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Effects of Intervention in Active Transport to School of Adolescents in Improving their Body Composition in Europe

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Abstract

A health body composition is related to various factors including age, gender, attitudes, travel behavior, physical activity, and nutrition. Sedentary behavior and physical activity are determined as correlates of obesity, higher levels of body mass index (BMI), and inefficient levels of maximum Oxygen uptake(VO2 max). This paper aims to determine active transportation to and from correlates of BMI, VO2 max, and body efficiency in adolescents of five European countries including Greece, Poland, Croatia, Italy, and turkey. Two Multivariate Weighted Least Square (WLS) models and a Multinomial Logit regression (MNL) are applied to assess the relation between active transportation to and from school and BMI, VO2 max, and body efficiency respectively. The findings of this paper show that BMI and VO2 max are associated negatively with walking per week (days) and walking per day (hours) respectively. While there is a positive correlation between walking per week, (hours) and VO2 max In addition, the results of this study confirm that walking to and from school is linked with improvement of body efficiency from poor and fair status to the good level. This paper suggests using active transportation to obtain a better and healthier body composition in adolescents. This paper has five main sections, including 1-introduction, 2-Methodology, 3- Findings, 4- Discussion, and 5- Conclusion.

Keywords: Active transportation to school (ATS), body composition, body mass index (BMI), maximum Oxygen uptake (VO2 max), adolescents

1-Introduction

Obesity is a major health problem in the world, increasing the risk for diabetes, heart disease, hypertension, and various cancers (Freedman and Perry 2000; Baumgartner 2000; Bosy-Westphal and Müller 2021). Obesity in adolescents is also related to adverse levels of blood pressure, insulin, and other risk factors. Poor body efficiency in childhood and adolescence time will cause to adverse health outcomes in adulthood. Some investigations have confirmed that even after controlling for weight in adulthood, childhood obesity may influence health status (Freedman and Perry 2000; Willett et al. 1995).

Indeed, several studies concerning the association of "obesity" with disease risk is based on simple combinations of weight and height (Freedman and Perry 2000). Body composition is a key component of health in both individuals and society. The increasing numbers of obesity and poor body efficiency in children and adults have highlighted the importance of body composition for short-term and long-term health (Wells and Fewtrell 2006). Not only weight but also several components of body composition, in particular the amount and distribution of body fat, the amount and composition of lean mass, the amount of maximum Oxygen uptake (VO2 max), and body mass index (BMI) are now understood to be important health outcomes in children and adolescents. Age and gender are two important factor on evaluating body composition (Heyward 1996).

The assessment of body composition presents a suitable tool to assess nutritional and health statutes (Marra et al. 2019). Body Mass Index is a good indicator and still a widely used variable for the quantitation of body mass in health and disease. BMI does not show changes in energy partitioning as fat and lean mass during puberty (Bosy-Westphal and Müller 2021). During adolescence increasing BMI has different interpretations between girls and boys. Maximum Oxygen uptake (VO2 max) is an accepted indicator to assess personal cardiorespiratory fitness. Body composition and body efficiency is related to exercise and physical activity (PA) (Bandyopadhyay and Chatterjee 2003). Increased physical activity is associated with health status directly. Modernization and car-dependent cities led to passive lifestyles particularly, in young ages. Active transportation mode choices are suggested by governments around the world (Giles-Corti et al. 2010). The study confirmed the effectiveness of using cycling and walking for commuting among adults in the health in the UK (Jacob et al. 2021). Walking is correlated with a lower probability of being overweight and having hypertension, diabetes, and mental disease in compared to passive mode transportation (Tajalli and Hajbabaie 2017). (Mattisson et al. 2018) analyzed the association between health and mode choices in Sweden by employing Discrete Multinomial Logit (MNL). According to that study physical health was negatively correlated to active and public modes. (Schauder and Foley 2015) investigated the relationship between active transportation and health. The findings of that study showed active modes have contributed to reductions in cholesterol level and obesity. Also, a review investigation on the association between physical activity (PA) and health discussed active transportation (AT) can bring substantial health benefits (Mueller et al. 2015). (Dinu et al. 2019) discussed active transportation had significantly reduced risk of all-cause mortality, cardiovascular diseases and diabetes. AT was measured among university students and based on the results, active travelers to campus had better cardiovascular health and had lower blood pressure compared with inactivity students (Bopp et al. 2015). (Larouche et al. 2014a) explained biking is correlated with more health benefits than walking in Canada. However, both walking and baking are associated with health status. (Ulbricht 2014) assessed body composition and AT in adolescents of metropolitan region of Curitiba, Brazil. People who use AT to school had lower body fat and fewer hours secondary lifestyles than other in Curitiba. The findings of another study on the association AT to school and health benefits confirmed the effectiveness of AT, particularly, cycling is associated with more cardiovascular fitness among schoolchildren compared to walking (Larouche et al. 2014b). (Hsu et al. 2019) assessed the impacts of exercise and nutrition on body composition. According to that study the combination of aerobic exercise and resistance exercise decreased fat mass and improved walking speed and grip strength. An investigation on effectiveness of 24 months intervention and increasing physical activity showed long-term increased physical activity are associated with improvement in BMI and obesity status of adolescents (Durá-Travé et al. 2020). Also, the findings of that study confirmed the highest and fat free mass index increased significantly after intervention period. (Lazaar et al. 2007) evaluated the impacts of school-based PA on the body composition based on BMI and gender. The findings of that investigation showed six months of PA intervention led to improved body composition. The pattern of BMI category was different between obese and nonobese children but was similar based on gender (Lazaar et al. 2007). An intervention program for 6-12 months led to dropping in BMI of obese boys and girls. The amount of lean mass did not change by intervention in adolescents (Dao et al. 2004). The correlations between moderate-to-vigorous physical activity and central body fat indicators were assessed by (Martinez-Gomez et al. 2011). The results of that study on central body fat of young children showed there is a significant inverse relationship between indicators of central body fat and moderate-to-vigorous physical activity. The associations between moderate-to-vigorous physical activity and body fatness in children were analyzed in Chinese urban school. The findings that study illustrated considerable results on the different pattern between boys and girls. In other words, moderate-to-vigorous physical activity was correlated to lower percentages of fat in nine-years old girls. While there was no relation between moderate-to-vigorous physical activity and fat percentages among boys in the same age (Li et al. 2007). (Aars et al. 2019) studied the correlations between self-reported physical activity and body composition in Norwegian adolescents. Self-reported physical activity was positively associated with lean mass index and negatively correlated with fat mass index in Norwegian adolescents. While, there was no associations between physical activity and BMI in both gender (Aars et al. 2019). Reallocating 15-30 minutes of secondary time into moderate-to-vigorous physical activity was negatively related to body fatness in children (Sardinha et al. 2017).

