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Intensity of Physical Activity, TV Viewing Time, and Adiposity in Young Adults: Iowa Bone Development Study

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Abstract

This study focused on young adults, as emerging adulthood, when the majority of young adults are exposed to unhealthy lifestyle behaviors. This study examined the relationships between Physical Activity (PA) intensity (min/d), TV viewing (h/d), and adiposities (i.e., Total Body Fat (TBF), kg and Visceral Adipose Tissue (VAT), g) in young adults. Study participants were healthy young adults aged 19.8 years (182 females and 147 males) in the Iowa Bone Development Study. ActiGraph accelerometers and a PA questionnaire were used to measure PA and TV viewing. Dual-energy X-ray absorptiometry and peripheral quantitative computed tomography scans measured the adiposities. Vigorous PA, independent of the total volume of PA, was the best predictor of TBF in males (β=-.22, p<.01). In females, moderate (β=-.25, p<.01), moderate to vigorous (β=-.27, p<.01), and vigorous (β=-.12, p<.05) intensity PA were predictive. TV viewing, independent of sedentary time and total PA, was associated with TBF (β=0.18, p<.05 in males; β=0.12, p<.05 in females) and VAT (β=0.11, p<.05 in females). This study suggests that increasing PA intensity and restricting TV viewing time rather than reducing comprehensive sedentary time may be a more effective strategy in maintaining healthy body composition. PA interventions should suggest to female young adults to “move more” and males to participate in more intense activities.

Keywords: Physical activity; TV viewing; Adiposity; Young adult

Introduction

In addition to Total Body Fat (TBF), the excessive deposition of regional adiposities, such as Visceral Adipose Tissue (VAT) and Intramuscular Adipose Tissue (IMAT), are associated with greater risks for developing metabolic disorders. As widely appreciated, VAT is more highly related to the development of metabolic syndrome [1] and cardiovascular disease [2] than subcutaneous or peripheral fat [3]. IMAT has also been associated with metabolic syndrome in normal and overweight populations [4], and cardiovascular risk factors, such as fasting glucose and total cholesterol in healthy adults [5]. Physical Activity (PA), as a behavioral factor associated with adiposity, has been negatively associated with TBF and VAT [6] as well as IMAT in adults [7,8]. In addition, at least light above intensity (i.e., moderate and vigorous) PA has been associated with lower levels of adiposity in children and adolescents [9-12].

However, few studies have focused on the association between PA intensities and adiposity in young adults, aged 18 to mid-20s [13]. As individuals leave their parents’ homes, their lifestyle changes significantly including an increase in unhealthy behaviors (e.g., increased TV viewing and alcohol consumption) [14-16], and decrease in diet quality (e.g., young adults consume more fast food and soft drinks than fruit, vegetable, and dairy compared to diets as children) [17]. Young adulthood is a particularly important period in life because individuals establish the patterns of lifelong adult health behaviors [16,18]. Associated with their emerging unhealthy lifestyle, young adults gain body weight faster than other age groups [19], and their weight gain is associated with greater metabolic risks later in life [20]. In addition, obesity prevalence increases remarkably (almost doubles) from adolescence to the early 20s [14].

It has been known that PA participation declines over age from adolescence to adulthood. According to the recent meta-analysis from Corder, et al. Moderate-to-Vigorous PA (MVPA) declines by 5.2 min/day in the transition from adolescence to adulthood [21]. PA patterns change as adolescents are transitioning to young adulthood and the most notable fact is that levels of vigorous PA steadily decline and sedentary time increases concomitantly [21-24]. Also, there is a gender difference in PA patterns in that there have been greater reductions of MVPA in females when compared to males and greater increases of sitting time during web-based activities in males compared to females [25]. However, little attention has been paid to the relationships between PA intensities and adiposity in young adults. Particularly, the effect of the PA pattern changes or its intensity on regional adiposities (e.g., VAT or IMAT) is not well understood.

