HEALTH PSYCHOLOGY AND BEHAVIORAL MEDICINE
2023, VOL. 11, NO. 1, 2278290
https://doi.org/10.1080/21642850.2023.2278290

Taylor & Francis
Taylor & Francis Group

Positive relationships of character strengths with fitness and physical activity in primary school children

Kensaku Sasayama[a], Tomoya Imura[b], Minoru Adachi[c], Tazuko Aoki[c] and Minglu Li[c]

[a]Faculty of Education, Mie University, Tsu, Japan; [b]Graduate School of Teacher Education, Saga University, Saga, Japan; [c]Graduate School of Education, Okayama University, Okayama, Japan

ABSTRACT

Objective: This study is the first to examine the relationship between character strengths, objective physical fitness, and physical activity in primary school children.

Design: This cross-sectional study was conducted in 2016 and 2017 at a school in Japan. Main Outcome Measures: We obtained informed consent from 236 fourth-grade students; 122 fifth-grade students; and 142 sixth-grade students. After excluding participants with missing data, 473 children (247 boys and 226 girls; aged 9–12 years) with informed consent were included in the study. We measured character strengths, physical fitness, and/or physical activity of fourth- to sixth-grade participants.

Results: Among boys, the total score of physical fitness was significantly associated with perseverance-honesty, courage-ideas, compassion-gratitude, and fairness-care ($p < 0.05$). Among girls, the total score of physical fitness was significantly associated with perseverance-honesty, courage-ideas, and compassion-gratitude ($p < 0.05$). Regarding the relationship between character strengths and physical activity, perseverance-honesty was significantly associated with total steps and moderate-to-vigorous physical activity (MVPA), whereas courage ideas were significantly associated with total steps ($p < 0.05$) in boys. In girls, perseverance-honesty was associated with MVPA ($p < 0.05$).

Conclusions: Our findings revealed that character strengths are positively associated with objective physical fitness and physical activity in primary-school children.

ARTICLE HISTORY
Received 6 April 2023
Accepted 25 October 2023

KEYWORDS
Character strengths; well-being; health behavior; accelerometer; fitness

Introduction

Positive psychology research has been gaining popularity in recent years which has emphasized the need to clarify individual, positive character strengths (Peterson & Seligman, 2004). Peterson and Seligman (2004) developing their Value in Action Inventory of Strengths (VIA-IS) and it was the first attempt to identify and classify positive

CONTACT Kensaku Sasayama sasayama@edu.mie-u.ac.jp Faculty of Education, Mie University, 1577, Kurima-machiya-cho, Tu, Mie, Tsu 514-8507, Japan

Supplemental data for this article can be accessed online at https://doi.org/10.1080/21642850.2023.2278290.

psychological traits of human beings. VIA-IS identified 6 classes of virtues underlying 24 distinct character strengths (Wisdom and Knowledge [creativity, curiosity, open-mindedness, love of learning, perspective]; Courage [bravery, persistence, integrity, vitality]; Humanity [love, kindness, social intelligence]; Justice [citizenship, fairness, leadership], Temperance [forgiveness and mercy, humility and modesty, prudence, self-regulation], and Transcendence [appreciation of beauty and excellence, gratitude, hope, humor, spirituality]).

In adults, previous studies reported that character strengths were positively associated with physical well-being (Proyer et al., 2013; Stuntz, 2017, 2019). Proyer et al. (2013), based on a health behavior model (Kubzansky et al., 2009; Vollrath et al., 1999), focused on the fact that personality indirectly affects health by influencing compliance with health behaviors in adults. Proyer et al. (2013) suggested that character strengths, as assessed by VIA, are related to preferred health behaviors. Indeed, Proyer et al. (2013) have reported that character strengths in adults may mediate health behaviors, such as pursuing sports to enhance physical fitness (PF). Stuntz (2017, 2019) also contended that character strengths in adults are positively associated with subjective physical activity (PA). Proyer et al. (2013) reported that among character strengths in adults, curiosity, zest, teamwork, leadership, self-regulation, and hope were positively associated with subjective PF (cardiorespiratory fitness and/or strength). These previous studies in adults suggest that character strengths are associated with high PA and PF.

Several reviews have reported that PA in children is positively associated with physical and mental aspects (Janssen & LeBlanc, 2010; Poitras et al., 2016). In addition, improved PF has been reported to have a positive effect on depression, anxiety, mood states, self-esteem, and academic performance as well as physical health (Ortega et al., 2008). Because children's PA and PF track into adulthood (Malina, 2001; Telama, 2009), it is important to promote PF and PA during childhood. If there is a positive association between character strengths and PF and PA, this could lead to intervention studies that increase character strengths or PF and PA.

The Values in Action Inventory for Youth (VIA-Youth) has been developed to measure character strengths in children and adolescents (Park & Peterson, 2005). However, to our knowledge, the relationship between character strengths, PF, and PA has not been examined in children. This may be due to difficulties in measuring PA and PF in children. Previous studies in adults (Proyer et al., 2013; Stuntz, 2017, 2019) regarding the relationship between character strengths, PA, and PF have subjectively measured PA and PF. Questionnaires assessing subjective PA have been confirmed to be reliable and valid for adults (Craig et al., 2003). However, recall methods, such as questionnaires, are challenging and less reliable for children than adults (Chinapaw et al., 2010; Sirard & Pate, 2001) as young children have often not developed the capacity for introspection; self-report, therefore has its limitations. Therefore, objective methods like accelerometry are widely used internationally to assess PA in children and adolescents (Brazendale et al., 2021; Cooper et al., 2015; Manyanga et al., 2020; Troiano et al., 2014). Accelerometers are worn across the waist and are simply operated; moreover, they objectively evaluate PA, and their validity has been confirmed (Evenson et al., 2008; Kumahara et al., 2004).