The impact and power of associations between different level of physical activity and different components of body composition vary in different age groups, gender, and countries. Although several studies investigated associations between physical activity and improved body composition status, there is a need to more studies to consider different components of body composition and compare results in different age, gender and also context to reach deep understanding and consistent results. Policy makers and strategists need to consistent findings on the level of physical activity related to improved body composition to tackle obesity and other dependent diseases for children and adolescents. Although, there is a rich body of literature, the most of our knowledge come from North America and high-income countries in North Europe. There are shortcomings on different countries with different policies and programs, socioeconomic conditions and different culture and attitudes. The one of objectives of the current study is to fill knowledge gap in less or non-studied context. This study aims to assess the associations of active transportation to school (ATS) with BMI and VO2 max in five European countries including Poland, Greece, Italy, Croatia, and Turkey. Changing from passive transportation into ATS was suggested to adolescents 14-18 years old (intervention). Another objective of this paper is to evaluate the impact of intervention on physical activity level not only for commuting but also for leisure purposes. The last but not least aim of this study is to determine ATS correlates of body efficiency in adolescents. Due to aims and answering to research questions the rest of this paper is presented as follows. Research questions, hypothesis and methodological approach of this paper are presented in section 2. Section 3 is a summery of findings. A brief discussion of findings of this paper as long with comparison to other studies are discussed in section 4. Finally, Finally, section 5 presents the conclusions.

2- Methodology

2-1- Research questions and hypothesis

Three research questions have been answered in this paper: (1) to what extent can an intervention in school mobility mode affect the levels of active school transport and physical activity of European adolescents? (2) which active school mobility factors significantly influence European adolescents' body composition including Body Mass Index and VO2 Maximum? and finally (3) can adolescents improve their body efficiency only by walking to school and back? The main hypothesis of this study is that ATS, particularly walking can effectively improve the BMI, VO2 max, and body efficiency of the adolescents of 14 to 18 years of age in European cities.