TV viewing has been associated with high body mass index, waist circumference [26], and TBF [11] independent of both MVPA and sedentary time in youth. Therefore, TV viewing, as it is distinct from sedentary behavior, has been established as a risk indicator for predicting adiposity and health outcomes in adolescents [11,27]. A review study from Ekelund, et al. [27] concluded that TV viewing independent of PA might be associated with adiposity in youth; although, it could be explained partially by residual confounding related to snacking during TV viewing. However, whether TV viewing is a discrete predictor for TBF and regional adiposity in young adults is unknown. Few studies have reported the associations between adverse health outcomes (increases of fatness or cardio metabolic factors) and TV viewing [28-30]. According to Cleland, et al. [31], TV viewing and waist circumference had a positive association which might be mediated by increased energy intakes in young adults aged 26 to 36 years. However, the fact whether TV viewing itself (independent of sedentary or PA time) is associated with adiposity in this population was not studied in their study [31]. An explicit understanding of TV viewing as a discrete predictor from PA level for TBF, VAT, and IMAT in young adults is warranted.

In this report, using objective and precise measures of adiposity and PA, we examined which PA intensities were most highly associated with adiposity levels (i.e., TBF, VAT, and IMAT) in young adults. A subjective measure, TV viewing, was also examined since it is known to be an independent predictor of adiposity in youth [11,26] and might also independently predict adiposity in young adults. A better understanding of these associations could help to inform preventive recommendation as to what intensity of PA is more likely to contribute to maintaining an appropriate level or reduction of adiposity during young adulthood.

Methods

Participants

Young adults (mean age of 19.8 years, n=329, females=182 and males=147) were recruited from the Iowa Bone Development Study (IBDS), which is an ongoing longitudinal cohort study examining bone health and body composition during childhood through young adulthood. Initial recruitment and examination of this cohort were conducted between 1998 and 2001 when participants were approximately 5 years of age. In this report, participants at approximately age 19 years (wave 7) were included. Almost all (approximately 95%) participants were white and two-thirds of their parents have college degrees or higher education. Additional information on the IBDS regarding study participant or design have been published elsewhere [32]. All participants were instructed to read and fill out the written informed consent and the study protocol, which were approved by the University of Iowa Institutional Review Board.

Measures

Physical activity measures

PA intensities by time (min/day) and sedentary time (min/day) were objectively measured by an ActiGraph accelerometer (model GT3X+, ActiGraph, Inc., Pensacola, FL), and all PA data were downloaded by using ActiLife software (ver. 6.13.3, ActiGraph LLC). The 2-regression model from Crouter and colleagues [33] was applied to estimate PA intensity. Activity was measured using 10-s epochs sorted into intensities by Metabolic Equivalent Task (MET) value within each minute. The combinations of 6 continuous 10-s epochs were converted to 1-minute epochs [33]. The accelerometers with adjustable belts were sent to participants and returned through the U.S. Postal Service. Participants were asked to wear the accelerometers on their waist during their waking hours (at least 10 h/day: PA data inclusion criteria) for 5 consecutive days from Wednesday to Sunday. Accelerometry data were only used from participants who wore the monitor at least 3 days. Participants wore the accelerometers during the autumn months (September to November) to minimize the seasonal variation. MET categories were sedentary <1.5 METs, 1.5≤light <4.0, 4.0≤moderate<7.0, and vigorous≥7 METs [34]. The rationale behind the application of the higher MET value cut-points than the PA compendium (3 METs for moderate and 6 METs for VPA) is that physical fitness levels in young adults are higher than that of adults [35], therefore the higher threshold of MET value might be appropriate in our study population [36]. The variables of the total volume of PA were recorded as total MET-min/day in order to represent total energy expenditure and were calculated by adding light, moderate, and vigorous intensity PA. The values of total PA MET-min/day were obtained from a formula that multiplies total activity (min/day) by each participant's corresponding MET value.

Anthropometry and adiposity measures

During each participant's visit to the University of Iowa General Clinical Research Center and Clinical Research Unit, trained nurses assessed their height (cm) using a Harpenden stadiometer (Holtain Ltd., Crosswell, UK) and body weight (kg) using a Healthometer physician's scale (Continental, Bridgeview, IL). Adiposity level and whole-body scans were measured by dual-energy x-ray absorptiometry (DXA) scans using a Hologic QDR 4500 DXA (Delphi upgrade, Hologic, Inc., Waltham, MA) with a 12.3 version of the software, and the fat-beam mode was employed to assess total fat mass. TBF mass (kg) and fat-free mass (kg) were obtained from the DXA images. VAT (g) was derived from estimation equations confirmed by the manufacturer, which accurately predicts VAT since VAT cannot be directly measured by DXA. This method to obtain VAT from DXA was validated by Computed Tomography (CT) in both adults and overweight children [26,37]. Additionally, abdominal adiposity measured by DXA was proved to be accurate and precise method in adults compared with CT [38]. IMAT area (mm^2) was measured by pQCT scans using a Stratec XCT 3000 with XCT 6.00 version (Stratec, Inc., Pforzeim, Germany) at the 66% site of the left tibia. A site from the proximal tibial plateau to the center of the medial malleolus was measured for tibial length. To reduce the measurement variability, one trained research technician assessed the DXA or pQCT scans. Both DXA and pQCT were registered in the state of Iowa, and the safety compliance was confirmed by the Health Protection Office at the University of Iowa.

