerning math grades.

Courage, which consists of bravery, perseverance, honesty, and zest, was the strongest predictor of adolescents' math grades. This aligns with other studies (Wagner & Ruch, 2015; Weber & Harzer, 2022) showing that perseverance, honesty, and zest were positively associated with adolescents' overall school achievement (Wagner & Ruch, 2015). Weber and Harzer (2022) also found positive relationships between school achievement and bravery, which were mediated by school satisfaction and academic self-efficacy. Our results also align with the literature as courage is negatively correlated with social and general anxiety (Abdollahi et al., 2022; Muris et al., 2010) on the one hand, and on the other hand, anxiety is negatively correlated with math grades (Barroso et al., 2021). The concept of character strengths has overlapping aspects with personality traits (e.g., the traits of the Big Five concept), and even the concepts can be seen as unique (Harzer, 2020). Especially, courage positively correlates with extraversion, conscientiousness, and openness/intellect (Muris et al., 2010), and these personality traits are related to adolescents' grades (Caprara et al., 2011; Laidra et al., 2007). That hints that persistent, sincere, and enthusiastic adolescents are doing well in math.

Table 2
Descriptive statistics for the grades and the character strengths by age groups.

	Age group				
	10–11	12–13	14–15	16–17	18–20
Math grade	10.79 (2.77)	10.36 (3.09)	8.91 (2.89)	7.74 (3.90)	8.30 (3.52)
Language grade	9.66 (1.90)	9.71 (3.21)	9.39 (2.72)	8.64 (2.68)	8.57 (2.61)
Sports grade	12.39 (2.23)	11.86 (1.98)	12.09 (2.25)	10.90 (2.87)	12.14 (2.78)
Wisdom	3.52 (0.62)	3.57 (0.74)	3.40 (0.49)	3.61 (0.42)	3.46 (0.51)
Courage	3.77 (0.59)	3.67 (0.67)	3.55 (0.48)	3.40 (0.53)	3.42 (0.52)
Humanity	4.01 (0.52)	3.97 (0.64)	3.93 (0.56)	3.91 (0.70)	4.02 (0.45)
Justice	3.53 (0.56)	3.66 (0.56)	3.43 (0.50)	3.50 (0.50)	3.57 (0.50)
Temperance	3.15 (0.91)	3.43 (0.80)	3.17 (0.78)	3.33 (0.70)	3.01 (0.84)
Transcendence	3.80 (0.40)	3.84 (0.60)	3.69 (0.54)	3.65 (0.59)	3.52 (0.38)

Table 3
Regression analysis of the math grade.

	b	*SE(b)*	*beta*	*t*	*p*	95 % CI(*b*)	
						LL	UL
(constant)	10.722	2.446		4.383	<0.001	5.899	15.546
Gender	0.208	0.443	0.031	0.471	0.638	−0.664	1.081
Age	−0.363	0.114	−0.241	−3.192	0.002	−0.586	−0.139
Club sport	−0.414	0.627	−0.048	−0.661	0.510	−1.651	0.822
Years of sports	0.020	0.063	0.022	0.311	0.756	−0.105	0.144
Wisdom	1.035	0.578	0.164	1.791	0.075	−0.104	2.175
Courage	1.771	0.600	0.287	2.950	0.004	0.587	2.955
Humanity	−0.222	0.548	−0.038	−0.405	0.686	−1.302	0.859
Justice	−1.148	0.570	−0.176	−2.014	0.045	−2.272	−0.024
Temperance	0.812	0.289	0.189	2.808	0.005	0.242	1.383
Transcendence	−1.067	0.562	−0.168	−1.901	0.059	−2.175	0.040

Note. LL: lower level, UL: upper level.

Table 4
Regression analysis of the language grade.

	b	*SE(b)*	*beta*	*t*	*p*	95 % CI(*b*)	
						LL	UL
(constant)	6.172	1.996		3.091	0.002	2.235	10.108
Gender	1.296	0.361	0.240	3.587	<0.001	0.583	2.008
Age	−0.235	0.093	−0.197	−2.533	0.012	−0.418	−0.052
Club sport	0.232	0.512	0.034	0.454	0.650	−0.777	1.241
Years of sports	0.033	0.051	0.048	0.640	0.523	−0.069	0.134
Wisdom	0.850	0.472	0.170	1.802	0.073	−0.080	1.780
Courage	0.358	0.490	0.073	0.730	0.466	−0.609	1.324
Humanity	−0.392	0.447	−0.086	−0.876	0.382	−1.273	0.490
Justice	0.759	0.465	0.147	1.632	0.104	−0.158	1.677
Temperance	0.021	0.236	0.006	0.087	0.930	−0.445	0.486
Transcendence	−0.392	0.458	−0.078	−0.856	0.393	−1.296	0.511

Note. LL: lower level, UL: upper level.

