

Effects of sitting time associated with media consumption on physical activity patterns and daily energy expenditure of Saudi school students

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Abstract. [Purpose] This study was performed to assess the effect of daily sitting time during media consumption on physical fitness, total energy expenditure (TEE), and body composition indices of Saudi school children. [Subjects and Methods] A total of 180 healthy Saudi school students (8–18 years) were included in this study. Sitting time, total energy expenditure, and levels of physical activity were evaluated with pre-validated internet based questionnaires. Body composition indices were evaluated using anthropometric analysis. [Results] Out of the studied participants, only 22.2% of students were physically inactive. Children with moderate and active physical scores demonstrated less sedentary behavior (TV viewing and computer usage), lower body composition values (BMI, WC, WHtR), and higher TEE than sedentary or mild activity level participants. Boys showed higher fitness scores and less sedentary behavior than girls. Media sitting time among the studied subjects correlated negatively with physical scores and positively with body composition. [Conclusion] The data presented here suggests that poor physical fitness, lower TEE, and longer sitting times differentially influence normal body composition indices among school children which may lead to overweight or obese individuals. Thus, decreasing sitting time during media consumption and enhancing physical activity may play a pivotal role in preventing obesity in young children. **Key words:** Media sitting time, Body composition, Physical activity

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INTRODUCTION

Being overweight or obese is considered to be one of the biggest risk factors of poor health among school children worldwide¹⁾. Previous studies have shown a significant increase in obesity over a 12 year period, in all age groups of children and adolescents which was likely to result in them become overweight adults^{2, 3)}. Studies have proposed the inclusion of daily physical activity as an essential intervention to prevent obesity among school populations^{4–7)}.

Recently, leisure time has become more sedentary because of activities such as watching television (TV), playing video game, and surfing the internet, and more people, especially in industrialized countries are expending less daily energy³⁾. A sedentary lifestyle has been associated with increased risk of obesity and related diseases (e.g., diabetes)^{8–10)}. The average time spent watching TV in the US, Europe, and Australia has been reported to be 5 hours, 3.5 hours and 4 hours, respectively⁷⁾. During leisure time, the proportion of

time spent watching TV while sitting and using a computer has increased from 26% in 1975 to 43% in 2005¹¹⁾.

Physical activity has been shown to lower the genetic predisposition to increased body mass index (BMI)^{12, 13)}. It has been widely reported that an active lifestyle during childhood and adolescence optimizes growth and development^{14–16)}. The body mass index has also been found to be related to total percentage of body fat in both boys and girls which can be influenced by genetic predisposition and environmental factors^{17–23)}.

Different instruments have been used to measure daily physical activity including physiological (e.g., oxygen consumption, heart rate) and behavioral tools (e.g., questionnaires, interviews, diaries)^{24, 25)}. It is also important to investigate the amount of time spent performing sedentary activities daily (e.g., television, electronic games, computers), which may contribute to increased weight, body fat, blood pressure, and serum lipids^{26, 27)}. Because of the increased prevalence of overweight and obese youth and the risk of subsequent chronic disease in adulthood, it is important to determine the correlates of obesity in youth^{28, 29)}. However, to the best of our knowledge, there have been no studies that have examined the relationships between physical activity and sedentary behaviors (such as TV viewing, computer usage, and passive commuting) among obese and non-obese Saudi children and adolescents. Therefore, understanding the effect of sitting time associated with media consumption

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on lifestyle and physical activity patterns is important for the development of health-promoting interventions among schoolchildren who exhibit these behaviors. Accordingly, this study was performed to assess the effect of daily sitting time associated with media consumption on physical fitness, total energy expenditure, and body composition indices of Saudi schoolchildren.

SUBJECTS AND METHODS

A total of 214 healthy Saudi school students (8–18 years; mean ±SD age = 14.40 ±2.36 years) from different Saudi schools were recruited for this study during the period of 2013–2014. The study lasted three months and the participants were recruited through electoral roll randomized selection. Out of these, only 180 healthy participants (90 boys, 90 girls) were included in the study. None of the school children included in this study reported any kind of disability such as cerebral palsy, muscle weakness, or paralysis. All the participants provided informed consent before participation and this study was approved by the Ethical Committee of

Rehabilitation Research, Chair of King Saud University. The demographics and baseline characteristics of the participants are shown in Table 1.

Children or their parents were asked to assess the average number of minutes per day (weekdays and weekend days combined) that the children spent with screen media (TV, video, computer, and video game usage)³⁰. TV viewing time was defined as the time spent watching TV, videotapes, or DVDs, while computer time was defined as the time spent on a home computer or playing video games.