In addition, it may be important to examine the relationship between PA and character strengths, given that 'VIA' itself contains the word 'Action.' Piaget demonstrated

through his cognitive development theories that before the formal operational stage, children develop their cognition through sensory experiences, sports, and the operation of objects (Flavell, 1963). However, the concepts of 6 virtues are so abstract for children to understand because they do not have enough abilities of language. Therefore, we hypothesis that it might be possible for children to learn them not by reading stories but physical activities of everyday lives. If we would find the relation between character strengths and physical activities for young children, we will be able to develop ways to teach virtues for much younger children. Because children in primary schools are higher in PA than adults (Wolff-Hughes et al., 2014), it may be possible to teach character strengths to children who do not yet have the ability for abstract thought, through PA. Therefore, the purpose of this study was to examine the relationship between character strengths, objective PF, and PA in primary school children.

Materials and methods

Study design and setting

The Strengthening of the reporting of observational studies in epidemiology statement (STROBE) and STROBE checklist guided the reporting of our study (STROBE, 2023; see Supplementary material). This cross-sectional study was conducted in November 2016 and 2017 at a school in Kurashiki, Okayama Prefecture, Japan. We measured the character strengths, PF, and PA of the participants. Character strengths and PF were measured for fourth-to sixth-grade students in 2016. Due to the limited number of accelerometers, we selected only fourth graders, who were a large number of participants and were in the middle of the grades, to measure PA.

Participants

In order to target healthy and general primary school students, we obtained approval from one public primary school to conduct the study. We invite all children in grades fourth-six at a school and obtained informed consent from 236 (120 in 2016 and 116 in 2017) out of 303 (133 in 2016 and 170 in 2017) fourth-grade students (9–10 years old), 122 out of 123 fifth-grade students (10–11 years old), and 142 out of 151 sixth-grade students (11–12 years old). After excluding participants with missing data, 473 participants (247 boys and 226 girls) were included in the study.

Data collection procedures

Character strengths. In this study, we used the Character Strengths Scale for Children in Japan designed by Imura et al. (2013). The traditional VIA-Youth Scale has approximately 200 items (Park & Peterson, 2005), and is difficult to conduct at schools. Additionally, there are too many items to be answered by children respondents. To address these issues, Imura et al. (2013) developed the Character Strengths Scale for Children in Japan, which comprises only 24 items in four categories, reducing the burden of answering the scale. Imura et al. (2013) tested the validity of the Character Strengths Scale for Children in Japan using confirmatory factor analysis. The scale indicated a reasonable

model fit with the Goodness of Fit Index = .956, Adjusted Goodness of Fit Index = .943, and Root Mean Squared Error of Approximation = .047. The Cronbach's alpha coefficients of the subscales ranged from .77 to .83, which confirmed high internal consistency. Moreover, the Character Strengths Scale for Children in Japan was positively related to well-being (Imura et al., 2013), and demonstrated acceptable validity according to the nomination method (Imura & Aoki, 2014). The four categories of character strengths are similar to those in the VIA-Youth (Park & Peterson, 2006; Toner et al., 2012), and are as follows: perseverance-honesty, courage-ideas, compassion-gratitude, and fairness-care.

Perseverance-honesty entails perseverance (e.g. 'When I start a project, I always complete it') and honesty (e.g. 'I will be truthful even when others are not watching me'). Courage ideas comprise courage (e.g. 'I persist in what I believe is right') and ideas (e.g. 'When I do something, I would like to consider different solutions'). Compassion-gratitude refers to compassion (e.g. 'Even if my friend makes a mistake, I will forgive them') and gratitude (e.g. 'When I reflect on the past, I realize that there are so many things to be thankful for'). Finally, fairness-care (e.g. 'Even if I do not like someone, I will treat them fairly') and care (e.g. 'I am always careful not to hurt others' feelings') were measured. The responses were recorded on a 4-point Likert scale, with answers ranging from 1 ('strongly disagree') to 4 ('strongly agree').

PF. PF was assessed using the norms established by the National Statistical Survey on Physical Fitness and Motor Ability of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) in Japan (Ministry of Education, 1999). The test included the following eight items: hand grip (to assess muscle strength), sit-ups (abdominal strength and endurance), sit-and-reach (flexibility), side-to-side jump (agility), 20 m shuttle run (cardiorespiratory endurance), 50 m dash (speed), standing broad jump (explosive leg strength), and softball throwing (explosive arm strength and throwing ability). PF tests were conducted by school teachers according to the manual. In this study, according to the MEXT manual (Ministry of Education, 1999), hand grip, sit-and-reach, side-to-side jump, standing broad jump, and softball throwing were performed twice each, while sit-ups, 20 m shuttle run, and 50 m dash were performed once each. To exclude the effect of school grades, values of PF were calculated with a standardized score (T-score) using the national average (e-Stat, 2017) for the eight items. The total PF score was calculated as the average of the T-scores for the eight test items.