TV viewing measures

During the clinical visits, self-reported PA questionnaire (PAQ) was used to assess TV viewing time. The mean TV viewing time (h/ day) was queried by recalling the last 7 days and the response categories were set as: "I watched less than 1 h/day or not at all", "I watched more than 1 h/day, but less than 2 h/day", "I watched more than 2 h/day, but less than 3 h/day", "I watched more than 3 h/day, but less than 4 h/day", "I watched 4 h/day or more". The average values for the categories were analyzed in the result as continuous variables for TV viewing. The self-reported PAQ for TV viewing has been shown to be moderately correlated to the objective measurement (r=.54, p<.001) in adults [39].

Statistical analyses

Sex-specific analyses were applied to data in this study because adiposity development and PA patterns in daily life differ biologically and behaviorally between males and females [40,41]. A descriptive analysis was conducted that represents mean, standard deviation, median, and interquartile range of participants' characteristics (Table 1). All study variables were compared between males and females using a student's t-test. Normality was tested by a Shapiro-Wilk test. While most outcome and exposure variables were somewhat positively skewed, residual diagnostics showed the satisfactory distribution for residuals for all models except VAT models for males. Robust regression analysis using Hayes's freely available PROCESS macro for SPSS [42] was performed for VAT variable in males to reduce the influence of outliers [43,44]. To be sure that wear time of activity monitor did not bias our study results, we further conducted analyses using different indicators of MVPA (proportion of MVPA time in total wear time: MVPA time in hours divided by wear time in hours) and sedentary time (proportion of sedentary time: sedentary time in hours divided by wear time in hours). To examine the strongest independent relation with TBF, each PA intensity was included in each separated multiple linear regression model while adjusting for height, fat-free mass, and total PA (Tables 2-4). Multi-collinearity was tested in each multiple linear regression analysis through the variance inflation factor (VIF). All VIF values of MPA, MVPA, and VPA in all multiple regression models were ranged from 1.005 to 3.431 which are not in the range of collinearity [45]. To examine the association between PA intensity and adiposity regardless of total energy expenditure, the total volume of PA was controlled. A significance level was set as <.05 and SPSS version 23 (IBM Corp. in Armonk, NY) was used for all the statistical analyses.

Variables	Male		Female	
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)
n	147		182	
Age (years)	19.8±0.7		19.8±0.7	

Height (cm)	180.2±7.7	179.8 (174.5-184.7)	166.3±6.9**	166.2 (161.5-171.5)
Weight (kg)	84.7±19.9	79.9 (71.4-94.2)	70.3±19.2**	65.0 (56.8-78.7)
BMI (kg/m²)	26.0±5.6	24.6 (22.4-28.5)	25.4±6.5	23.4 (21.0-28.3)
TBF mass (kg)	20.6±11.3	17.1 (13.7-23.6)	25.7±12.6**	21.2 (16.8-31.6)
Fat-free mass (kg)	64.0±10.5	63.3 (57.3-70.9)	45.5±8.0**	43.9 (39.7-50.4)
VAT mass (g)	302.4±135.4	266.2 (227.0-323.9)	258.0±188.0*	185.6 (128.3-308.4)
IMAT area (mm²)	2348.0±521.6	2288.4 (1997.8-2660.1)	1769.7±305.6**	1756.5 (1570.3-1984.6)
SED (min/d)	576.2±167.0	541.7 (450.6-699.1)	549.0±129.2	541.5 (458.0-638.2)
LPA (min/d)	234.0±79.3	220.4 (176.8-277.6)	247.7±66.9	235.7 (199.5-288.0)
MPA (min/d)	75.9±35.7	74.2 (50.3-94.4)	55.8±28.3**	52.0 (38.0-69.0)
MVPA (min/d)	79.4±38.0	76.5 (51.9-101.2)	58.4±31.2**	53.7 (38.8-69.2)
VPA (min/d)	3.5±5.0	1.7 (0.6-4.7)	2.6±5.5	0.6 (0.0-2.3)
Total PA (MET-min/d)	985.1±322.6	945.1 (726.6-1151.0)	906.0±275.3*	869.0 (731.2-999.7)

