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Food and beverages intake and physical activity levels in European children. The IDEFICS study.

Ingesta de alimentos y bebidas y niveles de actividad física en niños europeos. Estudio IDEFICS.

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Fecha de presentación: 7 de septiembre de 2015.

Abstract:

Introduction: Physical activity (PA) levels and dietary habits are considered as the most important factors in childhood's obesity.

Aim: To determine the association between physical activity levels and food and beverages intake in European children aged 2 to 9 years.

Methods: A sample of 7229 children (49% girls) from eight European countries participating in the IDEFICS study were included. Dietary intake and physical activity were assessed. Analyses of covariance (ANCOVA) and binary logistic regression were used to compare food consumption between groups of children with different time spent in moderate or vigorous physical activity (MVPA).

Results: Boys who spent less time in MVPA were less likely to consume fruit, cereals, ketchup, snacks, meat, yoghurt, pasta and candies than those children who spent more time in MVPA. At the same time, boys who spent less time in MVPA were less likely to consume fast food than those allocated in the highest tertile.

Girls who spent less time doing MVPA were less likely to consume SSB, yoghurt, meats, eggs, ketchup, pasta and candies than those children allocated in the highest tertile. In contrast, girls allocated in the first tertile were more likely to consume water and fast food than those with high level of MVPA.

Conclusion:

Dietary intake varied between levels of MVPA in European children. Higher time spent in MVPA is not necessarily related with healthier food consumption.

Key words: Idefics study, physical activity, food and beverages intake, Food frequency questionnaire, accelerometry.

Introducción: Los niveles de actividad física (PA) y habitos alimeticios están considerados como los factores más importantes en la obesidad infantil.

Objetivo: Determinar la asociación entre los niveles de actividad física y el consume de alimentos y bebidas entre niños europeos de entre 2 y 9 años de edad.

Métodos: Se incluyó una muestra de 7229 niños (49% niñas) procedentes de los ocho países europeos que participaron en el estudio IDEFICS. Se registró la ingesta dietética y la actividad física. Se usó un analisis de covarianza (ANCOVA) y una regression logística binaria para comparar el consumo de alimentos entre grupos de niños que realizan actividad física moderada o vigorosa (MVPA) con distinta frecuencia.

Resultados:

Los niños que realizan más MVPA tienen una menor posibilidad de consumer frutas, cereales, ketchup, snacks, carne, yogur, pasta y caramelos que los niños que realizan más MVPA. Al mismo tiempo, los chicos que realizan MVPA durante menos tiempo tienes menos posibilidad de consumir alimentos conocidos como comida rápida que aquellos que se encuentran en el tercil más alto.
Las chicas que dedican menos tiempo a realizar MVPA tienen menos posibilidad de consumir bebidas azucaradas, yogur, carne, huevos, ketchup, pasta y caramelos que aquellas chicas localizadas en el tercil más alto. En contraste, las chicas que se encuentran en el primer tercil tienen mayor posibilidad de consumir agua y alimentos conocidos como comida rapida que aquellas que tienen unos mayores niveles de MVPA.

Conclusión:
La ingesta dietética varía entre distintos niveles de MVPA en niños europeos. Dedicar más tiempo a realizar MVPA no está necesariamente relacionado con un consumo de alimentos más saludable.

Palabras clave: Estudio IDEFICS, actividad física, ingesta de alimentos y bebidas, cuestionario de frecuencia de consumo de alimentos, Acelerometría.

Indice

Abbreviation:

FFQ: Food frequency questionnaire.

PA: physical activity.

SSB: sugar sweetened beverages.

Introduction

The prevalence of overweight and obesity combined rose 27.1% for adults and 47.1% for children between 1980 and 2013 around the world.[1] In fact, in 2008, the prevalence of overweight and obesity were more than one-third of adults in the world.[2] Worldwide, the prevalence of childhood overweight increases from 4.2% in 1990 to 6.7% in 2010,[3] 43 million children were estimated to be obese in 2010, out 35 million were from developing countries.[4] The prevalence of children and adolescent's overweight and obesity has increased in developed and developing countries,[1, 3] but some studies had shown an stabilization about overweight and obesity levels among children and adolescents from several countries as France,[5] Netherland,[6] Australia[7] and USA.[8]