2-2- Data and Variables

The data used in this study was gathered in mid-2022 (when the Corona pandemic was almost over in most of the European countries) under a project called "Promotion of Physical Activity of the Youth through Active Mobility to School" (PAYAMOS) funded by the European Commission. The data collection focused adolescents of between 14 and 18 years in Italy (Sassari), Greece (Thessaloniki), Poland (Krakow), Turkey (Malatya), and Rijeka, Croatia. During the baseline and follow-up data collection phases, the respondents' bodies were measured and tested, and they were interviewed twice, once before the intervention and once after it. The overall sample included 990 respondents including 188 adolescents in Sassari, Italy; 244 in Thessaloniki, Greece; 247 in Krakow, Poland, 153 in Malatya, Turkey, and 158 in Rijeka, Croatia. The 40-question data collection instrument consisted of non-standard questions prepared by the project team focusing on individual, household, and mobility traits, as well as the short version of the International Physical Activity Questionnaire (IPAQ) and a European project named "Assessing Levels of Physical Activity and fitness at population level" (ALPHA). Seven individual and household factors including age, household size, car ownership, number of people with a job, length of time of living in the current home were considered in this study. The ATS, mobility habits in leisure time, and the PA were taken from the IPAQ section of the questionnaire. The mobility-related questions collected data about the mobility habits per week (day), per day (hour), and per day (minutes). The PA variables were all related to the leisure times and included vigorous physical activity per week (day), vigorous physical activity per day (hours), vigorous physical activity per day (minutes), moderate physical activity per week (day), moderate physical activity per day (hours), and moderate physical activity per day (minutes). Two variables represent body composition in this study: BMI, and VO2 max (ml/kg/min). These data were gathered using the equipment explained in the Intervention part of the methodology section of this paper. VO2 max is the body's oxygen potential, which was calculated computationally from the nomogram by combining the lines of HRO2 (oxygen heart rate values) with the value of the work done and body weight (kg). BMI was quantified by means of body composition analyzer TANITA BC 420, by dividing weight (kg) by height (cm) multiplied by 100. The descriptive statistics of the continuous variables of this paper (all except body efficiency) have been summarized in Table1. Finally, the physical efficiency (the only categorical variable of this study) was estimated by ASTRAND-Rhyming test, resulting in a 7-cateogry classification including very poor, poor, fair, average, good, very good, and excellent. The values of these categories for the overall sample was 41, 117, 53, 34, 14, 8, and 1 for the range of very poor to excellent, and 6 could not be classified by the test equipment. All the above variables and data, except the individual, household, and socio-economic variables, which were constant, were collected before and after the intervention that has been explained below.

2-3- Analysis Methods

In order to answer the first research question of this paper, the significance of differences between the values of fourteen variables of ATS and PA including motorized vehicles per week (day), motorized vehicles per day (hours), motorized vehicles per day (minutes), biking per day (hours), biking per day (minutes), walking per week (day), walking per day (hours), walking per day (minutes), vigorous physical activity per week (day) in leisure time, vigorous physical activity per day (hours) in leisure time, vigorous physical activity per day (minutes) in leisure time, moderate physical activity per week (day) in leisure time, moderate physical activity per day (hours) in leisure time, and moderate physical activity per day (minutes) in leisure time were checked by T-test (Table 2). The PA variables are related to the leisure times. The reason for using the leisure times is to examine the effects of changing school mobility on the PA of the adolescents in leisure/entertainment times, as it is expected that these are hypothetically connected. As a significance threshold, P-values of less than 0.05 were taken as significant results.

For finding the significant ATS correlates of body composition, two multivariate Weighted Least Square (WLS) models were developed for the dependent variables of BMI and VO2 max as representatives of body composition measures. These two dependent variables were related to the aftermath of intervention. Two different types of independent variables were included in the models: individual and household variables such as household size, car ownership, number of people with job, and length of time of living in the current home as well as ATS and PA variables listed in tables 1. The models were generated by eliminating the insignificant independent variables from the models, so the best model fit including R^2 and F-test results as well as the most possible number of significant independent variables were resulted. The models were weighted for the variable age. The age of all the participants were between 14 and 17 years in general and 14 and 18 years in Italy. Weighting the model based on age, adjusts the model results based on different ages and reduces the effect of age on correlates. For checking possible multicollinearity, variance inflation factor (VIF) was calculated for all independent variables, where values of between one and three indicated no multicollinearity. The validity of the output models was tested by ANOVA – F-test, whereas P-values of less than 0.05 indicated a valid model.

For answering the third research question about possibility of improving body efficiency only by walking to and from school, Multinomial Logit regression (MNL) was applied, where the dependent variable was the number of days of walking to school per week when two other active transport variables, i.e. walking per week (day) in leisure and motorized vehicle use per week (day) were controlled for. The dependent and independent variables of the model were all related to the times in which the participants increased their ATS during the intervention. The MNL model would clarify if participants have equal levels of walking during leisure times and motorized transportation, then how would the correlation between walking to and from school and body efficiency results change. The "good" body efficiency category was taken as the reference category; thus, the model could clarify the needed number of walking to and from school to change the weak body efficiency results to a good level. For checking the validity of the model, the Chi-square P-values of less than 0.05 would suggest a valid model.

Table 1: The descriptive Statistics of the variables used in this study.