SD: Standard Deviation; IQR: Interquartile Range; BMI: Body Mass Index; TBF: Total Body Fat; VAT: Visceral Adipose Tissue; IMAT: Intramuscular Adipose Tissue; SED: Sedentary Time; PA: Physical Activity; LPA: Light Physical Activity; MPA: Moderate Physical Activity; MVPA: Moderate to Vigorous Physical Activity; VPA: Vigorous Physical Activity; MET: Metabolic Equivalent Task. Significantly different with males, $^{*}p<.05$, $^{**}p<.01$.

Table 1: Demographic characteristics of the study participants.

Results

Characteristics of the 329 participants are presented in Table 1. PA variables (MPA, MVPA, and total PA) in males were significantly greater than that of females (p<.05). TBF mass was greater but fat-free mass, VAT mass, and IMAT area were lower in females than males (p<.01). There was no significant sex difference in age, body mass index, sedentary, LPA, and VPA time. Based on the body mass index cut points for defining body fatness (25.0 kg/m² or above=Overweight, 30.0 kg/m² or above=Obesity), 70 out of 147 male participants were overweight (48%) and 26 were obese (18%). In females, 70 out of 182 were overweight (38%) and 36 were obese (20%).

In multiple linear regressions analyses, after adjusting for height, lean body mass, and total PA, 1-minute increase in VPA was associated with 0.22 kg lower TBF among males (p<.01, R^2=.48) (Table 2). In females, 1-minute increases in MPA (p<.01, R^2=.69), MVPA (p<.01, R^2=.69), and VPA (p<.05, R^2=.68) were associated with 0.25 kg, 0.27 kg, and 0.12 kg lower TBF, respectively (Table 3).

	β	**SE**	***p***	**R^2**
(Intercept)		20.89	0.005	0.44
Height	-0.33	0.13	0	
Fat-free mass	0.78	0.1	0	
Total PA	-0.19	0.01	0.173	
MPA	0.02	0.04	0.887	
	β	**SE**	***p***	**R^2**
(Intercept)		20.92	0.006	0.44
Height	-0.33	0.13	0	
Fat-free mass	0.78	0.1	0	
Total PA	-0.13	0.01	0.348	
MVPA	-0.06	0.04	0.688	
	β	**SE**	***p***	**R^2**
(Intercept)		20.71	0.028	0.48
Height	-0.28	0.13	0.002	
Fat-free mass	0.78	0.09	0	
Total PA	-0.1	0	0.207	
VPA	-0.22	0.19	0.009	
TBF: Total Body Fat; β: Standardized Coefficient; SE: Standard Error; MPA: Moderate Physical Activity; VPA: Vigorous Physical Activity				

Table 2. Association between different PA categories and TBF in males: multiple regression analysis.

	β	**SE**	***p***	**R^2**
(Intercept)		15.38	.013	.69
Height	-0.29	0.10	.000	
Fat-free mass	0.98	0.09	.000	
Total PA	0.15	0.00	.101	
MPA	-0.25	0.04	.007	
	β	**SE**	***p***	**R^2**
(Intercept)		15.34	.018	.69
Height	-0.28	0.10	.000	
Fat-free mass	9.74	0.09	.000	
Total PA	0.16	0.00	.069	
MVPA	-0.27	0.03	.003	
	β	**SE**	***p***	**R^2**

(Intercept)		15.58	.010	.68
Height	-0.28	0.11	.000	
Fat-free mass	0.96	0.10	.000	
Total PA	-0.02	0.00	.779	
VPA	-0.12	0.11	.049	
TBF: Total Body Fat; β: Standardized Coefficient; SE: Standard Error; MPA: Moderate Physical Activity; VPA: Vigorous Physical Activity.				

Table 3: Association between different PA categories and TBF in females: multiple regression analysis.