Body mass was measured to the nearest 0.1 kg using a portable digital metric scale, that was calibrated using standard weights. Standing height was measured to the nearest 5 mm using a wall-mounted height board and BMI was subsequently calculated as body mass/height² (kg·m⁻²). Waist circumference (WC) was measured as the minimum circumference between the iliac crest and the rib cage³¹ and WHtR was calculated as WC divided by height.

The participants' pattern of physical activity was measured with the short form International Physical Activity Questionnaire (IPAQ)^{32, 33}. The participants were asked to

Table 1. Demographic data of the school children participating in the study (mean ±SD; n=180)

	Boys (n=90)	Girls (n=90)	Total (n=180)
Age (y)	14.69 ±2.39	14.01 ±2.26	14.40 ±2.36
Height (cm)	169.6 ±7.4	165.6 ±6.9	167.8 ±7.2
Weight (kg)	69.72 ±7.4	66.1 ±7.97	67.9 ±8.1
BMI (kg/m ²)	23.1 ±3.3**	24.11 ±2.1	24.6 ±4.1
WC (cm)	100.70 ±18.67**	111.27 ±20.15	108.5 ±18.7
WHtR	0.49 ±0.09 **	0.43 ±0.05	0.48 ±0.08
BMR (kcal/day)	1,749 ±124.6**	1,518 ± 94.9	1,635 ±109.8
TEE (kcal/day)	2,662 ±328.7**	2,261 ±417.5	2,463 ±375.6
7-d Activity (counts /min)	476 ±98.7**	436 ±68.3	462 ±88.7
Television Viewing (h/d)	2.52 ±0.93**	2.72 ±1.0	2.64 ±1.2
Computer usage (h/d)	2.93 ±0.85**	2.56 ±0.87	2.75 ±0.86

Data expressed as mean ±SD; p < 0.05, ** p < 0.01; *** p < 0.001. BMR: basal metabolic rate (kcal/day); TEE: total energy expenditure (kcal/day). WC: waist Circumference (cm)

Table 2. Association between body composition indices, energy expenditure, total sitting time during media consumption and physical activity status of school children (N = 180)

	Mild (n=40; 22.2%) (≤ 500 METs-min/ week)		Moderate (n=35; 19.4%) (500–2500 METs-min/ week)		Active (n=105; 58.3%) (≥ 2,500 METs-min/ week)	
	Boys (n=10)	Girls (n=30)	Boys (n=15)	Girls (n=20)	Boys (n=65)	Girls (n=40)
BMI (kg/m ²)	30.4± 4.2	26.9± 6.4	25.3± 2.6**	24.1± 2.4**	21.8± 1.3**	22.6± 2.4**
Waist (cm)	112± 7.9	102± 27.9	85± 18.5**	98± 5.8**	65± 16.5**	81± 4.5**
Hips (cm)	98± 7.5	88.5± 8.9	100± 9.1**	81.5± 5.4 **	85± 6.3**	78.6± 2.3**
WHtR	0.59±0.09	0.62± 0.05	0.49± 0.06**	0.48± 0.03**	0.44± 0.08**	0.45± 0.06**
BMR (kcal/day)	1,410± 45.3	1,542± 38.5	1,761± 76 **	1,545± 76.2**	1,735± 88.5**	1486± 75.8**
TEE (kcal/day)	1,765± 120.8	1,786± 98.5	2,560± 252**	2,320± 314.5**	2,850± 314.5**	2690± 180.5**
Television Viewing (h/d)	2.9± 1.3	3.6 ± 0.96	2.6± 0.96**	3.1± 0.85**	1.9± 0.73**	2.6± 0.81**
Computer usage (h/d)	3.5± 0.89	3.4± 0.85	2.8± 0.88**	3.0± 0.83**	1.85± 0.83**	2.3± 0.75**
TMST (h/d)	3.1± 1.5	3.9± 1.6	2.6 ± 2.7**	3.2± 0.56**	1.66± 1.3**	2.7± 1.6**

Data expressed as mean ±SD; p < 0.05, ** p < 0.01; *** p < 0.001. BMR: basal metabolic rate (kcal/day); TEE: total energy expenditure (kcal/day); TMST: total media sitting time

report the average number of days per week and minutes per day during which they participated in physical activities. The total number of weekly minutes of walking as well as moderate and vigorous physical activity was computed according to the IPAQ scoring manual^{34, 35}. The participants were classified according to physical activity level; mild (≤ 500 METs-min/week), moderate (500–2500 METs-min/week), or active (≥ 2500 METs-min/week).

Basal metabolic rate (BMR) and total daily energy expenditure (TDEE) were estimated from body mass, height, age, sex, and physical activity according to the Harris and Benedict equation³⁶. These calculations were performed for both obese and non-obese children.

