Associations of self-control with physical activity, physical fitness, and adiposity in adolescents

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Running Head: Self-control: PA, fitness, and adiposity

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Abstract

The associations between self-control and objective measures of physical activity, physical fitness, and adiposity are yet to be explored in young people; a gap in the literature that the present study aimed to address. The study employed a cross-sectional design. A total of 101 young people participated in the study. Participants completed the Brief Self-Control Scale as a measure of trait self-control. Free-living physical activity was assessed using an Actigraph GT3X+ triaxial accelerometer, which was worn for 7 d. Participants also completed the 15 m version of the multi-stage fitness test as a measure of physical fitness. For the assessment of adiposity, three criterion measures were used: body mass index, sum of skinfolds, and waist circumference. Data were analyzed using the *glm* function in the open access software R. Higher levels of trait self-control were associated with higher physical fitness (measured by distance run on the multi-stage fitness test) and lower adiposity (BMI, waist circumference and sum of skinfolds) in adolescents. There was a tendency for a positive association between self-control and time spent in vigorous physical activity, though this did not reach statistical significance. In a combined model, self-control was also associated with both physical fitness and waist circumference, with these effects independent of each other. These findings suggest that self-control is associated with healthy behaviors and characteristics in adolescents; and is thus potentially an attractive target for future interventions aimed at increasing physical activity and physical fitness, and reducing adiposity, in this population.

Keywords: trait self-control, physical activity, physical fitness, adiposity, healthy behaviors

Introduction

Self-control is defined as the ability to volitionally inhibit predominant response tendencies and to resist immediate undesirable temptations to support the pursuit of long-term goals.[1] Self-control helps individuals to exhibit appropriate behavior by helping to control urges, juggle competing goals, and to maintain focus on the desired goal.[2] The capacity to exert self-control can differ both between individuals (i.e., trait self-control), as well as across situations within the same individual (i.e., state self-control).[3] Specifically, the trait perspective of self-control has been linked to a number of positive outcomes including, enhanced psychological well-being, improved interpersonal relationships, and higher levels of achievement and performance.[3,4] With regards to health and well-being, self-control is required to, for example, maintain an exercise training program or adhere to a diet. In both cases, self-control is required to overcome the temptation presented by a proximal goal (e.g., skip an exercise training session, or eat an unhealthy food); in favour of pursuing the desired distal goal (e.g., to become fitter, or follow a dietary plan).

Despite the well-documented benefits of physical activity for health and well-being in young people,[5,6,7] more than half of young people aged 5 to 18 years do not meet the recommendations of 60 min moderate-vigorous physical activity per day.[8] Furthermore, it is suggested that there has been a decline in endurance-based measures of physical fitness in young people since 1990;[9] alongside an increasing prevalence of overweight and obesity,[10] contributing to deleterious health outcomes. Given these concerning patterns of low physical activity, low physical fitness, and high adiposity in young people, developing an understanding of factors that may be associated with these behaviors and characteristics are of great interest; and may inform the development and implementation of future interventions.

The associations between self-control and health behaviors in young people have mostly focused on eating habits; with very few studies exploring the associations between trait self-control and physical activity. Adolescents (aged 15-20 years old) with high trait self-control are reported to have healthier eating habits (e.g., higher frequency of breakfast consumption and lower intake of chocolate and snacks), and a lower BMI, compared to those individuals with low self-control.[11,12] Furthermore, some evidence also suggests that adolescents with higher trait self-control are more physically active than their counterparts with low self-control.[11,12] However, it is important to note that within these studies, the physical activity data were based on self-report measures, which is associated with reporting errors, social desirability and recall bias, particularly in young people.[13] To our knowledge, no studies to date have examined the association between device-measured physical activity (overcoming the aforementioned limitations associated with self-report measures) and trait self-control.