PA. In this study, to examine the relationship between character strengths and the volume and intensity of PA, total steps and moderate-to-vigorous physical activity (MVPA) were measured using a uniaxial accelerometer (Kenz Lifecorder EX [LC]; Suzuken Co. Ltd, Nagoya, Japan). Sasayama and Adachi (2020) reported that the activity level for MVPA is equivalent to a value of ≥5 as detected using LC. Therefore, the MVPA cut-off value was calculated based on previous study (Sasayama & Adachi, 2020). Participants wore the LC device on their waists for eight consecutive days, including two weekends and six weekdays. Based on previous studies (Mattocks et al., 2008), accelerometer data were collected for at least three weekdays. The valid wear time was a minimum of 600 min on weekdays. The non-wearing time was defined as a minimum of 60 min of 0 consecutive counts (Aadland et al., 2018).

Ethics statement

The procedure conformed to the principles of the Declaration of Helsinki (World Medical Association, 2013). This study was approved by the Institutional Review Board of the Okayama University of Science (approval No. 28-5). All participating children and their parents provided written informed consent prior to commencement of the study. The participants could revoke consent at any time.

Statistical analyses

Character strengths, PF, and PA variables were reported as mean ± SD. Between-grade differences were examined using one-way analysis of variance (ANOVA) for age, character strengths, and PF. Bonferroni-adjusted pairwise comparisons were performed for a statistically significant ANOVA ($p < 0.05$). The associations between character strengths and PF were analyzed using grade-adjusted partial correlation coefficients. Associations between character strengths and PA were analyzed using Pearson's correlation coefficients. Effect size of r values of 0.1, 0.3 and 0.5 represent small, medium, and large effects, respectively and Cohen's d values of 0.2, 0.5 and 0.8 represent small, medium, and large effects, respectively (Cohen, 2013). All analyses were performed using IBM SPSS Statistics software (version 24.0; IBM Japan, Ltd., Tokyo, Japan). The results were considered statistically significant at $p < 0.05$.

Results

Characteristics of participants

Table 1 presents participants' characteristics, ages, character strengths, PF, and PA scores. The PF of participants is shown Supplementary Table 1. Age ranges of the participants were 9–12 years. The average number of days and wear time of the accelerometer were 4.16 ± 0.78 (days), 12.17 ± 1.37 (hours) for boys and 4.30 ± 0.77 (days), 12.48 ± 1.36 (hours) for girls. Regarding the age of the boys, fourth grades were lower than fifth ($p < 0.01$, $d = 2.20$) and sixth ($p < 0.01$, $d = 4.00$) grades, and fifth grades were lower than sixth grades ($p < 0.01$, $d = 1.80$). Regarding the age of the girls, fourth grades were lower than fifth ($p < 0.01$, $d = 2.00$) and sixth ($p < 0.01$, $d = 4.27$) grades, and fifth grades were lower than sixth grades ($p < 0.01$, $d = 2.22$). In regard to character strengths, the fourth graders were higher than the fifth ($p = 0.04$, $d = 0.37$) and sixth ($p < 0.01$, $d = 0.80$) grades in perseverance-honesty for boys. Fifth grades were higher than sixth grades in compassion-gratitude ($p = 0.04$, $d = 0.40$). The fourth grades were higher than the fifth grades in courage-ideas for girls ($p = 0.04$, $d = 0.52$). In regards to PF, sixth grades were lower than fourth ($p = 0.03$, $d = 0.41$) and fifth ($p < 0.01$, $d = 0.61$) grades in sit-and-reach for boys. The sit-ups for girls were higher in the fifth grade than in the sixth grade ($p < 0.01$, $d = 0.58$). In sit and reach for girls, fifth grades were higher than fourth ($p < 0.01$, $d = 0.88$) and sixth ($p < 0.01$, $d = 1.10$) grades. Fifth grades were lower than fourth ($p < 0.01$, $d = 0.83$) and sixth ($p = 0.01$, $d = 1.24$) grades in the 20-meter shuttle run for girls. Total steps (steps/day) and MVPA (min/day) were 15,198.0 ± 3470.8 and 48.7 ± 15.3 for boys and 12,959.9 ± 2818.7 and 37.3 ± 12.5 for girls, respectively.

Table 1. Characteristics of participants.