The health effects of overweight and obesity in adulthood have been related with several diseases as cardiovascular disease,[1, 2, 9] diabetes,[1, 2, 9] cancer,[1] osteoarthritis, [1] chronic kidney disease[1] and ischemic stroke.[2] Moreover, during childhood, higher body mass index (BMI) has been associated with unhealthy effects like hypertension,[10, 11] dyslipidemia,[10, 12] hyperinsulinemia,[12, 13] metabolic syndrome[10] and long term cardiovascular complications.[13] Physical activity (PA) levels and dietary habits are considered as the most important factors in childhood's obesity.[14, 15] Regular PA and healthy dietary habits has been associated with health benefits.[16-18] For example, usual PA practice is associated with improved psychological health, for instance it is linked with a best self-esteem[16, 19] improve social skills[19] and reduced depressive symptoms[16-18]. Moreover, it is related with physical fitness, and linked with a better cardiorespiratory health,[16, 18, 20] skeletal muscle[16, 18, 20] and bone health[17-19]. In addition PA enhance the cardio-metabolic risk profiles due to its effect on body fatness reduction,[16, 18] lipid profile decrease[20] and blood pressure.[21] On the other hand, a healthy diet based on fruits and vegetables has been associated with reduced risk of some illness. For example the regular consumption of fruit and vegetables is linked with low incidence of type 2 diabetes,[22, 23] strokes[23-25], heart diseases[23, 24, 26] and some cancers[23-25, 27]). Also is related with a better blood profile, including stabilization of glucose concentrations,[26] lower blood pressure[26, 28] and cholesterol levels[26]), and better digestive health,[28] for instance having greater stool bulk[29] and faster transit time[29]).

Some studies have observed a relationship between PA levels and the food intake.[15, 30-33] For example, Platat C et al. observed in French preadolescents aged 12 years ,that higher PA levels were positively associated with a higher consumption of vegetable, fruit and fruit juices.[34] *Coulson et al.*[33] showed that greater consumption of fresh foods

was associated with higher PA levels in English adolescents. In the same line, in Iranian adolescents[31] observed a higher vegetables, fruits and dairy products intake was associated with higher PA levels measured with self-administrated questionnaires. Storey KE *et al.*[15] observed in Canadian adolescents aged 9 to 14 years that higher fruit and vegetables intake and lower grain products intake was associated with higher PA levels in Web-Span study. In the same line, Al-Hazaa HM *et al.*[32] observed also in adolescents, that a healthier food intake was related with higher PA levels. In a sample of European adolescents from the HELENA study, a positive association was observed between fruit and milk products consumption and high PA levels.[30] Cavadini C et al. observed that athletic Swiss' adolescents had higher frequency consumption for dairy products, fruit, fruit juices and salad than non-athletic Swiss' adolescents.[35]

To the authors knowledge the association between PA levels using an objective method (accelerometry) and food and beverages intake in 2.0 to 9.0 aged European children haven't been reported yet. The main hypothesis of the current study is that high levels of PA are linked with healthier food and beverages intake. The aim of the current study is to determine the association between PA levels and food and beverages intake in European children aged 2 to 9 years. It could provide important information to establish new intervention strategies for the prevention of children's overweight and obesity.

Material and Methods.

Study population.

The IDEFICS (Identification and prevention of Dietary and lifestyle induced health EFfects In Children and infants) study is a multi-center cross sectional study on lifestyle and nutrition among children from eight European countries (Sweden, Germany, Hungary, Italy, Cyprus, Spain, Belgium and Estonia). The population-based cohort is 16.228 children aged 2.0-9.0 years. The sample of this analysis was taken from the baseline survey (T_0) of the IDEFICS Study. Data were collected for baseline from September 2007 to June 2008.

Inclusion criteria for study sample.

Children who life in that European countries were in primary school or pre-school and accepted the chance to participate was eligible for participation and has been recruited. Children who had available data about weight, height and parents questionnaire were included in IDEFICS study.

In addition, for the current study, only were included children with complete information in the food frequency questionnaire and with valid data from accelerometer from at

least three days. From the total sample which comprises 16.228 children, 7.229 children (3.574 females) fulfilled the inclusion criteria.

Parents signed an informed consent and child was asked to give verbal assent before examination. Participants were free to refuse specific modules. For each country, participating centres obtained ethical approval from the local authorities established in the Declaration of Helsinki.

Socio-economic status.