Research conducted in adults has reported a positive association between trait self-control and both physical activity and (aerobic and muscular) fitness.[14] Specifically, those with higher trait self-control spent more leisure time being physically active, covered a greater distance on the 12-min Cooper run test (aerobic fitness), and performed better on a holistic battery of muscle function tests (e.g., push-ups, sit-ups, standing long jump).[14] Furthermore, it was also reported that there was a negative association between self-control and BMI, whereby participants with higher trait self-control had a lower BMI.[14] However, the study of Kinnunen et al.[14] was conducted in adults; whilst it is possible that high levels of trait self-control may also be associated with objective measures of physical fitness and adiposity in young people, this is yet to be explored.

If associations do exist between self-control and health behaviors in young people, this has important implications for potential interventions to enhance health and well-being (through physical activity and diet), using self-control training techniques as a potential intervention. However, it is important to fully understand and document the relationships between self-control and physical activity, physical fitness and adiposity, before investing effort in the design and implementation of such interventions. Therefore, the aim of the present study was to explore the associations between self-control and physical activity, physical fitness and adiposity, in adolescents aged 11-15 years old.

Methods

Study Design

The present study employed a cross-sectional design. Following approval from the host institution's ethical advisory committee, written parental consent and participant assent were obtained and a health screen questionnaire completed (by parents on behalf of the young people) to ensure participants had no medical conditions that could affect their participation in the study. Due to the nature of the school-based research and data collection for the present study, participants were recruited via their schools. Five schools in the East Midlands, UK, were contacted using convenience sampling and agreed to participate in the study. The location of the schools varied and included rural urban town and inner city (index of multiple deprivation ranged from 10586 to 30035 (32^{nd} to 92^{nd} percentile)).

All measures were undertaken in the participant's school, as part of a larger study examining cardiometabolic health in young people.[15] The present study reports on the associations of physical activity, physical fitness and adiposity, with self-control in young people. Participants completed a familiarization trial during which they self-reported their date of birth (to calculate age) and sex, and they were presented an opportunity to practice each of the measures involved in the study. Following familiarization, participants were provided with an Actigraph GT3X+ accelerometer to wear for 7 d. After the 7 d of physical activity measurement, participants completed the main experimental trial, consisting of the brief self-control scale, anthropometric measurements, and the multi-stage fitness test (for details of each, see measures section).

Participants

A total of 113 young people were recruited to participate in this study. However, 12 participants dropped-out due to being absent from school for one of the experimental sessions (*n* = 8) or attending a school trip (*n* = 4). Therefore, 101 young people completed the study; sixty-three participants (34 girls) in year 7 (11-12 y) and 38 participants (23 girls) in year 10 (14-15 y) (Table 1). Exclusion criteria for participation in the study were any health condition that may be exacerbated by completing the exercise aspects of the study, as determined by the parent completed health screen questionnaire.

[Table 1 near here]

Measures

Brief self-control scale

Trait self-control was measured using the thirteen item Brief Self-Control Scale.[17] Participants indicated the extent to which each of the statements reflected how they usually act on a five-point Likert scale, ranging from 1 *(not at all)* to 5 *(very much).* Five items were reverse scored as they reflected lack of self-control (e.g., "I wish I had more self-discipline"). The items have demonstrated acceptable internal consistency and predictive validity in previous research.[17] The Brief Self-Control Scale provides a total score for trait self-control (scores range from 13 to 65), with higher scores indicating higher trait levels of self-control. The Brief Self-Control Scale was preferred in the present study given that thirteen items was considered more appropriate for the study population, and demonstrates validity with the full Self-Control Scale.[17,18]

Height and Weight

For descriptive purposes, height was measured using a Leicester Height Measure (Seca, Hamburg, Germany), and body mass was measured using digital scales (Seca 770; Seca, Hamburg, Germany). These measures were taken behind a privacy screen in the school setting.