In Table 4, after adjusting for height, fat-free mass, sedentary time and total PA, 1-hour increase in TV viewing was associated with 0.18 kg and 0.12 kg higher TBF among males ($p<.05$, $R^2=.47$) and females ($p<.05$, $R^2=.69$), respectively. One-hour increase in TV viewing was also associated with 0.11 g higher VAT among females ($p<.05$, $R^2=.62$). After adjustments of height, fat-free mass, and total PA, there were no significant associations between any PA intensity and VAT or IMAT in males or females (data not shown).

	Male				**Female**			
Model for TBF	**β**	**SE**	***p***	**R^2**	**β**	**SE**	***p***	**R^2**
(Intercept)		21.90	.010	.47		15.59	.011	.69
Height	-0.33	0.14	.001		-0.28	0.11	.000	
Fat-free mass	0.78	0.10	.000		0.95	0.10	.000	
SED	0.00	0.01	.991		-0.03	0.01	.628	
Total PA	-0.16	0.00	.077		-0.06	0.00	.228	
TV viewing	0.18	0.78	.027		0.12	0.50	.016	
Model for VAT	**β**	**SE**	***p***	**R^2**	**β**	**SE**	***p***	**R^2**
(Intercept)		336.84	.001	.16		254.39	.000	.62
Height	-0.31	2.10	.003		-0.53	1.75	.000	
Fat-free mass	0.46	1.51	.000		1.00	1.59	.000	
SED	0.03	0.09	.730		0.08	0.08	.200	
Total PA	0.04	0.05	.781		-0.13	0.04	.023	
TV viewing	0.20	11.98	.243		0.11	8.01	.046	
TBF: Total Body Fat; SED: Sedentary Time; VAT: Visceral Adipose Tissue; β: Standardized Coefficient; SE: Standard Error. A robust regression analysis for males.								

Table 4: Associations between TV viewing time and adiposity variables (TBF and VAT).

Discussion

The primary purpose of this study was to examine which PA intensity has the strongest association, independent of the total volume of PA, with different types of adiposities (i.e., TBF, VAT, and IMAT) in young adults. TV viewing was also examined since it is known to be an independent predictor of adiposity in youth. As expected, MPA, MVPA, VPA, total PA, and TV viewing all showed significant associations with lower levels of adiposity in the study participants. However, sedentary time did not show any association. VPA, and TV viewing for males as well as MPA, MVPA, VPA, and TV viewing for females were identified as significant predictors for TBF (independent of total PA and, for TV viewing, independent of total sedentary time). However, we did not find any significant associations between PA intensities and VAT or IMAT.

We focused on young adulthood, a critical time when individuals are exposed to various unhealthy lifestyle factors including increases in TV viewing time, physical inactivity, fast food intake, and alcohol consumption [14-16]. By demonstrating evidence that different intensities of PA have different associations on TBF in young adults, we provide insight as to which prescription of PA participation is the most efficacious for maintaining healthy body composition or reducing regional adiposities in young adults. Furthermore, this study provides supportive evidence in order to establish healthy PA guidelines, particularly for young adults.

In agreement with previous findings in youth [9,46-48] and adults [49], our results showed significant associations between TBF and VPA in both male and female participants. Specifically, the primary result of our study demonstrated that VPA was more strongly related to TBF compared to other intensities in males. In females, the relationship of VPA to TBF was also significant but similar in magnitude to the relationship of MPA and MVPA to TBF. Therefore, we could suggest at least a moderate intensity of regular PA is required to maintain healthy body composition status or reduce adiposity in females. In other words, initiating even a moderate activity may result in changes in body composition in female young adults. On the other hand, at least vigorous intensity of PA may be suggested to maintain healthy body composition in male young adults who are relatively physically active than females [41,50,51].

Regardless of age, sex, or health status, the primary barrier of regular PA participation is a lack of time in the general population [52]. Accumulated evidence has suggested that a relatively shorter duration of VPA is time-efficient and has similar benefits when matched to continuous lower intensity activities [53]. For example, Scott, et al. [54] reported the effects of a minute of VPA correspond to 2 or 3 minutes of MPA on the same improvement in body composition. In addition, Bartlett, et al. [55] reported that high-intensity interval training (90% of VO_2max, running 6 times at 3 minutes per interval) showed a greater rate of perceived enjoyment (retrospectively measured) compared to lower intensity running (70% of VO_2max, continuous 50 minutes). Based on the findings of this study and previous studies, VPA might be an efficacious PA strategy for managing healthy body composition in young adults. Future research in a well-designed randomized controlled trial to compare the effects of vigorous and other intensities of PA on adiposity, especially in young adults, is needed.