International Standard Classification of Education (ISCED)[36] was used as proxy indicator to the socioeconomic status (SES). In this study, the higher parent's educational level was selected as the reference SES for the family. Parents self-reported their educational level in the core questionnaire. ISCED was codified in order from lowest to highest from level 1 to level 6. In this study, educational level were re-coded to establish groups organized by low, medium or high educational level, "level 1" and "level 2" were re-coded as "low educational level", "level 3" and "level 4" were re-coded as "medium educational level" and "level 5" and "level 6" were re-coded as "high educational level".

Anthropometric measurements.

Weight (kg) and height (cm) were measured by trained researcher according to a standardized protocol with participants in barefoot and in underwear. Body weight was assessed in fasting status on a calibrated scale (model: electronic scale TANITA BC 420 SMA with an adapter; Tanita Europe GmbH) to the nearest 0.1kg. Height of the children was measured with a calibrated stadiometer (model: telescopic height measuring instrument SECA 225 Stadiometer; SECA) to the nearest 0.1cm. Finally, body max index (BMI) of children was calculated as body weight in kg divided by the square of height in meters.

Physical activity.

PA were objectively assessed using validated Actigraph uniaxial accelerometers[37] (Actitrainer or GT1M; Actigraph, LLC, Pensacola, FL, USA). Children were instructed to wear the accelerometer for at least 2 weekdays and 1 weekend day. Parents completed a diary where they wrote all the moments when the children didn't wear the accelerometer. It was allocated on the right hip of children with an elastic belt. The children must wear the device whole day except during water-based activities and during sleep. The monitor was set to record PA in a 15s epoch. Evenson's cut-point was used to calculate the time spent doing PA during childhood.[38, 39] Accelerometer software generates the counts per minute (CPM), which let to obtain the total

monitoring time spent doing different intensities of PA. The Evenson cut-offs[40] (sedentary:0-100, light:101-2295, moderate:2296-4011 and vigorous ≥4012 CPM). Average CPM was used for the calculation of PA : Average CPM was defined as the sum of daily counts divided by valid time. Valid time is the mean of time that children wear the accelerometers according the protocol. We adjusted minutes to calculate the time of sedentary activity, light activity, moderate activity, vigorous activity and MVPA in accordance with Evenson cut-offs. Minutes were adjusted dividing the raw minutes by wearing time and multiplying the resulting fraction by the average wearing time. We use MVPA time to determinate the association among PA and dietary intake. Consequently, time spent doing MVPA were distributed in tertile groups separated by gender.

Food frequency questionnaire.

Dietary food intake had been assessed using validated[41] Children's Eating habit Questionnaire (CEHQ) which includes the Food frequency questionnaire (FFQ). Country-specific food examples were included to facilitate the understanding. The CEHQ-FFQ got 43 food group items clustered into thirty-six according to their nutritional profiles: (i) vegetables (cooked vegetables and legumes); (ii) fried potatoes; (iii) raw vegetables; (iv) fruit; (v) sweetened fruit; (vi) water; (vii) manufactured fruit juices; (viii) soft drinks; (ix) light soft drinks; (x) breakfast cereals; (xi) sweetened breakfast cereals; (xii) milk; (xiii) sweetened milk; (xiv) yoghurt; (xv) sweetened yoghurt; (xvi) fish; (xvii) fried fish; (xviii) fried eggs; (xix) eggs; (xx) mayonnaise; (xxi) cold cults; (xxii) meat (raw and cooked meat); (xxiii) cheese (sliced, spreadable and grated cheese); (xxiv) jam & honey; (xxv) chocolate/nut-based spread; (xxvi) butter & margarine; (xxvii) ketchup; (xxviii) white bread; (xxix) whole meal bread; (xxx) pasta & rice; (xxxi) milled cereal; (xxxii) pizza; (xxxiii) fast food (hamburgers, hot dogs, kebabs, etc.); (xxxiv) nuts; (xxxv) snacks (crisps, popcorn, savoury pastries and fritters, etc.); and (xxxvi) sweets (chocolates, candy bars, biscuits, cakes, puddings, ice creams, etc.). The food items were grouped into 28 food groups, according to the nutritional values: vegetable; potatoes; legumes; fruit; water; fruit juices; sweetened beverages; cereal; milk; yoghurt; fish; meat; eggs ; soy replacement; cheese; chocolate; butter; honey; ketchup; bread; pasta; fast food; nuts; snack; savory pastries; candy; biscuits; and ice cream (see table A, Apendix).