	Boys ($n = 247$)						Girls ($n = 226$)					
	Fourth-grade ($n = 106$)		Fifth-grade ($n = 66$)		Sixth-grade ($n = 75$)		Fourth-grade ($n = 113$)		Fifth-grade ($n = 54$)		Sixth-grade ($n = 59$)	
Age	9.6	(0.5)[a]	10.7	(0.5)[c]	11.6	(0.5)	9.7	(0.5)[a]	10.7	(0.5)[c]	11.7	(0.4)
Character strengths												
Perseverance-honesty	3.4	(0.5)[a]	3.2	(0.6)	3.0	(0.5)	3.5	(0.4)	3.4	(0.4)	3.4	(0.5)
Courage-ideas	3.1	(0.6)	3.0	(0.7)	2.9	(0.6)	3.2	(0.5)[d]	2.9	(0.7)	3.1	(0.6)
Compassion-gratitude	3.3	(0.6)	3.4	(0.5)[c]	3.2	(0.5)	3.6	(0.4)	3.6	(0.4)	3.5	(0.4)
Fairness-care	3.0	(0.7)	3.0	(0.7)	2.9	(0.6)	3.3	(0.5)	3.1	(0.6)	3.2	(0.5)
Physical fitness												
Hand grip[1]	52.0	(8.6)	49.7	(7.0)	52.8	(11.4)	49.8	(8.2)	51.6	(9.5)	49.9	(9.1)
Sit-ups[1]	49.8	(9.5)	50.0	(8.5)	47.9	(8.5)	47.6	(10.2)	51.1	(12.7)[c]	45.1	(7.4)
Sit and reach[1]	49.4	(8.3)[b]	51.6	(9.5)[c]	45.9	(9.1)	48.6	(8.6)[d]	56.5	(9.6)[c]	46.6	(8.4)
Side-to-side jump[1]	53.0	(8.5)	50.9	(9.5)	49.8	(8.9)	53.1	(9.2)	50.0	(11.8)	49.9	(7.6)
20m shuttle run[1]	47.4	(8.6)	46.0	(9.0)	46.7	(9.0)	49.1	(8.5)[d]	42.0	(9.3)[c]	46.6	(6.2)
50m dash[1]	46.4	(16.6)	49.0	(9.1)	48.0	(10.3)	47.2	(8.8)	48.2	(12.5)	49.0	(9.3)
Standing broad jump[1]	50.4	(10.6)	49.9	(8.5)	49.9	(10.8)	49.5	(8.7)	49.4	(8.7)	49.1	(8.3)
Softball throwing[1]	48.3	(10.1)	48.1	(8.9)	48.9	(11.5)	51.8	(12.0)	49.9	(9.7)	51.6	(10.3)
Total score[2]	49.6	(7.0)	49.4	(6.0)	48.7	(7.3)	49.6	(6.3)	49.8	(7.0)	48.5	(5.8)
Physical activity												
Total steps (steps/day)	15198.0	(3470.8)	-	-	-	-	12959.9	(2818.7)	-	-	-	-
MVPA (min/day)	48.7	(15.3)	-	-	-	-	37.3	(12.5)	-	-	-	-

Notes: MVPA: moderate-to-vigorous physical activity; Values are means ± standard deviations; [1]T-score; [2]Total score was calculated as the average of the T-scores of the eight test physical fitness items; [a]Fourth-grade differ from fifth-grade and sixth grade ($p < 0.05$, one-way ANOVA tests; Bonferroni analyses); [b]Fourth-grade differs from sixth-grade ($p < 0.05$, one-way ANOVA tests; Bonferroni analyses); [c]Fifth-grade differs from sixth-grade ($p < 0.05$, one-way ANOVA tests; Bonferroni analyses); [d]Fourth-grade differs from fifth-grade ($p < 0.05$, one-way ANOVA tests; Bonferroni analyses).

Character strengths and PF

Table 2 shows the relationship between the character strengths and PF. For boys, the total score of PF was associated with perseverance-honesty ($r = 0.26$, $p < 0.05$), courage-ideas ($r = 0.24$, $p < 0.05$), compassion-gratitude ($r = 0.23$, $p < 0.05$) and fairness-care ($r = 0.20$, $p < 0.05$). Among girls, the total score of PF was associated with perseverance-honesty ($r = 0.17$, $p < 0.05$), courage-ideas ($r = 0.25$, $p < 0.05$) and compassion-gratitude ($r = 0.19$, $p < 0.05$). The relationship between character strengths and PF (Pearson correlation tests) is shown Supplementary Table 2.

Character strengths and PA

Table 3 shows the relationship between character strengths and PA. Among boys, perseverance-honesty was associated with total number of steps ($r = 0.26$, $p = 0.01$) and MVPA ($r = 0.21$, $p = 0.03$). In addition, courage-ideas were associated with the total number of steps ($r = 0.20$, $p = 0.04$). For girls, perseverance-honesty was associated with MVPA ($r = 0.19$, $p < 0.05$).

Discussion

To our knowledge, this study was the first to examine the relationship between character strengths, objective PF, and PA in primary school children. Among both boys and girls, character strengths were positively associated with total PF scores. Regarding the relationship between character strengths and PA, perseverance-honesty was associated with total steps and MVPA, and courage-ideas was associated with total steps in boys. In girls, perseverance-honesty was associated with MVPA. Our findings suggest that character strengths are positively associated with objective PF and PA among Japanese primary-school children.

While previous studies showed a positive association between character strengths and PF in adults (Proyer et al., 2013), our study demonstrated that character strength was also positively related to PF in children (Table 2). Overall, there were more associations between character strengths and PF in boys than girls. Moreover, there were positive links between character strengths and all PF items for boys. Among girls, character strengths was positively associated with PF, except for hand grip strength. Our results suggested that character strengths and PA are positively related for both boys and girls. While previous studies (Brdar & Kashdan, 2010; Gillham et al., 2011; Shoshani & Shwartz, 2018; Toner et al., 2012) indicate that children's character strengths are associated with mental well-being, our findings illustrate that character strengths are also associated with physical well-being. Furthermore, while no trend was observed among girls, character strengths was large related to cardiorespiratory fitness in boys compared to other PF categories. Our study suggests that there is a gender difference between character strengths and PF in children. The association between character strengths and PF may have been clearer for boys because PA was higher for boys than for girls (Wolff-Hughes et al., 2014).