Statistical analyses were performed using SPSS version 13.0 for Windows (SPSS Inc., Chicago) and data are presented as the mean \pm SD. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test and since body mass values were skewed, a non-parametric (Mann-Whitney U) test was adopted to compare normal and overweight children. Associations between BMI, physical activity level, and other variables were calculated using correlation coefficients (r & β) tests. Statistical significance was accepted for values of $\alpha < 0.05$.

RESULTS

Overall, 180 Saudi school students participated in this study and Table 1 shows the characteristic baseline values of the participants. Boys had significantly higher ($p < 0.01$) WHtRs and lower ($p < 0.01$) WCs and BMIs than girls. However, girls reported significantly lower ($p < 0.01$) physical activity, BMR, TEE, and computer usage values along with significantly higher ($p < 0.01$) TV watching times than boys.

Based on physical activity, the students were classified into three groups; mild ($n=40$), moderate ($n=35$), and active ($n=105$). Table 2 shows the effect of these scores on body composition indices, energy expenditure, and total time spent sitting during media consumption. The exercise levels were found to directly affect the body composition indices of the participants. The students in the moderate and active physical activity groups had significantly lower ($p=0.01$) BMI, WC Hips circumference, and WHtR values than those of the low or sedentary physical activity group students with longer media sitting times (Table 2). Also, the values of

significantly higher BMR and TEE and significantly lower sitting time were greater in the physically active boys than in the physically active girls (Table 2). The findings of this study suggest that physical activity, especially at moderate and active intensities, may be effective at reducing high body weights and obesity caused by sitting while consuming media for long periods.

Tables 3 and 4 present the partial correlation coefficients and the results of the multiple regression analysis (r and β) of physical activity, media time, and body composition indices. The students in the moderate and active physical activity groups showed significant inverse correlations with the body composition indices, BMI ($p < 0.001$), WC ($p < 0.001$), and WHtR ($p < 0.001$), and a positive association with TEE ($p < 0.001$) (Table 3).

Finally, for girls, there were significant positive correlations between total media time and BMI ($p < 0.001$), WC ($p < 0.001$), and WHtR ($p < 0.001$). In boys, computer usage was the only variable that was significantly associated with body composition ($p < 0.001$). Physical activity scores and TEE correlated negatively with total media time, TV viewing, and computer usage in all participants (Table 4).

DISCUSSION

Although genetics, nutrients, and hormones are major determinants of the normal maturation and growth of children,

Table 3. Correlation coefficients (r and β) between body composition indices, energy expenditure, and physical fitness score of school children derived from partial correlation and multiple regression analysis

Body composition and TEE rate	Physical fitness score	
	r	β
BMI	-0.415 ***	-0.015 **
WC (cm)	-0.522 ***	-0.025 ***
WHtR	-0.396 ***	-0.012 ***
TEE (kcal/day)	0.275 ***	0.48 ***

** $p < 0.01$; *** $p < 0.001$. BMR: basal metabolic rate (kcal/day); TEE: total energy expenditure (kcal/day); TMST: total media sitting time; BMI: body mass index, WC: waist circumference, WHtR: waist height ratio

Table 4. Correlation coefficients (r & β) between body composition indices, energy expenditure, physical fitness score, and total sitting time during media consumption of school children derived from partial correlation and multiple regression analysis

Body composition	Total media time (h/d)		TV (h/d)		Computer usage (h/d)	
	r	β	r	β	r	β
BMI	0.64**	0.011**	0.98**	0.035**	0.74**	0.042**
WC (cm)	0.53**	0.021**	0.64**	0.028**	0.39**	0.031**
WHtR	0.91**	0.029**	0.49**	0.027**	0.23**	0.036**
physical fitness score	-0.245**	-0.009**	-0.123**	-0.013**	-0.250**	-0.048**
TEE (kcal/day)	-0.115**	-0.012**	-0.145**	-0.019**	-0.265**	-0.057**

** $p < 0.01$; *** $p < 0.001$. BMR: basal metabolic rate (kcal/day); TEE: total energy expenditure (kcal/day); TMST: total media sitting time; BMI: body mass index, WC: waist circumference, WHtR: waist height ratio

the level of habitual physical activity is another factor that affects several biological traits, including body composition^{37, 38}).

Recently, studies have proposed that the higher rates of low physical activity among young persons may be related to changes in social and environmental factors that initiate sedentary behaviors^{39, 40}. These changes may affect the body composition indices of children and adolescents leading to childhood obesity that can extend into adulthood with consequent health issues such as cardiovascular and metabolic diseases⁴¹.

In this study, the potential effects of media time and computer usage on physical activity, total energy expenditure, and body composition indices were investigated.