Children's parents or guardian filled in at home by reporting the number of times the child consumed the specified food groups during a typical week. The FFQ let participants to choose how many times they are consuming one kind of food using the options "never/less than once a week", "1-3 times a week", "4-6 times a week", "1

time/day", "2 time/day", "3 times/day" and "4 or more times/day". Food groups were re-coded to establish groups organized by times per day, "never/less than once a week" were re-coded to "0 times/day", "1-3 times a week" to "0.28 times/day", "4-6 times a week" to "0.71 times/day". The options "1 time/day", "2 times/day", "3 times/day" and "4 or more times/day" weren't modified.

Data analyses.

The Statistical Package for the Social Sciences for Windows version 22 (SPSS Inc., Chicago, USA) was used for statistical analyses. Descriptive statistics, including means and standard deviations (SD) were calculated for each variable.

The χ^2 test and the unpaired t-test were used to compare sample characteristics stratified by sex groups. Significant differences between sexes were found in both PA levels and food and beverages intake. Differences in food intake in accordance with time spent doing MVPA was analyzed by analysis of covariance (ANCOVA), adjusted by age, BMI and SES. Food and beverages frequency was dichotomized on the basis of the population medians consumptions. Binary logistic regression analyses were performed to obtain odd ratio (ORs) and 95% CIs of food and beverages intake according the median consumption, by tertiles of MVPA after adjusting for age, BMI and SES. P values <0.05 was considered to be statistically significant.

Results

Table 1 shows by sex descriptive information about sociodemographic characteristics (age, SES, BMI), food and beverages consumption, and time spent doing PA. Sex differences were observed in age categories, food group consumption and PA levels ($p<0.05$). Boys and girls were mainly categorized into the optimal weight status (98.3% for boys and 98.8% for girls). In general, mean for food group consumption were higher for boys than girls. However, girls showed higher consumption in vegetables, water, eggs, cheese, butter and nuts. Time spent in light and higher PA were higher in boys than girls, in contrast, mean of sedentary activity was higher in girls than boys.

Table 2 shows the analysis of covariance results (means and standard deviation) for food group consumption by tertiles of moderate and vigorous PA categorized for boys and girls.

Boys who spent more time doing moderate or vigorous physical activity (MVPA) during whole day had higher consumption of fruits, yoghurts and candies than those who were allocated in the first tertile (table 2). However, regarding the consumption of cheese

and pizza, hamburger and hot dog were more consumed among male children who spent less time in MVPA (table 2).

On the other hand, girls who spent more time in MVPA during whole day had higher consumption of vegetables, eggs, butter, sugar sweetened beverages and candies than those who were allocated in the first tertile. At the same time, girls with higher levels of MVPA had lower consumption of water and savoury pastries than those who had higher level of MVPA (table 2).

Table 3 shows the results of logistic regression analysis by food group consumption and tertiles of moderate and vigorous physical activity separated by gender.

Boys who spent less time doing MVPA (T1) were less likely to consume fruit, cereals, ketchup and snacks than those children allocated in the highest tertile (T3) [(OR 0.81, 95% CI, 0.67-0.97) for fruit; (OR 0.71, 95% CI, 0.58-0.87) for cereals; (OR 0.79, 95% CI, 0.66-0.94) for ketchup; (OR 0.81, 95% CI, 0.68-0.96) for snacks]. In the same direction, boys allocated in the second tertile were less likely to consume meat, than those with high level of MVPA (OR 0.82, 95% CI, 0.68-0.98).
Moreover, boys from T1 and T2 were less likely to consume yoghurt ((OR 0.68, 95% CI, 0.56-0.81), (OR 0.73, 95% IC, 0.61-0.86), respectively), pasta ((OR 0.59, 95% CI, 0.44-0.82), (OR 0.64, 95% CI, 0.48-0.87), respectively) and candies ((OR 0.55, 95% CI, 0.46-0.66), (OR 0.68, 95% CI, 0.58-0.80), respectively). On the other hand, boys from tertile one and two were more likely to consume other kind of cereals as pizza as main dish and hamburger, hot dog, kebab, wrap and falafel than those children allocated in the tertile with high level of MVPA ((OR 1.57, 95% CI, 1.31-1.87); (OR 1.35, 95% CI, 1.15-1.58), respectively).