Variable Type	**Variable**	**N**	**Mean**	**Std. Dev.**	**Variable Type**	**Variable**	**N**	**Mean**	**Std. Dev.**
Individual and Socioeconomic Variables	Age	957	15.89	1.25	ATS and PA variables related to during the intervention	Motorized vehicles per week (day)	248	3.82	2.05
	Household size	990	4.18	1.24		Motorized vehicles per day (hours)	65	1.74	0.87
	Car ownership	990	1.68	1.02		Motorized vehicles per day (minutes)	79	26.66	10.58
	Number of people with job	990	1.88	0.83		Biking per day (hours)	70	1.89	1.34
	Length of time of living in the current home	990	11.84	5.96		Biking per day (minutes)	58	28.17	11.86
ATS and PA variables related to before the intervention	Motorized vehicles per week (day)	835	4.48	2.47		Walking per week (day)	274	5.58	1.80
	Motorized vehicles per day (hours)	612	2.42	1.83		Walking per day (hours)	73	1.45	0.76
	Motorized vehicles per day (Minutes)	459	23.25	13.62		Walking per day (minutes)	110	26.27	9.52
	Biking per day (hours)	171	1.79	1.,35		Walking per week (day) in leisure time	228	3.17	2.39
	Biking per day (minutes)	247	23.47	12.17		Walking per day (hours) in leisure time	94	2.84	1.51
	Walking per week (day)	990	4.66	2.46		Walking per day (minutes) in leisure time	68	25.44	11.22
	Walking per day (hours)	434	2.20	1.,71		Vigorous physical activity per week (day) in leisure time	228	2.69	2.01
	Walking per day (minutes)	525	25,.5	10.82		Vigorous physical activity per day (hours) in leisure time	104	1.94	0.99
	Walking per week (day) in leisure time	990	2.85	2.72		Vigorous physical activity per day (minutes) in leisure time	48	27.60	10.05
	Walking per day (hours) in leisure time	425	1.97	1.46		Moderate physical activity per week (day) in leisure time	175	1.59	1.66

	Walking per day (minutes) in leisure time	328	26.57	10.14		Moderate physical activity per day (hours) in leisure time	50	1.66	0.94
	Vigorous physical activity per week (day) in leisure time	990	1.86	2.16		Moderate physical activity per day (minutes) in leisure time	28	28.93	11.58
	Vigorous physical activity per day (hours) in leisure time	434	1.81	1.18	Body configuration measures before (1) and after (2) intervention	Body Mass Index 1	285	21.68	3.37
	Vigorous physical activity per day (minutes) in leisure time	226	27.54	10.71		Body Mass Index 2	273	21.62	3.29
	Moderate physical activity per week (day) in leisure time	990	1.27	1.75		VO2 max 1 (ml/kg/min)	270	37.12	8.51
	Moderate physical activity per day (hours) in leisure time	345	1,.63	1.14		VO2 max 2 (ml/kg/min)	267	38.04	8.52
	Moderate physical activity per day (minutes) in leisure time	230	28.49	12.22					
Intervention	Number of days of intervention	286	129.7	23.80					
	Active mode choice per week (bicycle, walking, skate, kick-scooters) during the intervention	192	3.32	1.92					

2.4.Intervention

The intervention included adolescents who used motorized transportation for going to school and getting back home and agreed to change their school mobility mode to walking or biking (active transport). Those who agreed were taken into an intervention group that consisted of 286 pupils out of the 990 participants, who were present in the baseline data collection. During the intervention, twelve Polish participants dropped out of the intervention group, so at the end 274 of them completed the intervention. The overall intervention times for the overall sample was 129.74 days (std. deviation=23.8 days). The duration of the time they changed their mobility mode was different in the case-cities; the mean intervention times for Croatian (N=46), Greek (N=62), Italian (N=55), Polish (N=74), and Turkish (N=49) sub-samples were 85.78, 121, 149.95, 153.19, and 124 days respectively. The intervention group were tested twice: (1) at the beginning of the intervention they were interviewed by a complete questionnaire (as explained before) and (2) at the end of the intervention time, by a shorter questionnaire including their perceptions and mobility modes at the time. At both times, i.e. before and after intervention, their body composition (BMI and VO2 Max.) as well as body efficiency were measured by the following equipment: TANITA Body Composition Analyser was applied to measure the body efficiency and VO2 Max. of the participants and Åstrand-Ryhming Test was used for measuring their BMI.

The Åstrand-Ryhming Test is a cycle test devised by Per-Olof Åstrand from Swedish School of Sport and Health Sciences (GIH). The measurement includes a submaximal cycle ergometer aerobic fitness test, which is based on the relationship between heart rate during work and percentage of maximal aerobic capacity. The original test method and nomogram (Åstrand, P.-O. & Ryhming, I., 1954) was later expanded and modified (Åstrand, I., 1960) with a nomogram accounting for men and women of different ages. A very important part of the test for this study was the 6-minute submaximal cycle test, the objective of which was to measure the VO2 Max. Body Composition Analysis is measured on TANITA Body Composition Analyser, which was used in this study to measure the BMI of the participants by the BIA method.

3- Findings

3-1- The effects of the intervention on ATS and PA

The results of the T-test show that the levels of motorized vehicle use per week highly significantly decreased from 4.48 to 3.82 days (the means can be found in Table 1). However, the mean of motorized vehicle use per day significantly increased from 23.25 minutes to 26.66 minutes (P=0.033). As expected, the mean of walking to school per week highly significantly increased from 4.66 to 5.58 days (Table 2). The intervention also influenced the PA of the participants during their leisure times. The amount of the mean vigorous physical activity in leisure time highly significantly increased from 1.86 to 2.69 days per week. Likewise, the mean moderate physical activity in leisure time highly significantly increased from 1.27 to 1.59 days per week. These results reflect the success of the intervention in changing not only the levels of ATS but also vigorous to moderate physical activity during the leisure times of the adolescents.