Adiposity

For the assessment of adiposity, three criterion measures were used: body mass index (BMI), sum of skinfolds, and waist circumference. BMI was calculated using height and body mass, as previously described. Skinfolds were measured at four sites (triceps, subscapular, supraspinale and front thigh). All measurements were taken in line with the International Society for the Advancement of Kinanthropometry (ISAK) guidelines.[19] As per recommendations, two measurements were taken at each site and the mean used as the criterion measure. However, if the discrepancy between the first two measurements was >10%, a third measurement was taken and the median used as the criterion measure. The sum of skinfolds was used as the overall measure of adiposity, in line with other work in young people.[20] Finally, waist circumference was measured at the end of an exhalation, at the narrowest point between the xiphoid process of the sternum and the iliac crest, to the nearest 0.1 cm.[21] Skinfold and waist circumference measures were taken by a trained kinanthropometrist, behind a privacy screen in the school setting.

Physical activity

Free-living physical activity was assessed using an Actigraph GT3X+ triaxial accelerometer (Actigraph; Pensacola, FL, USA). Participants were provided with the accelerometer at the familiarization session. Participants were instructed to wear the accelerometer for 7 d and to wear the accelerometer at all times ($24\ h{\cdot}d^{-1}$); with the only exception being to remove the accelerometer for water-based activities such as showering or swimming, based on previous recommendations.[22,23] Prior to leaving the familiarization session, participants were fitted with the accelerometer (worn on a waist band above the right hip) by a member of the research team, to ensure that the accelerometer was properly fitted. The accelerometers were initialised to capture data at 90 Hz. The accelerometers were subsequently returned to the research team at the main experimental trial.

Data were downloaded using Actilife software (v6.13.4; Actigraph; Pensacola, FL, USA) and converted to .csv files (15 s epochs). Non-wear time was classified based on the previous algorithm outlined by Choi et al. [24]. Participants were removed from subsequent analyses if they did not have 4 days of valid wear time (≥ 10 h per day), including 1 weekend day (n = 17); thus analysis for physical activity variables was performed on 84 participants. Furthermore, assumed periods of sleep (23:00 to 06:00) were removed prior to analysis, in line with previous work.[23] Activity classifications (time spent in each intensity of activity) were based on the count cut-offs of Romanzini et al.[25] summarized as: sedentary (≤ 180 counts$\cdot$15s^{-1}), light physical activity (181-756 counts$\cdot$15s^{-1}), moderate physical activity (757-1111 counts$\cdot$15s^{-1}), and vigorous physical activity (>1112 counts$\cdot$15s^{-1}). A further moderate-vigorous physical activity variable was created, as the sum of the time spent in moderate plus time spent in vigorous activity (i.e., > 757 counts$\cdot$15s^{-1}).

Physical fitness

For the assessment of physical fitness, participants completed the 15 m version of the multi-stage fitness test (MSFT). The MSFT is a commonly used field-based measure of physical fitness in young people[26] and has demonstrated excellent reliability in this population.[27] The 15 m version was used to practical limitations in that some of the school sports hall facilities were not large enough to allow the full 20 m version[28] to be used. The 15 m version of the MSFT starts at a speed of 6 km$\cdot$h^{-1} and increases by 0.5 km$\cdot$h^{-1} with each stage (each stage is ~ 1 min in duration). Participants were instructed to run to volitional exhaustion, or until they were unable to maintain the required pace for 3 consecutive shuttles. Verbal encouragement was provided by the research team throughout and an experienced member of the research team run alongside the participants for pacing purposes. The criterion measure used was the distance covered (m), in line with previous work.[15,20]

Statistical Analysis

Data were analyzed using the open access software R (v4.0.5; www.r-project.org). All variables displayed a normal distribution, with the exception of the time spent in vigorous physical activity; subsequently this variable was log transformed prior to analyses. Initially, regression models were run using the *glm* function in R to assess the relationship between self-control and each variable of interest (time spent in each activity classification [physical activity], distance run on the MSFT [physical fitness], and BMI, sum of skinfolds and waist circumference [adiposity]). Subsequently, a multiple regression model was built, also using the *glm* function in R, to find the combination of variables that best explained the variance in self-control (judged by the lowest Akaike Information Criterion [AIC]). Prior to this model being built, the variables of interest were checked for collinearity (using the *cor.test* function); any variables with a correlation of $r > 0.7$ were not included in the same model. For all models, residuals were assessed to ensure they met the underlying assumptions of normality and homoscedasticity. Statistical significance was accepted as $p < 0.05$.