The girls reported longer average daily hours of watching TV than boys of the same age. These findings agree well with previous studies that have also reported females have longer average of media times than to males^{42, 43}. However, boys showed higher computer usage than girls. Previous research has reported that young adults (18–30 years) spend almost twice as much of their leisure time using a computer than older adults⁴⁴. Our present data is also in agreement with studies that concluded gender was associated with computer time and TV viewing⁴⁵; gender may be a determinant of screen-viewing time in young adults.

In this school-based study, the negative effects of TV viewing and computer usage on body composition were only observed in girls. Although there were significant increases in BMI, WC, and WHtR in girls who reported more screen-viewing time, computer usage was the only variable that was significantly correlated with body composition in boys.

Partial correlation and regression analysis revealed significant positive correlations between body composition parameters and total sitting time, TV viewing, and computer usage. This result is supported by other studies that showed an increase in BMI in response to a greater number of hours watching TV in childhood and adolescence, which may extend into adulthood^{24, 25}. An increase in TV viewing has been associated with BMI in both children and adults^{9, 46}; however, this relationship is stronger among young children²⁷. These results support the recommendation that children and adolescents should only spend two hours per day watching TV^{47, 48}.

The present study investigated the effect of TV viewing and computer usage on TEE and revealed that girls had lower values of TEE than boys. There was an inverse correlation between total screen viewing (TV watching and computer usage) and these results agree with a previous study that addressed the link between TV viewing and energy expenditure in older children⁴⁹. The reduction in TEE may be related to the fact that a considerable amount of girls' daily energy intake is spent while watching TV⁵⁰. Also, TV watching increases the consumption of food, consequently resulting in a higher energy intake in children^{51, 52}. Furthermore, a decrease in TV viewing has been shown to have a positive effect on BMI by reducing energy intake⁵³.

TV viewing and computer usage are habits of a sedentary lifestyle that is linked with lower total energy expenditure (TEE); thus, it should be monitored in children to overcome obesity⁵⁴. Most studies have shown that during TV viewing,

TEE may be slightly higher (18%) than the resting metabolic rate (RMR) in adolescents and adults^{55, 56}.

Physical inactivity promoted by a sedentary lifestyle may play a role in increasing the number of overweight and obese children^{57, 58}. Therefore, being able to estimate the potential correlation between physical activity, a sedentary lifestyle, and body composition in young children and adolescents may be useful for understanding the etiology of childhood obesity.

The present study examined physical activity levels in relation to body composition as parameters of physical fitness in Saudi schoolchildren. The participants were classified into three activity level groups: mild (22.2%), moderate (19.4%), and active (58.3%). It was found that physical activity significantly correlated with better physical fitness as measured by body composition and TEE levels in boys but not girls. Boys with higher physical activity levels had better BMIs, WCs, and WHtRs than those in the mild or sedentary activity level groups. In physically active children, of both genders, physical fitness status showed significant inverse correlations with BMI ($p < 0.001$), WC ($p < 0.001$), and WHtR ($p < 0.001$), and a positive association with TEE ($p < 0.001$). The data presented here are in agreement with previous studies in different adolescent populations worldwide that reported that boys had better fitness than girls^{40, 59, 60}. These differences in physical fitness between the genders may be due to variances in hematological parameters and ventricular chamber sizes⁶¹.

Similarly, a positive relationship was observed between overall obesity in both genders and physical inactivity during the transformation from adolescence to adulthood, and it was linked with abdominal obesity in females at the age of 31 years⁶². Other research has also discussed the link between obesity and physical inactivity (i.e., lower fitness) in adolescents and children, and proposed that low physical activity is one of the biggest factors connecting obesity and impaired physical fitness^{63–66}.

In the study presented here, physically active participants had significant negative relationships between physical fitness and total time spent watching TV media and computer usage compared to participants in the mild activity level group. In the female sample, those who spent more time in front of a screen showed lower levels of physical activity than boys. These data are in agreement with others the results of other researchers who have reported statistically significant relationships between TV viewing times and body fat percentages in children and youth²⁷.

It has been reported that patterns of physical activity and behaviors of a sedentary lifestyle play a pivotal role in weight gain⁶⁷ and that media-based screen time such as TV viewing and computer usage interfere with the time that should be spent being physically active⁶⁸. Most studies have reported that children watching TV for fewer hours have lower obesity rates than those who watch TV for four hours or more⁶⁹. Thus, reducing sedentary behaviors in children should be considered as one of the most important interventions for reducing and treating obesity²⁶. Finally, the data show that physically inactive students with sedentary behaviors such as time spent in front of screen may be at risk of overweight and obesity syndromes.

In conclusion, the data suggest that poor physical fitness, lower TEE, and more time spent sitting while consuming media may differentially influence normal body composition indices among schoolchildren and may lead to diseases associated with being overweight or obese. Thus, decreasing sitting time while consuming media and enhancing physical activity, may have an important role in preventing obesity in young children.

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