Table 2: The results of T-tests for examining the possible differences in the levels of active school transport and physical activity caused by the intervention.

Variable	Difference of Means	t	df	2-tailed P
Motorized vehicles per week (day)	0.704	4.157	205	<0.001
Motorized vehicles per day (hours)	-0.061	-0.287	48	0.775
Motorized vehicles per day (Minutes)	-6.422	-2.204	44	0.033
Biking per day (hours)	-0.087	-0.385	22	0.704
Biking per day (minutes)	-2.238	-0.722	20	0.479
Walking per week (day)	-0.843	-5.287	273	<0.001
Walking per day (hours)	0.686	1.785	34	0.083
Walking per day (minutes)	0.73	0.453	73	0,652
Vigorous physical activity per week (day) in leisure time	-0.636	-4.134	227	<0.001
Vigorous physical activity per day (hours) in leisure time	0.127	0.767	62	0.446
Vigorous physical activity per day (minutes) in leisure time	0.250	0.102	19	0.920
Moderate physical activity per week (day) in leisure time	-0.211	-1,604	174	<0.001
Moderate physical activity per day (hours) in leisure time	-0.129	-0.643	30	0.525
Moderate physical activity per day (minutes) in leisure time	-0.250	-0.059	19	0.954

3-2- ATS correlates of BMI and VO2 max

As mentioned in the methodology section, two WLS models were developed for BMI and VO2 max The first model on BMI shows that car ownership, change in walking to school per week (day), change in biking to school per day (minutes), change in walking per week (day) in leisure time, change in moderate physical activity per week (day) in leisure time (all changes values indicated comparison of before and after the intervention) are the significant predictors of BMI, the last of which was highly significant (Table 3). The VIF values were all between 1 and 3, so they did not show any sign of multicollinearity.

The most important result of the model is that walking to school per week (P=0.002) and biking to school per day (P=0.001) are significantly associated with BMI change after intervention. In increase of one day per week in walking to school and back in a duration of 130 days is associated with a 0.32 of a unit decrease in BMI. However, the result of biking to school and back counterintuitively shows that biking one more is correlated with higher BMIs. These results work with walking and moderate physical activity in leisure times. Although these variables are significantly or highly significantly correlated with BMI change after intervention, but they have kept in the model to control for their effects. The effects of household car ownership have also been controlled for in the model. In other words, if the effects of these three variables are fixed, then levels of walking and biking to school will be significantly correlated with BMI change. The R^2 of the model is equal to 0.876, which indicates that 87.6% of the variability of BMI of the participants are addressed by the model (Table 3). The F-test results show that the model is valid (P<0.001).

The results of the second model on VO2 max show that the change in walking per week and the change in walking per day after intervention in school mobility were significantly correlated with the changes in VO2 max regardless of the levels of car ownership, the duration of intervention, and the change in motorized vehicles per week (Table 4). In other words, if we control these variables, the number of the days that the adolescents walk to school and back or the minutes per day of their walking to school are associated with VO2. Max. One more day of walking to school per week is associated with 0.6% of increase in VO2 max (P=0.01), in other words, this variable can significantly increase the dependent variable of this model. But the duration of time the adolescents walk to school per day can decrease their VO2 max (P<0.001). This model explains 79.3% of the variability of VO2 max (R^2=0.793). The model validity was checked by ANOVA – F-test, whereas the P-value was 0.002.

Fig. 1 depicts the univariate relation between the number of the days per week of all modes ATS with the mean change in BMI and VO2 max before and after the intervention. As seen in the figure, increasing the number of days of school mobility from two days to four or five days is associated with a change in BMI. The same is true about VO2. Max. Using active modes for school mobility from four days to five or six days is related to an increased change in the levels of VO2 max

Table 3: Multivariate Weighted Least Square (WLS) model explaining the ATS and PA correlates of BMI (R^2=0.876).

Variable	B	Std. Error	β	t	P	Collinearity Statistics	
						Tolerance	VIF
Constant	-0.076	0.204		-0,.371	0.720		
Car ownership	-0.255	0.099	-0.323	-2.576	0.030	0.875	1.143
Change in walking to school per week (day) during the intervention compared to before it	-0.133	0.031	-0.613	-4.248	0.002	0.660	1.516
Change in biking to school per day (minutes) during the intervention compared to before it	0.036	0.008	0.855	4.575	0.001	0.393	2.544
Change in walking per week (day) in leisure time during the intervention compared to before it	-0.134	0.033	-0.807	-4.049	0.003	0.346	2.894
Change in moderate physical activity per week (day) in leisure time during the intervention compared to before it	0.291	0.047	0.895	6.197	<0.001	0.658	1.519
ANOVA - F Test							
Sum of Squares	**df**	**Mean Square**	**F**	**P**			
72,204	5	14.441	12.771	<0.001			

Table 4: Multivariate Weighted Least Square (WLS) model explaining the ATS and PA correlates of VO2 max (R^2=0.793).