Results

For descriptive purposes, mean values for physical activity, physical fitness, adiposity and self-control, for the whole sample and split by year group and sex, are displayed in table 2. There was no difference in self-control between the year groups ($p = 0.19$) or sexes ($p = 0.16$), nor did year group and sex interact to affect self-control ($p = 0.18$). Therefore, all participants were analyzed together, regardless of year group and sex.

[Table 2 near here]

Individual Models

A summary of the findings of the regression models assessing the relationships between self-control and each variable of interest are displayed in Table 3. In summary, there were no associations between self-control and physical activity (time spent in each activity classification, all $p > 0.05$). However, there was a tendency for a positive association between self-control and time spent in vigorous physical activity ($p = 0.10$); whereby higher self-control was associated with spending more time in vigorous physical activity.

There was a significant positive association between self-control and physical fitness (distance run on the MSFT); whereby higher physical fitness (measured by distance run on the MSFT) was associated with higher self-control ($p = 0.01$). Furthermore, there were significant negative associations between self-control and each measure of adiposity (BMI, waist circumference and sum of skinfolds; all $p < 0.001$); whereby higher self-control was associated with lower measures of adiposity (lower BMI, lower waist circumference and lower sum of skinfolds).

[Table 3 near here]

Combined Models

In order to assess which variables could be included in the same model, the degree of collinearity between the significant variables in Table 3 was checked. The adiposity variables (BMI, waist circumference and sum of skinfolds) were collinear with each other (BMI & waist circumference, $r = 0.85$; BMI & sum of skinfolds, $r = 0.79$; waist circumference and sum of skinfolds, $r = 0.71$), thus could not be included in the same model. However, physical fitness (distance run on the MSFT) was not collinear with any of the adiposity measures (BMI, $r = -0.37$; waist circumference, $r = -0.19$; sum of skinfolds, $r = -0.56$); thus these variables could be combined in the same model.

When combining variables into the same model, the best model (with the lowest AIC) included physical fitness (distance run on the MSFT) and waist circumference (Model 3, Table 4). Specifically, higher self-control was associated with both higher physical fitness (greater distance run on the MSFT) and a lower waist circumference; with these effects statistically significant and independent of each other (Table 4). When combining physical fitness (distance run on the MSFT) with BMI (Model 1) and sum of skinfolds (Model 2), the models had a higher AIC (indicating a poorer model fit) and physical fitness was not statistically significant (Table 4). This suggests that the model which explained the greatest variance in trait self-control included physical fitness (distance run on the MSFT) and waist circumference; and that these effects were independent of each other.

[Table 4 near here]

Discussion

The main findings of the present study are that higher levels of trait self-control were associated with higher physical fitness (measured by distance run on the MSFT) and lower adiposity (BMI, waist circumference and sum of skinfolds) in adolescents. In addition, there was a tendency for a positive association between self-control and time spent in vigorous physical activity, though this did not reach statistical significance. Furthermore, self-control was associated with both physical fitness and adiposity (combined model of physical fitness and waist circumference explained the greatest variance in trait self-control), with these effects independent of each other. Overall, these findings suggest that self-control is associated with healthy behaviors and characteristics in adolescents; and is thus potentially an attractive target for future interventions aimed at increasing physical activity and physical fitness, and reducing adiposity, in this population.