Although character strengths showed a small correlation to PA than PF, PA and character strengths were related for both boys and girls (Table 3). In their study, Stuntz (2019) reported a correlation between character strengths in all 23 measured items and PA. In

Table 2. Relationship between character strengths and physical fitness.

	Hand grip[1]		Sit-ups[2]		Sit and reach[3]		Side-to-side jump[4]		20m shuttle run[5]		50m dash[6]		Standing broad jump[7]		Softball throwing[8]		Total score	
	r	*p* value	*R*	*p* value	*r*	*p* value	*r*	*p* value	*r*	*p* value	*r*	*p* value	*r*	*p* value	*r*	*p* value	*r*	*p* value
Boys ($n = 247$)																		
Perseverance-honesty	0.10	0.11	**0.19**	**0.00**	**0.14**	**0.03**	**0.24**	**0.00**	**0.23**	**0.00**	**0.26**	**0.00**	**0.15**	**0.02**	**0.13**	**0.05**	**0.26**	**0.00**
Courage-ideas	**0.18**	**0.00**	**0.18**	**0.00**	0.12	0.07	**0.19**	**0.00**	**0.27**	**0.00**	0.12	0.05	**0.14**	**0.03**	**0.16**	**0.01**	**0.24**	**0.00**
Compassion-gratitude	0.10	0.11	**0.15**	**0.02**	**0.23**	**0.00**	**0.17**	**0.01**	**0.22**	**0.00**	**0.13**	**0.04**	0.10	0.12	**0.19**	**0.00**	**0.23**	**0.00**
Fairness-care	0.09	0.16	**0.13**	**0.04**	**0.21**	**0.00**	**0.15**	**0.02**	**0.19**	**0.00**	0.09	0.17	**0.13**	**0.04**	**0.14**	**0.03**	**0.20**	**0.00**
Girls ($n = 226$)																		
Perseverance-honesty	0.00	0.98	0.11	0.09	0.09	0.17	0.12	0.06	**0.16**	**0.01**	**0.17**	**0.01**	**0.16**	**0.02**	0.07	0.27	**0.17**	**0.01**
Courage-ideas	0.05	0.44	**0.15**	**0.03**	0.01	0.92	**0.25**	**0.00**	**0.19**	**0.01**	**0.21**	**0.00**	**0.21**	**0.00**	**0.26**	**0.00**	**0.25**	**0.00**
Compassion-gratitude	0.08	0.26	**0.16**	**0.02**	**0.19**	**0.00**	0.12	0.07	0.11	0.09	0.12	0.08	**0.16**	**0.02**	0.09	0.18	**0.19**	**0.00**
Fairness-care	0.11	0.10	**0.15**	**0.03**	0.05	0.42	0.11	0.12	0.05	0.46	0.03	0.68	0.08	0.26	0.06	0.34	0.12	0.07

Notes: [1]muscle strength; [2]abdominal strength and endurance; [3]flexibility; [4]agility; [5]cardiorespiratory endurance; [6]speed; [7]explosive leg strength; [8]explosive arm strength and throwing ability; Analyses were adjusted for grade. Boldface indicates statistical significance for partial correlation tests ($p < 0.05$).

Table 3. Relationship between character strengths and physical activity.

	Total steps		MVPA	
	r	*p* value	*r*	*p* value
Boys ($n = 106$)				
Perseverance-honesty	**0.26**	**0.01**	**0.21**	**0.03**
Courage-ideas	**0.20**	**0.04**	0.16	0.10
Compassion-gratitude	0.13	0.20	0.07	0.48
Fairness-care	0.10	0.30	0.05	0.64
Girls ($n = 113$)				
Perseverance-honesty	0.17	0.07	**0.19**	**0.05**
Courage-ideas	0.13	0.16	0.11	0.26
Compassion-gratitude	0.15	0.12	0.16	0.08
Fairness-care	−0.02	0.81	0.00	0.99

Note: MVPA; moderate-to-vigorous physical activity; Boldface indicates statistical significance for Pearson correlation tests ($p < 0.05$).

addition, Stuntz (2017) contended that higher character strengths in resilience predicted positive exercise behavior. In our study, the character strengths of perseverance-honesty (both boys and girls) and courage-ideas (in boys) were associated with PA. Although they did not assess character strengths, Reed et al. (2013) reported that grit is a significant predictor of PA in adults. Grit is defined as perseverance of effort and passion for a long-term goal (Duckworth et al., 2007). In addition, Rutberg et al. (2020) reported that grit as perseverance in children may be a target for making PA interventions sustainable. Thus, character strength of perseverance-honesty may influence the continuation of PA in children. However, since our study had a cross-sectional design, caution should be exercised when interpreting the results. Although this study cannot address causality, our study suggests that high character strengths is associated with increased PF and PA. These results support the need for character strengths interventions in primary school education. Several studies have focused on character strength interventions among children (Lavy, 2020; Linkins et al., 2015). These interventions may not only enhance character strengths, but also increase children's physical well-being and PA. Thus, character strengths may promote favorable mental and physical development among children.

We measured PA during consecutive weekdays. High level of PA here might be explained as having the habit of exercising each day. Habits play a role in self-regulation without the intervention of motivation or metacognition (Fiorella, 2020). For example, people who have the habit of reading every day and those who do not will have different amounts of knowledge regardless of their awareness and motivation. Regarding personality, Ryan and Bohlin (1999) distinguish it from character, which is not a disposition one is born with, but something acquired by habit after birth. Across educational settings, there is little knowledge of the effects of habits on growth and development, and further research is needed (Fiorella, 2020).