Variable	B	Std. Error	Beta	t	P	Collinearity Statistics	
						Tolerance	VIF
Constant	-5.815	4.770		-1.219	0.258		
Car ownership	1.078	0.612	0.309	1.761	0.116	0.516	1.938
Number of days of intervention	0.033	0.038	0.162	0.873	0.408	0.462	2.163
Change in walking per week (day) during the intervention compared to before it	0.815	0.243	0.604	3.350	0.010	0.488	2.048

Change in walking per day (hours) during the intervention compared to before it	-1.672	0.268	-0.990	-6.252	<0.001	0.634	1.578
Change in motorized vehicles per week (day) during the intervention compared to before it	-0.111	0.260	-0.068	-0.428	0.680	0.627	1.595
ANOVA - F Test							
Sum of Squares	**df**	**Mean Square**	**F**	**P**			
1817.643	5	363.529	10.984	0.002			

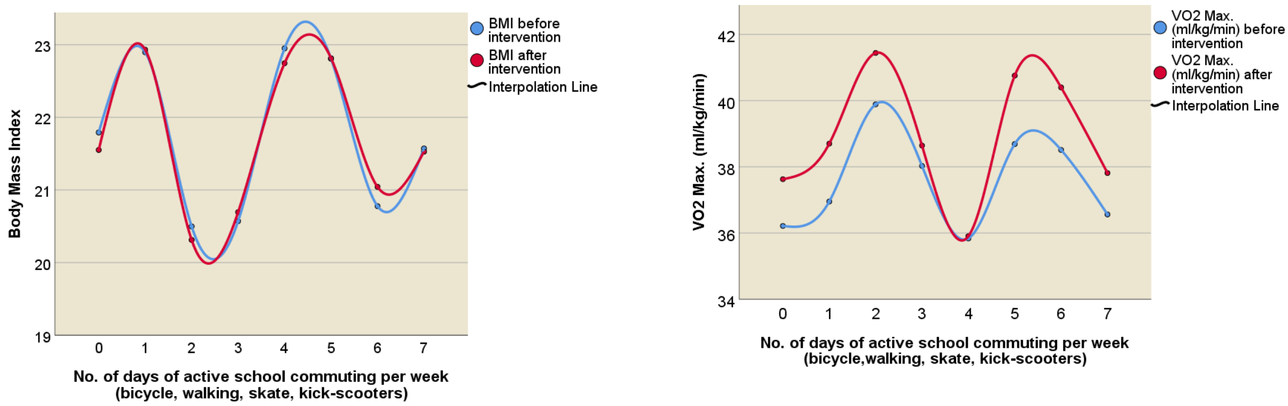

Fig. 1: The relation between the number of the days per week of ATS during the intervention times with the mean change in BMI (left) as well as VO2 max (right).

3-3- ATS correlates of body efficiency

The results of the MNL model of body efficiency with the three variables of active transportation during the intervention times including Walking per week (day), walking per week (day) in leisure time, and motorized vehicles per week (day) are seen in Table 5 and Table 6. As seen in Table 5, the model fit shows that the number of days of walking to and from school during intervention was a significant variable (P=0.005). The other two mobility variables were taken into the model just to fix them for all participants. in other words, if these two variables are equal for all participants, then there would be a relationship between the number of days of school walking and body efficiency. But the main question that the model can answer is, how much walking to and from school is needed to change the weak body efficiency results to better statuses.

Table 6 clarifies this issue, in which the poor and fair body efficiency results are significantly correlated with the reference category of “good” body efficiency. According to the model, there are two findings: (1) for each additional day of walking to and from school, the body efficiency status of adolescents is 41% more likely to improve from poor to good (P=0.039); (2) for each additional day of school walking, improvement of the body efficiency from fair to good will be 45% more probable (P=0.023). Both findings have been resulted when the two walking in leisure times and the number of the days of motorized transportation use are controlled for. The model has a Nagelkerke R^2 of 0.141, in other words, by only adding to the number of days of walking to and from school, it will be possible for the adolescents in European case-cities to add to the probability of affecting their body efficiency by 14.1%. The validity test (P=0.04) including goodness-of-fit test shown in Table 6 indicates a valid MNL model.

Improving the body efficiency of the adolescents is important, especially because it is connected with body efficiency, i.e. BMI and VO2. Max. As seen in Fig. 2, the BMI of participants decreased as a result of the intervention especially in the lower body efficiency categories like very poor, poor, and fair. The same is seen for the participants with very good efficiency, but the change is less than the weaker efficiencies. Nevertheless, the VO2 max of participants with average and good physical efficiency decreased after the intervention.