One of the main findings of the present study was that higher self-control was associated with higher levels of physical fitness (distance run on the MSFT) in an adolescent population. To our knowledge, the present study is the first to examine the relationship between self-control and fitness in adolescents. Thus, the present study provides novel evidence in adolescents, which is in accordance with evidence in adults where higher self-control has been reported to be positively associated with a greater distance covered on the 12-minute Cooper run test,[14] higher $\dot{V}O_2$ max,[29] and greater performance on a battery of muscle function tests.[14]

The findings of the present study suggest that there are no associations between self-control and time spent in each of the physical activity classifications (sedentary, light physical activity and moderate physical activity). However, higher trait self-control tended to be associated with more time spent in vigorous physical activity, although this did not reach statistical significance. To our knowledge, the present study is the first to examine the associations between self-control and device-measured physical activity, with the previous studies that have reported a positive association between self-control and physical activity having used self-report based measures of physical activity.[11,12] Given that self-report measures of physical activity are associated with many limitations, particularly in young people,[13] this may explain the variance between the findings of the present study and those previously reported. Nonetheless, the findings of the present study suggest that self-control may be particularly important for adolescent's participation in higher intensity, vigorous, physical activity.

Another key finding of the present study was the negative association between self-control and all measures of adiposity (BMI, waist circumference and sum of skinfolds). These findings are in accordance with previous studies which also report a negative association between self-control and BMI, in young people[11,12] and adults.[14] However, the present study extends these findings by going beyond using BMI as the sole measure of adiposity, and also examining waist circumference and sum of skinfolds as additional measures of adiposity. This could be of particular importance given that waist circumference and sum of skinfolds have been reported to be of greater importance for cardiometabolic health than BMI in adolescents.[20] It is also important to note that the association of self-control with physical fitness and adiposity were independent of each other; as evidenced by the model which explained the greatest variance in self-control including both physical fitness and waist circumference. This suggests that self-control has the potential to influence physical fitness and adiposity independently and is thus important for a range of healthy behaviors and characteristics in this population.

Therefore, it is pertinent to suggest that self-control could be an appropriate intervention target for future interventions aimed at increasing physical fitness and reducing adiposity in this population. Given the well-documented positive effects of higher physical fitness and lower adiposity on health and well-being,[20] it is thus possible that interventions aimed at enhancing self-control in young people could, through increased physical activity, increased physical fitness and reduced adiposity, enhance health and well-being. Indeed, it has previously been reported in a large sample (~12,000) of older adolescents (mean age: 16 years old) that lower levels of self-control were associated with a greater risk of being diagnosed with a range of both physical and mental health conditions.[30] However, we hypothesise that it is unlikely that self-control directly impacts health and well-being and, rather, it has an indirect effect through variables such as physical activity, physical fitness and adiposity, with preliminary evidence of these relationships in adolescents provided in the present study. For example, adolescents with higher self-control are more likely to select healthy behaviors (e.g., to complete a bout of physical activity) and resist unhealthy alternatives (e.g., watching television); ultimately increasing physical fitness, reducing adiposity, and enhancing health and well-being. Furthermore, it has previously been suggested that self-control can be enhanced through specific self-control training interventions in young people.[31] Based upon the associations of self-control with healthy behaviors demonstrated in the present study, the potential for interventions to enhance self-control (and subsequently increasing physical activity and physical fitness) to ultimately enhance health and well-being warrant further investigation.

However, whilst the present study is the first to examine the important associations between self-control and physical activity, physical fitness and adiposity in adolescents, it is not without limitation. Importantly, the present study is cross-sectional in nature, and thus whilst the findings demonstrate associations between self-control and healthy behaviors and characteristics in adolescents, it does not demonstrate causality (i.e., the direction of the effect). Indeed, it has previously been suggested that the relationship between self-control and exercise/physical activity is bi-directional in nature.[32] Therefore, future intervention-based work should consider the direction of this relationship. In particular, the associations between self-control and healthy behaviors and characteristics in the present study should be extended by implementing a self-control-based intervention and measuring the effect on physical activity, physical fitness and adiposity in adolescents. Importantly, previous research has suggested that an individual's self-control capacity can be trained by employing specific training techniques[33] including squeezing a handgrip twice per day for two weeks[34] and use of the non-dominant hand daily for everyday tasks for two weeks.[35] Therefore, future research should aim to develop self-control training interventions suitable for an adolescent population. Given the associations demonstrated in the present study, such interventions would have the potential to increase (vigorous) physical activity, enhance fitness and reduce adiposity; thus leading to enhanced health and well-being.