Our results found no relationship between sedentary time and any adiposities. This result coincides with previous findings that MVPA and/or VPA, not sedentary time, were strongly associated with lower levels of adiposity in youth [10-12]. Thus, our result suggests that sedentary time itself in young adulthood may not directly lead to excessive adiposity deposition. However, we did find that TV viewing, independent of sedentary time and total PA, was associated with TBF in males and TBF and VAT in females. This finding is also consistent with previous findings in youth [11,26,27] and adds to the sparse literature addressing young adults' PA behavior. The effect of TV viewing but not sedentary time on adiposity might be largely due to excessive unhealthy eating that may accompany with TV viewing [56]. Another possible reason might be that nighttime sleep disturbance, associated with TV viewing [57], influences the accumulation of adiposity. TV viewing has been reported as a significant risk factor for metabolic health in adults including those who meet the U.S. PA Guideline of MVPA of ≥ 150 min/week [58]. Current public health approaches may be more effective with a shift from reducing all sedentary behavior to a more specific recommendation on TV viewing.

In our regression models, a significant association between PA intensities and VAT or IMAT was not found (data not shown). Jiménez - Pavón, et al. [59] have reported that VPA had a stronger association with waist circumference measured central adiposity in female youth, compared to MPA or MVPA. Moreover, waist circumference or waist-to-hip ratio has shown the stronger negative association with VPA than MPA or MVPA in youth [60-63]. However, it is unclear if the different intensity of PA moderates the relationship between VAT and PA in young adults. To the best of our knowledge, our study is the first study to examine the relationship between sedentary time, PA intensities, the total volume of PA, and IMAT in young adults. In our study, IMAT measured at calf did not show any correlations with PA variables or sedentary time in both males and females. It may be that the variability in IMAT in our sample was not large enough to detect associations with PA. Generally, benefits of PA for attenuation of IMAT deposition is mediated by the movement of skeletal muscle [64], which leads to fatty acid oxidation; therefore, PA is involved in IMAT accumulation [65]. However, we could not confirm if different PA intensities and sedentary time have a different association with IMAT. Further investigation to examine the relationship between IMAT and PA intensities or sedentary time in young adults is warranted.

This study has several limitations. First, the study was conducted based on a cross-sectional design, which is inadequate for determining causality between the exposure and outcome variables. The associations between exposure and outcome variables may be bi-directional (i.e., reverse causation). Second, this demographic of samples (i.e., aged 19 years, relatively high socio-economic condition, and Caucasian Midwestern residents) may not allow the results to be generalized to a wider population. Third, we did not study the energy intake of participants in the cross-sectional period and the past, which may be a crucial confounding factor to the associations between PA and adiposity. Fourth, we only studied TV viewing time but no other types of screen time (e.g., smartphone, tablet, or computer use) which is a risk factor related to physical inactivity and adverse health outcomes. On the other hand, our study has strengths in that we recruited a relatively large number of 19-year-old participants with homogeneous characteristics, PA and sedentary time were objectively measured, and we employed criterion measures for adiposity.

Conclusion

In conclusion, not only VPA but also MPA, MVPA and TV viewing, independent of total PA and sedentary time respectively, showed significant associations with adiposity in young adults. The study results show that every 10 min/day increase in regular VPA is associated with a 2.2 kg lower TBF in male young adults. In females, every 10 min/day increase in MVPA and VPA are associated with 2.7 kg and 1.2 kg lower TBF, respectively. In addition, every 1-hour increases in TV viewing are associated with 0.18 kg and 0.12 kg higher TBF in male and female young adults, respectively. Therefore, based on the study results, we suggest that increasing PA intensity and restricting TV viewing time (and thus, perhaps, unhealthy eating habits), rather than reducing comprehensive sedentary time, may be a more effective strategy in maintaining healthy body composition. We demonstrated that the PA recommendations of MVPA for healthy body composition for Americans might be adequately applied to young adults aged approximately 19 years [66]. PA interventions should suggest to female young adults to "move more" and males to participate in more intense activities. Our findings could be useful for health professionals or prevention programs in the development of efficient PA interventions by reflecting how PA changes in young adults [21].

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Informed consent

Informed consent was obtained from all individual participants included in the study.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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