This study had several limitations. First, the relationship between character strengths and PF could not be examined in younger grades (grades 1–3), and may vary across age groups. Second, although our study objectively measured PA, only the fourth grade participants underwent PA assessment. In addition, accelerometer may underestimate PA because they are not worn during swimming, bathing, or contact sports. Third, in this study, there are not examine the possible confounders (overweight/obesity, diet, sleep and socioeconomic status [e.g. parental education],) of the study association. Specifically, better diet quality has been reported to be associated with better PF (Bizzozero-Peroni

et al., 2022), and especially in children, also with PA (Arriscado et al., 2014). In addition, better body composition and sleep quality were associated with higher levels of PF (Fonseca et al., 2021; Ortega et al., 2008). Moreover, social inequality indicators, such as parent education level, could affect both exposure (character strengths) and outcomes (PF and PA) (Brazo Sayavera et al., 2023). Future studies should consider these confounding factors in the associations. In addition, it is necessary to analyze the influence of childhood traumatic events on character strengths and, therefore, their impact on PF and PA levels. Fourth, this is a cross-sectional study, and it is necessary to examine the relationship between character strength, PF, and PA longitudinally. This is because these variables may mutually influence each other. In fact, a literature review (Ortega et al., 2008) and meta-analyses (Buecker et al., 2020; Rodriguez-Ayllon et al., 2019) have suggested that PF and PA positively impact mental health (e.g. depression, anxiety, and self-esteem) as well as physical factors. Thus, PF or PA may be positively related to other health aspects in people, such as promoting personality development. Moreover, encouraging PA and PF may lead to increased character strengths. In our study, the relationship between character strengths, PF, and PA showed relatively small correlation. A longitudinal study is needed to determine the directionality of the relationship, and which variable exerts the greatest influence. Despite these limitations, this study provides a novel contribution to the literature by demonstrating the positive relationship between character strengths, objective PF, and PA among primary school children. Future studies are necessary to longitudinally examine this relationship, and to include younger children.

Conclusions and implications

This study showed that character strengths are positively associated with objective PF and PA among Japanese primary-school children. This finding suggested that higher character strengths, fitness and PA may improve the other factor, respectively. To clarify this, it is necessary to examine these relationships longitudinally.

Acknowledgements

We are thankful to the children and parents who participated in this study and the teachers for their support. Conceptualization and investigation: Kensaku Sasayama, Tomoya Imura, Minoru Adachi, and Tazuko Aoki; Writing – original draft preparation: Kensaku Sasayama, Tomoya Imura, and Minglu Li; Writing – review and editing: Minoru Adachi and Tazuko Aoki. All authors read and approved the final manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Suzuken Memorial Foundation under grant number 16–017; and the Japan Society for the Promotion of Science under Grant KAKENHI Grant-in-Aid for Scientific Research (B) Grant Number 20H01680.

Data availability statement

The data are available from the corresponding author upon reasonable request.

Institutional review board statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by an Institutional Review Board/Ethics committee. See details under Methods.

References

Aadland, E., Andersen, L. B., Anderssen, S. A., & Resaland, G. K. (2018). A comparison of 10 accelerometer non-wear time criteria and logbooks in children. *BMC Public Health*, *18*(1), 323. https://doi.org/10.1186/s12889-018-5212-4

Arriscado, D., Muros, J. J., Zabala, M., & Dalmau, J. M. (2014). Factors associated with low adherence to a Mediterranean diet in healthy children in northern Spain. *Appetite*, *80*, 28–34. https://doi.org/10.1016/j.appet.2014.04.027

Bizzozero-Peroni, B., Brazo-Sayavera, J., Martínez-Vizcaíno, V., Fernández-Rodríguez, R., López-Gil, J. F., Díaz-Goñi, V., Cavero-Redondo, I., & Mesas, A. E. (2022). High adherence to the Mediterranean diet is associated with higher physical fitness in adults: A systematic review and meta-analysis. *Advances in Nutrition*, *13*(6), 2195–2206. https://doi.org/10.1093/advances/nmac104

Brazendale, K., Beets, M. W., Armstrong, B., Weaver, R. G., Hunt, E. T., & Pate, R. R. (2021). Children's moderate-to-vigorous physical activity on weekdays versus weekend days: A multi-country analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 28. https://doi.org/10.1186/s12966-021-01095-x

Brazo Sayavera, J., Crochemore-Silva, I., Bizzozero Peroni, B., González-Gálvez, N., de Camargo, E. M., & López-Gil, J. F. (2023). Inequalities in the association between adherence to the Mediterranean diet and physical fitness in the young population during the COVID-19 lockdown. *Nutrición Hospitalaria*, 391–399. https://doi.org/10.20960/nh.04225

Brdar, I., & Kashdan, T. B. (2010). Character strengths and well-being in Croatia: An empirical investigation of structure and correlates. *Journal of Research in Personality*, *44*(1), 151–154. https://doi.org/10.1016/j.jrp.2009.12.001

Buecker, S., Simacek, T., Ingwersen, B., Terwiel, S., & Simonsmeier, B. A. (2020). Physical activity and subjective well-being in healthy individuals: A metaanalytic review. *Health Psychology Review*, 1–19. https://doi.org/10.1080/17437199.2020.1760728

Chinapaw, M. J., Mokkink, L. B., van Poppel, M. N., van Mechelen, W., & Terwee, C. B. (2010). Physical activity questionnaires for youth. *Sports Medicine*, *40*(7), 539–563. https://doi.org/10.2165/11530770-000000000-00000

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Academic press.