Furthermore, whilst the present study provides novel findings regarding the importance of self-control for physical activity, physical fitness and adiposity in adolescents; it does not consider the importance of self-control on diet and healthy eating in this population. Future work should extend the findings of the present study by also including measures of diet, to consider how self-control also impacts diet and the subsequent effects on health and well-being, and whether the relationships of self-control with physical activity and diet are potentially related. In addition, future work could also consider the associations between self-control and other aspects of health and well-being, such as mental well-being.

Conclusions

Overall, the findings of the present study suggest that trait self-control is associated with a range of healthy behaviors in adolescents. Specifically, higher self-control was associated with higher physical fitness and lower adiposity in adolescents. These findings provide important preliminary evidence that self-control is a potential target for interventions aimed at increasing physical activity, increasing physical fitness and reducing adiposity in adolescents; ultimately enhancing health and well-being in this population. It is important for future work to extend upon this proof of concept and begin to develop and evaluate such interventions in adolescent populations.

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Data Availability Statement: Data are available from corresponding author upon reasonable request

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Table 1: Descriptive characteristics (mean ± SD) of participants, split by year group and sex.

	Year 7			**Year 10**			**Combined**
	Boys	**Girls**	**Overall**	**Boys**	**Girls**	**Overall**	
n	29	34	63	15	23	38	101
Age [y]	11.46 ± 0.50	11.32 ± 0.47	11.38 ± 0.48	14.27 ± 0.45	14.22 ± 0.42	14.24 ± 0.43	12.46 ± 1.47
Height [cm]	155.67 ± 8.47	153.89 ± 6.82	154.71 ± 7.61	174.29 ± 5.28	166.24 ± 4.93	169.42 ± 6.39	160.24 ± 10.12
Body mass [kg]	46.77 ± 9.46	46.42 ± 8.70	46.58 ± 8.98	62.33 ± 10.40	58.18 ± 9.92	59.82 ± 10.18	51.56 ± 11.40
BMI [$kg \cdot m^{-2}$]	19.20 ± 2.97	19.49 ± 2.79	19.36 ± 2.85	20.45 ± 2.87	21.07 ± 3.62	20.83 ± 3.32	19.91 ± 3.10
BMI percentile [a]	64.31 ± 28.50	63.50 ± 28.14	63.78 ± 28.32	64.32 ± 29.56	59.72 ± 29.73	62.41 ± 29.62	62.59 ± 28.91

[a] Calculated based on age and sex specific centile data[16]

Table 2: Physical activity, physical fitness, adiposity and self-control values, split by year group and sex (data are presented as mean ± standard deviation).