Table 5: The likelihood ratio tests for the BL model of body efficiency

Variable	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	X^2	df	P
Intercept	565.484	13.952	6	0.030
Walking per week (day) during the intervention	570.277	18.745	6	0.005
Walking per week (day) in leisure time during the intervention	558.566	7.034	6	0.318
Motorized vehicles per week (day) during the intervention	555.597	4.064	6	0.668

Table 6: BL model of body efficiency during ATS intervention with the reference category “good body efficiency” (Nagelkerke R^2=0.141)

Levels of Body Efficiency	Active Transport to School Variables (during intervention)	B	Std. Error	Wald	P	β
Very poor	Intercept	2.595	1.166	4.955	0.026	
	Walking per week (day)	Nonsignificant				
	Walking per week (day) in leisure time	Fixed				
	Motorized vehicles per week (day)					
Poor	Intercept	Nonsignificant				
	Walking per week (day)	0.347	0.168	4.240	0.039	1.414
	Walking per week (day) in leisure time	Fixed				
	Motorized vehicles per week (day)					
Fair	Intercept	Nonsignificant				
	Walking per week (day)	0.371	0.163	5.190	0.023	1.449
	Walking per week (day) in leisure time	Fixed				
	Motorized vehicles per week (day)					
Average	Intercept	Nonsignificant				
	Walking per week (day)	Nonsignificant				
	Walking per week (day) in leisure time	Fixed				
	Motorized vehicles per week (day)					
Very good	Intercept	Nonsignificant				
	Walking per week (day)	Nonsignificant				
	Walking per week (day) in leisure time	Fixed				
	Motorized vehicles per week (day)					
Cannot classify	Intercept	Nonsignificant				
	Walking per week (day)	Nonsignificant				
	Walking per week (day) in leisure time	Fixed				
	Motorized vehicles per week (day)					

Model Fitting Information			
-2 Log Likelihood	X^2	df	P
551.532	29,707	18	0.040
Goodness-of-Fit (Pearson)			
X^2	df	P	
703.846	690	0.349	

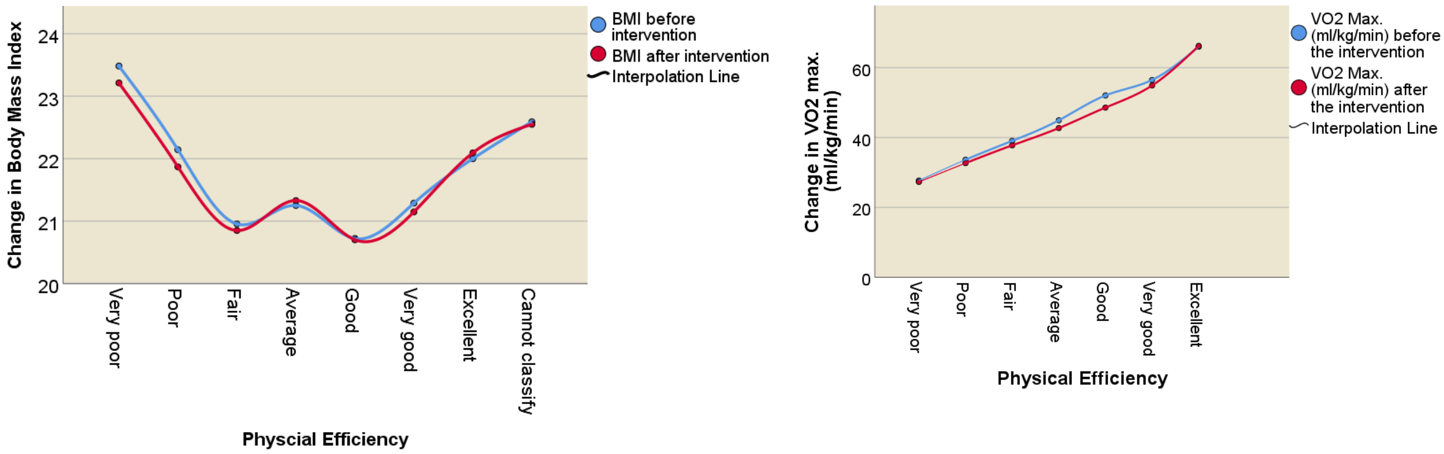

Fig. 2: The relation between the number of the days per week of ATS during the intervention times with the mean change in BMI (left) as well as VO2 max (right).