On the other hand, girls who spent less time doing MVPA (T1) were less likely to consume SSB, yoghurt, meats, eggs, ketchup, pasta and candies than those children allocated in the highest tertile (T3) [(OR 0.82, 95% CI, 0.68-0.98) for SSB; (OR 0.80, 95% CI, 0.66-0.96) for yoghurt; (OR 0.74, 95% CI, 0.60-0.92) for meats; (OR 0.82, 95% CI, 0.67-0.99) for eggs; (OR 0.79, 95% CI, 0.61-0.94) for ketchup; (OR 0.65, 95% CI, 0.47-0.91) for pasta; (OR 0.70, 95% CI, 0.58-0.84) for candies]. In contrast, girls allocated in the first tertile were more likely to consume water and fast food, than those with high level of MVPA [(OR 1.25, 95% CI, 1.05-1.50) for water; (OR 1.30, 95% CI, 1.09-1.56) for fast food].

In addition, girls from T1 and T2 were less likely to consume vegetables ((OR 0.68, 95% CI, 0.57-0.82), (OR 0.81, 95% IC, 0.67-0.98), respectively) and butter ((OR 0.67, 95% CI, 0.56-0.81), (OR 0.82, 95% CI, 0.68-0.99), respectively).

Discussion

The purpose of the present study was to use IDEFICS study survey to determine the association between PA levels and food and beverages intake in European children. In both, European male and female children, the food intake did not differ in the majority of food groups. Food intake was only significantly different for potatoes, cereals, savoury pastries, biscuits, snacks and ketchup among sexes. According with the Mediterranean pyramid recommendations[42], higher proportion of children had low consumption of vegetables, legumes, cereals and fruit. In addition, they got a higher consumption of sweets including jam, chocolate, candies, biscuits, ice creams and sugar sweetened beverages.

On the other hand, boys spent more time doing MVPA than girls, but mean time spent doing MVPA was not enough to reach the recommendations of 60 minutes of MVPA [43]. However, participant children are mainly in the optimal weight status.

Our results showed that PA levels are associated with food and beverages frequency consumption. Some studies have shown a positive association among high levels of PA activity and vegetables and fruit intake.[15, 30, 31, 44, 45] For instance, Kelishadi et al.[31], in Islamic school students, observed an association of fruit and vegetable. In the same line, in Canadian children, Storey KE et al.[15] showed that those who had higher PA levels got a higher vegetable and fruit consumption. Our results are in line with the previous ones, but only positive associations were found in girls for vegetables intake, and in boys for fruit consumption.

Results of the Helena study showed a negative association between bread and cereals and PA level in European female adolescents. Our results showed a positive association between cereals consumption and time spent doing MVPA in European male children, no association were found in girls. Results from the Helena study, Ottevaere C et al.[30] also show a positive association between grain products consumption and PA levels in European boys. In both sexes, our results showed direct association between pasta consumption and time spent in MVPA.

Moreover, Storey KE et al.[15] showed a positive association between PA levels and the consumption of dairy products. Also, in European adolescents, Ottevaere C et al. also showed that more active girls got higher levels of consumption of milk and cheese and

eggs.[30] Our result are in concordance with those obtained in European adolescents, however cheese consumption were different by PA levels in the males group, and the eggs consumption in the females group. Additionally, Ottevaere C et al.[30] show a positive association between water, meat, fish and meat products consumption with high levels of PA in European male adolescents. Our results are in concordance with those obtained in European adolescents, but statistical differences were found in both sexes. Moreover, regarding the water consumption, in was inversely associated with MVPA levels in girls. In a sample of Pakistani children, Mushtaq MU et al.[45] no association were found between PA levels and fast food consumption, our results showed PA levels and fast food consumption. However, our results showed higher consumption of this kind of products in those who practise low levels of MVPA in both sexes. Furthermores, in the Helena study no associations were found between snack or ketchup consumption[30] and PA level; but in European children higher consumption of them was observed in those with high levels of MVPA. Our results are in line with those observed by Kelishadi et al.[31] that showed a positive association among candies and snacks consumption and PA levels in Islamic children. On the other hand, Ranjit et al.[44] didn't report any relation were found between PA levels and SSB consumption in American children. In IDEFICS study, only positive association were found between MVPA and SSB intake in girls.