		Year 7			Year 10			Combined
		Boys	**Girls**	**Overall**	**Boys**	**Girls**	**Overall**	
Physical activity	Sedentary time [min·d^{-1}]	1270.62 ± 41.13	1312.79 ± 31.06	1296.44 ± 40.60	1321.65 ± 26.84	1310.47 ± 55.90	1314.94 ± 46.31	1304.15 ± 43.77 * †
	Light PA [min·d^{-1}]	130.26 ± 28.28	104.13 ± 24.03	114.26 ± 28.53	89.35 ± 16.47	109.84 ± 53.20	101.64 ± 43.27	109.00 ± 35.73
	Moderate PA [min·d^{-1}]	36.02 ± 16.62	21.30 ± 10.20	27.00 ± 14.80	24.81 ± 14.18	18.43 ± 10.20	21.98 ± 12.17	24.50 ± 14.01 *
	Vigorous PA [min·d^{-1}]	3.11 ± 1.98	1.78 ± 1.80	2.30 ± 1.96	4.19 ± 4.19	1.26 ± 1.80	2.43 ± 3.27	2.35 ± 2.57 *
	Moderate-vigorous PA [min.d^{-1}]	39.13 ± 17.78	23.08 ± 11.66	29.30 ± 16.22	29.00 ± 16.54	19.69 ± 10.76	23.41 ± 13.93	26.85 ± 15.50 *
Physical fitness	MSFT distance [m]	1371.21 ± 402.20	1197.79 ± 433.27	1277.62 ± 424.93	2267.00 ± 447.56	1385.87 ± 411.23	1733.68 ± 605.69	1449.21 ± 544.96 * †
Adiposity	BMI [kg/m^2]	19.20 ± 2.97	19.49 ±2.79	19.36 ± 2.85	20.45 ± 2.87	21.07 ± 3.62	20.83 ± 3.32	19.91 ± 3.10 †
	Sum of skinfolds [mm]	59.09 ± 24.55	62.84 ± 26.10	61.06 ± 25.24	49.97 ± 25.33	67.64 ± 26.32	60.67 ± 27.04	60.91 ± 25.81 †
	Waist circumference [cm]	66.76 ± 7.09	66.84 ± 7.33	66.80 ± 7.16	73.07 ± 6.50	68.45 ± 7.00	70.27 ± 7.10	68.14 ± 7.30
Self-control		41.55 ± 5.57	44.85 ± 6.49	43.33 ± 6.26	41.80 ± 5.92	41.43 ± 7.67	41.58 ± 6.95	42.67 ± 6.55

* main effect of sex, $p < 0.05$; † main effect of year group, $p < 0.0$

Table 3: Regression models assessing the associations between self-control and physical activity, physical fitness and adiposity.

Variable	**Intercept**	**Parameter Estimate**	**Standard Error**	***t***	***p***	
Physical Activity						
Sedentary Time	56.49	-0.01	0.02	-0.65	0.52	
Light Physical Activity	41.22	0.01	0.02	0.71	0.48	
Moderate Physical Activity	42.70	0.01	0.05	0.04	0.97	
Vigorous Physical Activity [a]	42.60	0.83	0.50	1.67	0.10	
MVPA	42.50	0.01	0.05	0.20	0.84	
Physical Fitness						
MSFT Distance [b]	38.32	0.05	0.02	2.57	0.01	*
Adiposity						
BMI	59.01	-0.82	0.20	-4.20	<0.001	*
Waist Circumference	63.81	-0.31	0.09	-3.64	<0.001	*
Sum of Skinfolds	48.37	-0.10	0.02	-3.97	<0.001	*

Parameter estimates are displayed as the change in self-control (AU) for a 1-unit change in the variable of interest.
[a] log transformed; [b] parameter estimate is displayed per 15 m run (i.e., per shuttle)
* $p < 0.05$

Table 4: Combined regression model which explains the greatest variance in self-control

Model	**Variable**	**Parameter Estimate**	**Standard Error**	***t***	***p***	
Model 1	Intercept	54.93				
(AIC =	MSFT Distance	0.02	0.02	1.26	0.21	
655.0)	BMI	-0.72	0.21	-3.46	< 0.001	*
Model 2	Intercept	46.95				
(AIC =	MSFT Distance	0.01	0.02	0.48	0.63	
645.2)	Sum of Skinfolds	-0.09	0.03	-3.01	< 0.01	*
Model 3	Intercept	58.37				
(AIC =	MSFT Distance	0.03	0.02	1.96	0.04	*
643.8)	Waist Circumference	-0.28	0.09	-3.25	< 0.01	*

Parameter estimates are displayed as the change in self-control (AU) for a 1-unit change in the variable of interest, with the exception of the parameter estimate for MSFT Distance which is displayed for a 15 m increase in distance run (i.e., per shuttle).
* $p < 0.05$