Cooper, A. R., Goodman, A., Page, A. S., Sherar, L. B., Esliger, D. W., van Sluijs, E. M., Andersen, L. B., Anderssen, S., Cardon, G., Davey, R., Froberg, K., Hallal, P., Janz, K. F., Kordas, K., Kreimler, S., Pate, R. R., Puder, J. J., Reilly, J. J., Salmon, J, … Ekelund, U. (2015). Objectively measured physical activity and sedentary time in youth: The International children's accelerometry database (ICAD). *International Journal of Behavioral Nutrition and Physical Activity*, *12*(12), 113. https://doi.org/10.1186/s12966-015-0274-5

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., & Ainsworth, B. E. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, *35*(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, *92*(6), 1087. https://doi.org/10.1037/0022-3514.92.6.1087

e-stat. (2017). Report on physical and Motor Ability survey in 2016. https://www.e-stat.go.jp/stat-search/files?page = 1&layout = datalist&toukei = 00402102&tstat = 000001088875&cycle = 0&tclass1 = 000001107355&tclass2val = 0

Evenson, K. R., Catellier, D. J., Gill, K., Ondrak, K. S., & McMurray, R. G. (2008). Calibration of two objective measures of physical activity for children. *Journal of Sports Sciences*, *26*(14), 1557–1565. https://doi.org/10.1080/02640410802334196

Fiorella, L. (2020). The science of habit and its implications for student learning and well-being. *Educational Psychology Review*, *32*(3), 603–625. https://doi.org/10.1007/s10648-020-09525-1

Flavell, J. H. (1963). *The developmental psychology of Jean Piaget*. Van Nostrand.

Fonseca, A. P. L. M., de Azevedo, C. V. M., & Santos, R. M. R. (2021). Sleep and health-related physical fitness in children and adolescents: A systematic review. *Sleep Science*, *14*(4), 357. https://doi.org/10.5935/1984-0063.20200125

Gillham, J., Adams-Deutsch, Z., Werner, J., Reivich, K., Coulter-Heindl, V., & Linkins, M. (2011). Character strengths predict subjective well-being during adolescence. *The Journal of Positive Psychology*, *6*(1), 31–44. https://doi.org/10.1080/17439760.2010.536773

Imura, T., & Aoki, T. (2014). Reliability and validity of the character strengths scale for Japanese children and youth. *Journal of Seika Women's Junior College*, *40*, 1–6.

Imura, T., Aoki, T., Takahashi, T., Nonaka, Y., & Yamada, T. (2013). Character strengths and well-being in Japanese children and youth: Creating good habits. *The Japanese Journal of Psychology*, *84*(3), 247–255. https://doi.org/10.4992/jjpsy.84.247

Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 40–16. https://doi.org/10.1186/1479-5868-7-40

Kubzansky, L. D., Martin, L. T., & Buka, S. L. (2009). Early manifestations of personality and adult health: A life course perspective. *Health Psychology*, *28*(3), 364–372. https://doi.org/10.1037/a0014428

Kumahara, H., Schutz, Y., Ayabe, M., Yoshioka, M., Yoshitake, Y., Shindo, M., & Tanaka, H. (2004). The use of uniaxial accelerometry for the assessment of physical-activity-related energy expenditure: A validation study against whole-body indirect calorimetry. *British Journal of Nutrition*, *91*(2), 235–243. https://doi.org/10.1079/BJN20031033

Lavy, S. (2020). A review of character strengths interventions in twenty-first-century schools: Their importance and how they can be fostered. *Applied Research in Quality of Life*, *15*(2), 573–596. https://doi.org/10.1007/s11482-018-9700-6

Linkins, M., Niemiec, R. M., Gillham, J., & Mayerson, D. (2015). Through the lens of strength: A framework for educating the heart. *The Journal of Positive Psychology*, *10*(1), 64–68. https://doi.org/10.1080/17439760.2014.888581

Malina, R. M. (2001). Tracking of physical activity across the lifespan. President's council on physical fitness and sports. *Research Digest*, *3*(14), 1–8.

Manyanga, T., Barnes, J. D., Chaput, J. P., Guerrero, M., Katzmarzyk, P. T., & Mire, E. F. (2020). Body mass index and movement behaviors among schoolchildren from 13 countries across a continuum of human development indices: A multinational cross-sectional study. *American Journal of Human Biology*, *32*(2), e23341. https://doi.org/10.1002/ajhb.23341

Mattocks, C., Ness, A., Leary, S., Tilling, K., Blair, S. N., & Shield, J. (2008). Use of accelerometers in a large field-based study of children: Protocols, design issues, and effects on precision. *Journal of Physical Activity and Health*, *5*(s1), S98–S111. https://doi.org/10.1123/jpah.5.s1.s98

Ministry of Education, Culture, Sports, Science and Technology. (1999). *Physical fitness test reference guide at 6–11 years old*. https://www.mext.go.jp/a_menu/sports/stamina/05030101/001.pdf

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity*, *32*(1), 1–11. https://doi.org/10.1038/sj.ijo.0803774

Park, N., & Peterson, C. (2005). *The values in action inventory of character strengths for youth (What Do children need to flourish?* (pp. 13–23). Springer.