Strength of the study including a large number of participants from eight different countries. In addition, IDEFICS study was carefully planned and performed a standardised and quality-controlled data collection. All survey centres were done at the same time using the same standardized protocol. Moreover, accelerometry is one of the most valid method to assess PA among children in free-living. However, this study had some limitations too. The cross sectional design in one of the limitation, that not allow to establishing causal relationship between observed results. Moreover, food frequency questionnaire is a useful tool to assess qualitative food intake, however in has been validated for this population group.[41] FFQ was self-reported by parents or guardians of these children. Self-report is a source of error because it depended on participant's memory and these estimates may be influenced by desire to report healthy habits.

Conclusions

In summary, our sample of European children had a suboptimal consumption of fruits and vegetables and they have a very high consumption of sweets and candies, according with the recommendations for food consumption[42]. Also, the majority of

European children didn't spent time enough doing PA in order to complete the 60 min recommended.[43] Current results show that dietary intake was different between children with different levels of MVPA.

Moreover, our result shows that more time spent in MVPA is not necessarily connected with healthier food consumption than less time spent in MVPA. It is important to improve the children's adherence to the diet and PA recommendations, due to their benefit in the prevention of several diseases during childhood and adulthood periods. Also, it is important to perform additional researches to explain better the relationship between diet and PA practice.

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Table 1. Descriptive analysis about sample baseline (T_0).

	Boys		Girls		p-value
Age, mean (95%CI)	6.17(0.02)		6.25(0.29)		0.444
Age, categories, %					
- 2 to 5 years old	36.1		33.6		**0.035**
- 6 to 9 years old	63.9		66.4		
Socioeconomic status,%					
- Low	8.4		7.7		0.506
- Medium	54.3		54.7		
- High	37.3		37.7		
Body mass index, %					
- Optimal weight	98.3		98.8		0.063
- Overweight or obese	1.7		1.2		
Food groups consumption (times/day)					
	mean (95%CI)	median (IQR)	mean (95%CI)	median (IQR)	
Vegetable	1.17(1.14-1.21)	0.99(0.56-1.42)	1.22(1.18-1.25)	0.99(0.56-1.42)	0.086
Legumes	0.16(0.14-0.19)	0.00(0.00-0.28)	0.15(0.13-0.16)	0.00(0.00-0.28)	0.286
Potatoes	0.15(0.14-0.16)	0.00(0.00-0.28)	0.13(0.13-0.14)	0.00(0.00-0.28	**0.009**
Soy products	0.02(0.01-0.03)	0.00(0.00-0.00)	0.01(0.01-0.02)	0.00(0.00-0.00)	0.076
Fruit	1.41(1.36-1.46)	1.00(0.71-2.00)	1.41(1.36-1.46)	1.00(0.71-2.00)	0.976
Fruit juices	1.19(1.13-1.24)	0.71(0.28-1.00)	1.14(1.08-1.19)	0.71(0.28-1.00)	0.236
Milk	1.66(1.61-1.71)	1.28(0.99-2.00)	1.61(1.56-1.67)	1.28(0.71-2.00)	0.210
Cheese	0.82(0.77-0.87)	0.56(0.28-1.00)	0.85(0.77-0.93)	0.71(0.28-1.27)	0.549
Yoghurt	0.76(0.73-0.78)	0.71(0.28-1.00)	0.73(0.70-0.76)	0.56(0.28-1.00)	0.174
Butter	0.86(0.83-0.90)	0.56(0.00-1.28)	0.89(0.86-0.93)	0.71(0.00-1.42)	0.298
Meat	1.26(1.22-1.30)	0.99(0.71-1.56)	1.18(1.14-1.21)	0.99(0.56-1.56)	**0.004**
Fish	0.30(0.29-0.32)	0.28(0.00-0.56)	0.28(0.27-0.29)	0.28(0.00-0.56)	**0.044**
Egg	0.34(0.33-0.36)	0.28(0.00-0.56)	0.35(0.34-0.37)	0.28(0.00-0.56)	0.479
Bread	1.57(1.53-1.62)	1.28(0.71-2.00)	1.56(1.51-1.60)	1.28(0.71-2.00)	0.681
Pasta	0.49(0.47-0.51)	0.28(0.28-0.71)	0.48(0.46-0.50)	0.28(0.28-0.71)	0.529
Cereals	0.61(0.59-0.64)	0.28(0.00-1.00)	0.56(0.53-0.58)	0.00(0.00-0.28)	**0.002**
Fast food	0.34(0.33-0.36)	0.28(0.00-0.56)	0.34(0.32-0.36)	0.28(0.00-0.56)	0.651
Nuts	0.13(0.12-.014)	0.00(0.00-0.28)	0.14(0.13-0.15)	0.00(0.00-0.28)	0.127
Snacks	0.15(0.14-0.16)	0.00(0.00-0.28)	0.13(0.12-0.14)	0.00(0.00-0.28)	**0.005**
Savoury pastries	0.11(0.10-0.12)	0.00(0.00-0.28)	0.10(0.09-0.11)	0.00(0.00-0.28)	0.147
Ketchup	0.24(0.23-0.25)	0.28(0.00-0.28)	0.21(0.20-0.22)	0.28(0.00-0.28)	**<0.001**
Candy	0.29(0.27-0.30)	0.28(0.00-0.28)	0.28(0.26-0.29)	0.28(0.00-0.28)	0.466
Jam	1.59(1.48-1.71)	0.28(0.28-2.00)	1.47(1.37-1.58)	0.28(0.28-2.00)	0.132
Biscuits	0.34(0.32-0.35)	0.28(0.00-0.28)	0.30(0.29-0.32)	0.28(0.00-0.28)	0.003
Chocolate	0.55(0.53-0.57)	0.28(0.28-0.71)	0.53(0.51-0.55)	0.28(0.28-0.71)	0.307
Ice cream	0.24(0.23-0.26)	0.28(0.00-0.28)	0.24(0.23-0.26)	0.28(0.00-0.28)	0.003
Water	4.50(4.40-4.59)	7.00(2.00-7.00)	4.54(4.44-4.63)	7.00(2.00-7.00)	0.536
SSB	0.56(0.51-0.60)	0.00(0.00-0.28)	0.52(0.47-0.57)	0.00(0.00-0.28)	0.266
Physical activity (minutes/day)					
	mean (SD)		mean (SD)		
Sedentary activity	283.48(1.51)		290.71(1.48)		**0.001**
Light PA	379.96(1.07)		376.15(1.13)		**0.015**
Moderate PA	36.20(0.3)		27.94(0.23)		**<0.001**
Vigorous PA	6.91(0.10)		6.04(0.092)		**<0.001**
MVPA	43.76 (22.73)		34.06 (17.74)		**<0.001**