Table 5
Regression analysis of the sports grade.

	b	*SE(b)*	*beta*	*t*	*p*	95 % CI(*b*)	
						LL	UL
(constant)	11.510	1.876		6.137	<0.001	7.811	15.208
Gender	−0.647	0.337	−0.130	−1.920	0.056	−1.312	0.018
Age	−0.083	0.087	−0.076	−0.955	0.341	−0.256	0.089
Club sport	−1.313	0.481	−0.207	−2.732	0.007	−2.262	−0.365
Years of sports	0.113	0.048	0.176	2.333	0.021	0.017	0.208
Wisdom	−0.225	0.443	−0.049	−0.509	0.611	−1.098	0.648
Courage	0.919	0.457	0.204	2.010	0.046	0.017	1.821
Humanity	−0.039	0.417	−0.009	−0.093	0.926	−0.861	0.783
Justice	0.427	0.438	0.089	0.975	0.331	−0.436	1.290
Temperance	−0.018	0.220	−0.006	−0.081	0.935	−0.452	0.416
Transcendence	−0.100	0.440	−0.021	−0.227	0.821	−0.968	0.768

Note. LL: lower level, UL: upper level.

Temperance, which consists of forgiveness, humility, prudence, and self-regulation, was also a positive predictor of math grades. This is partly in line with a study showing positive correlations between school achievement, prudence, and self-regulation (Wagner & Ruch, 2015). Moreover, Weber and Harzer (2022) showed that forgiveness, prudence, and self-regulation were positively related to school achievement. This relation was mediated by self-efficacy. Cleary and Chen (2009) found better math grades in adolescents who exhibited more remarkable use of self-regulation strategies. For mathematics, it seems evident that people who treat problems with care and caution are successful.

Justice, which contains the character strengths of teamwork, fairness, and leadership, was negatively correlated with the math grade. On the contrary, Wagner and Ruch (2015) found positive relationships between overall school grades and teamwork and leadership. Weber and Harzer (2022) also showed that teamwork, fairness, and leadership were all positively related to adolescents' school achievement. This relationship was mediated by academic self-efficacy. However, other studies have demonstrated that the aspect of extraversion with its facets, e.g., sociability, assertiveness, or activity, is closely related to teamwork and leadership on the one side (Bono & Judge, 2004) and negatively to math grades (Furnham & Monsen, 2009). Furthermore, a study with undergraduate students showed introverts outperformed extroverts in statistics examination grades (Furnham & Chamorro-Premuzic, 2004).

The fact that math grades declined with age can be explained by decreasing motivation for math during adolescence (Gottfried et al., 2001). Many studies show that academic achievement and motivation are closely related (Fortier et al., 1995; Steinmayr & Spinath, 2009). The missing assumed effect of physical activity on math grades might be due to the measurement of physical activity that was only retrieved with participation in a sports club and years of extracurricular sports

activation. Those measurements should be improved in further studies using more fine-grained physical activity questionnaires or athletic performance measurements.

The language grade in our study was significantly predicted by age and gender, indicating better grades for younger and female students. Character strengths had no significant influence on adolescents' language grades. Grades declined with age, which can be explained by decreasing reading motivation during adolescence (Gottfried et al., 2001). Gender differences in favor of girls in language (Steinmayr & Spinath, 2008; Voyer & Voyer, 2014) and reading are also consistently reported. Girls perform better in language subjects at seven, eleven, and sixteen (Oakley et al., 2024). Although character strengths are not related to language grades, it has been shown that the personality traits of openness and extraversion show a more pronounced relationship to the German language subject than to the math subject (Brandt et al., 2020). The personal trait of openness, for example, includes, among others, the aspects of (intellectual) curiosity and creativity, which are also character strengths (Brandt et al., 2020). However, in this study here, we did not compare the relationship between character strengths and their different impact.

It is not astonishing that sports participation predicts sports grades, measured by the number of years practicing sports and participating in a sports club. The more you train, the better you get. However, courage also predicts sports grades. As mentioned above, courage consists of bravery, perseverance, honesty, and zest. Perseverance is related to the personal trait of conscientiousness, and the character strength of zest is associated with the personal trait of extraversion (Peterson & Seligman, 2004). Both personal traits might also be relevant in the context of sports. For example, athletes participating in international competitions demonstrate more conscientiousness (Allen et al., 2011). Conscientiousness and extraversion are the two prominent personalities in team sports (Shui et al., 2023). The authors conclude that the value of personality traits as a possible predictor is generally favorable.

A limitation to our study is that complexity or difficulty of the school subjects might have changed with the age of the participants. Older adolescents could have attended advanced courses particularly in math or language. This is not included in our assessment.

This study shows that the relationship between extracurricular sports activity and virtues, on the one hand, and school grades, on the other hand, depends on the subject of the school grade. Other studies mainly investigated how character strengths affect average grades. The virtue of courage is essential in mathematics and sports, whereas in language education, we did not find a relation to character strengths. The differentiation of the relevance of factors that lie in the pupil, such as physical activity and character strengths, concerning the performance in the different school subjects, is worth investigating in depth in further studies.

CRediT authorship contribution statement

Martina Rahe: Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Petra Jansen:** Writing – original draft, Methodology, Formal analysis, Conceptualization.

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Declaration of competing interest

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2025.104979.

Data availability

I have shared the data link

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