Park, N., & Peterson, C. (2006). Moral competence and character strengths among adolescents: The development and validation of the values in action inventory of strengths for youth. *Journal of Adolescence*, *29*(6), 891–909. https://doi.org/10.1016/j.adolescence.2006.04.011

Peterson, C., & Seligman, M. E. (2004). *Character strengths and virtues: A handbook and classification, 1*. Oxford University Press.

Poitras, V. J., Gray, C. E., Borghese, M. M., Carson, V., Chaput, J. P., Janssen, I., Katzmarzyk, P. T., Pate, R. R., Connor Gorber, S., Kho, M. E., Sampson, M., & Tremblay, M. S. (2016). Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism*, *41*(6), S197–S239. https://doi.org/10.1139/apnm-2015-0663

Proyer, R. T., Gander, F., Wellenzohn, S., & Ruch, W. (2013). What good are character strengths beyond subjective well-being? The contribution of the good character on self-reported health-oriented behavior, physical fitness, and the subjective health status. *The Journal of Positive Psychology*, *8*(3), 222–232. https://doi.org/10.1080/17439760.2013.777767

Reed, J., Pritschet, B. L., & Cutton, D. M. (2013). Grit, conscientiousness, and the transtheoretical model of change for exercise behavior. *Journal of Health Psychology*, *18*(5), 612–619. https://doi.org/10.1177/1359105312451866

Rodriguez-Ayllon, M., Cadenas-Sánchez, C., Estévez-López, F., Muñoz, N. E., Mora-Gonzalez, J., & Migueles, J. H. (2019). Role of physical activity and sedentary behavior in the mental health of preschoolers, children and adolescents: A systematic review and meta-analysis. *Sports Medicine*, *49*(9), 1383–1410. https://doi.org/10.1007/s40279-019-01099-5

Rutberg, S., Nyberg, L., Castelli, D., & Lindqvist, A. K. (2020). Grit as perseverance in physical activity participation. *International Journal of Environmental Research and Public Health*, *17*(3), 807. https://doi.org/10.3390/ijerph17030807

Ryan, K., & Bohlin, K. E. (1999). *Building character in schools: Practical ways to bring moral instruction to life*. Jossey-Bass.

Sasayama, K., & Adachi, M. (2020). Secular changes in total steps and moderate-to-vigorous physical activity among fourth-grade students in Japan in 2003/2004 and 2016/2017. *Journal of Sports Sciences*, *38*(4), 416–421. https://doi.org/10.1080/02640414.2019.1705053

Shoshani, A., & Shwartz, L. (2018). From character strengths to children's well-being: Development and validation of the character strengths inventory for elementary school children. *Frontiers in Psychology*, *9*, 2123. https://doi.org/10.3389/fpsyg.2018.02123

Sirard, J. R., & Pate, R. R. (2001). Physical activity assessment in children and adolescents. *Sports Medicine*, *31*(6), 439–454. https://doi.org/10.2165/00007256-200131060-00004

STROBE; Strengthening the reporting of observational studies in epidemiology. (2023). STROBE Checklists. https://www.strobe-statement.org/checklists/

Stuntz, C. P. (2017). Linking positive psychology and the transtheoretical model: How character strengths and processes of change relate to each other and to exercise. *Journal of Positive School Psychology*, *1*(2), 85–108.

Stuntz, C. P. (2019). Differences in character strengths levels and associations with positive outcomes across contexts. *Journal of Positive School Psychology*, *3*(1), 45–61.

Telama, R. (2009). Tracking of physical activity from childhood to adulthood: A review. *Obesity Facts*, *2*(3), 187–195. https://doi.org/10.1159/000222244

Toner, E., Haslam, N., Robinson, J., & Williams, P. (2012). Character strengths and wellbeing in adolescence: Structure and correlates of the values in action inventory of strengths for children. *Personality and Individual Differences*, *52*(5), 637–642. https://doi.org/10.1016/j.paid.2011.12.014

Troiano, R. P., McClain, J. J., Brychta, R. J., & Chen, K. Y. (2014). Evolution of accelerometer methods for physical activity research. *British Journal of Sports Medicine*, *48*(13), 1019–1023. https://doi.org/10.1136/bjsports-2014-093546

Vollrath, M., Knoch, D., & Cassano, L. (1999). Personality, risky health behaviour, and perceived susceptibility to health risks. *European Journal of Personality*, *13*(1), 39–50. https://doi.org/10.1002/(SICI)1099-0984(199901/02)13:1<39::AID-PER328>3.0.CO;2-J

Wolff-Hughes, D. L., Bassett, D. R., & Fitzhugh, E. C. (2014). Population-referenced percentiles for waist-worn accelerometer-derived total activity counts in U.S. Youth: 2003 - 2006 NHANES. *PLoS One*, *9*(12), e115915. https://doi.org/10.1371/journal.pone.0115915

World Medical Association. (2013). World medical association declaration of Helsinki. *JAMA*, *310* (20), 2191–2194. https://doi.org/10.1001/jama.2013.281053