4- Discussion

The aim of this study focuses on determining the associations of AT with BMI, VO2 max, and body efficiency among adolescents14-18 years old in five European cities. To reach main objective of the current study, two multivariate Weighted Least Square (WLS) models, and Multinomial Logit regression (MNL) were employed. According to findings, changes in active mode choices including walking to school per week (day) during, biking to school per day (minutes), walking per week (day) in leisure time, moderate physical activity per week (day) in leisure time during the intervention compared to before it were correlated to BMI changes. The relationships of walking (per week) for communing to school and for leisure was negative with BMI. In other words, decreasing in numbers of day per week for walking in both commuted and non-commuted trips was related to increasing BMI of adolescents in Greece, Poland, Croatia, Italy, and Turkey. However, the numbers of day for biking per week was correlated to BMI positively. It means there is a direct and positive correlation between increasing of BMI among adolescents and BMI. The findings of this paper accept negative associations between walking to school and BMI in another study on schoolchildren by (Rosenberg et al. 2006) while this paper rejects findings of that mentioned study on negative correlations od biking and BMI. The results of study on effectiveness of ATS and getting favorable BMI in early schoolchildren confirmed the positive impacts of walking on healthful trajectories of BMI across the adolescents in the current paper (Pabayo et al. 2010). (Brown et al. 2017) showed that although AT interventions might contribute obesity-related health, the transportation behavior affected BMI very small. Therefore, the findings are in the same line with positive associations of biking and BMI in this study. (Turrell et al. 2018) indicated people who use cycling and walking as means of transportation have a lower BMI in compared with others. However, the results of their study confirm our results in walking; they reject negative results for cycling in this study. Although, negative results for biking, the current study is in the agreement with another study on contributions of active mobility and healthier body composition in the UK (Flint and Cummins 2016). In addition, the results of this paper is in the same direction with the findings of an investigation on positive relationship between walking school buses (a small group of children that are taken by one or two parents to walk school) and having healthier BMI among children and adolescents (Smith et al. 2015). Also, the findings of this paper accept the results of a study on that showed the index of walkability was correlated with a 0.23-point reduction in BMI (Frank et al. 2006).

As mentioned in discussion, several studies confirmed the effectiveness of AT on the favorable BMI not only among children and adolescents but also for different socioeconomics groups (Furie and Desai 2012; Habinger et al. 2020). Although, the current study is in line with results of other studies in literature, the negative findings on biking is opposite with others' studies. This negative result could be related to time of biking. The time of physical activity plays an important role on the effectiveness level. This study analyzed the correlations between the number of days in biking per week and BMI. There is a need for more studies to assess minutes and hours of biking and BMI.

Changes walking per week (day), per day (hours), and in motorized vehicles per week (day) during the intervention compared to before it, as long with numbers of days for intervention, and car ownership were determined as correlates of VO2 max in this study. The positive results on effectiveness of walking to obtain favorable VO2 max in this study supports the results of another study in this area (ZERF 2017). (Cao et al. 2010) assessed correlations of physical activity with VO2 max in Japanese women. According to that study, there are associations between moderate-to vigorous physical activity and VO2 max in women and so, those results are in line with the current paper results. In this paper, changes walking per week (days) was correlate positively with VO2 max while, the associations between changes walking per day (hours) was negative. The results on the relationships between changes in walking per day (hours) and VO2 max are more accurate since time of physical activity is considerable factor. The findings of this study support the results of another study that emphasized on the impacts of PA on the acceptable levels of VO2 max (McMurray et al. 1998).

This study shows that the number of days of walking to and from school during intervention was a significant variable for body efficiency. According to this result, walking may contribute to healthier body composition. This finding accepts the results of another paper on a linkage between daily steps counts and body composition in children (Duncan et al. 2006). The results of this study disagree with an investigation that discussed that the relationship between intervention and body composition were not significant (Adamo et al. 2017). The results of current paper supports several study (Lohman et al. 2008; Salonen et al. 2015; Larouche et al. 2014b; Carrel et al. 2005) findings on effectiveness of ATS, PA, and intervention on body composition.

The findings of this paper approve that walking is linked with improved from poor and fair to good body efficiency status. Therefore, this paper suggests active transportation to and from school to promote physical activity in adolescents and gain better body efficiency and healthier body composition.

The BMI and VO2 max of children were calculated in average of 130 days. In this intervention period, BMI and VO2 max of children can be changed. So, this one is one of the limitations of this study. Another limitations is the results of T-test was not very good because of several participants in the survey do not answer to ALPHA questionnaire. The bigger sample size can provide better T-test results.

5- Conclusion

The current study assessed ATS correlates of BMI, VO2 max, and body efficiency in adolescents 14-18 years old in five European countries including Greece, Poland, Croatia, Italy, and Turkey. The results of this paper show that there are association between ATS and healthier BMI, VO2 max Walking per day (hours) and walking per week (days) are correlated negatively to VO2 max and BMI respectively. While increasing in walking per week (days) and biking per week (days) are associated with decreasing VO2 max and BMI respectively. Car ownership is significant variable for both BMI, and VO2 max. The relationship between ATS and body efficiency was analyzed by using MNL model. The model shows that for each additional day of walking to and from school, the body efficiency status of adolescents is 41% more likely to improve from poor to good and for each additional day of school walking, improvement of the body efficiency from fair to good will be 45% more likely. The results of this study

promote the active transportation to and from school as a way for increasing physical activity among adolescents and favorable body composition.
Policymakers needs to better and clearer understandings of correlates of body composition for different socioeconomic groups in different contexts. So, future studies cover knowledge gap in this area by conducting investigations on the effectiveness of interventions in different parts of the world. In addition to physical activity, diet and nutrition have impacts on body efficiency in different age groups. This study focuses on only the effectiveness of the intervention on body efficiency. Future studies can cover different factors can influence healthier body composition including attitudes, perception, and cultural issues.

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