Abbreviation: IQR, interquartile range; MVPA, moderate and vigorous of physical activity; SSB, sugar sweetened beverages; CI, confidence interval; SD, standard desviation.
Pearson chi-square test for categorized variables and t-test or continuous variable.
Calculated as weight in kilograms divided by height in meters squared, categories based on the cut-off values of Cole et al. [46]

Table 2. Analysis of covariance of food groups (times/day) consumption by tertiles of moderate and vigorous of physical activity.

	Boys			Girls		
	T1	T2	T3	T1	T2	T3
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Vegetable	1.13(0.03)	1.15(0.03)	1.23(0.03)	**1.15(0.03)[ab]**	**1.25(0.03)[a]**	**1.30(0.04)[b]**
Legume	0.17(0.03)	0.20(0.03)	0.15(0.02)	0.14(0.02)	0.15(0.01)	0.15(0.01)
Potatoes	0.15(0.01)	0.16(0.01)	0.15(0.01)	0.14(0.01)	0.13(0.01)	0.14(0.01)
Soy products	0.02(0.01)	0.03(0.01)	0.02(0.01)	0.02(0.00)	0.02(0.00)	0.02(0.00)
Fruit	**1.32(0.05)[b]**	1.38(0.05)	**1.50(0.04)[b]**	1.39(0.04)	1.42(0.04)	1.44(0.05)
Fruit juice	1.17(0.05)	1.14(0.05)	1.24(0.04)	1.15(0.04)	1.11(0.05)	1.19(0.06)
Milk	1.65(0.05)	1.61(0.05)	1.72(0.04)	1.60(0.04)	1.65(0.04)	1.60(0.05)
Cheese	**0.93(0.05)[b]**	0.83(0.04)	**0.75(0.04)[b]**	0.90(0.06)	0.85(0.07)	0.72(0.09)
Yoghurt	**0.71(0.03)[b]**	0.75(0.03)	**0.80(0.02)[b]**	0.70 (0.02)	0.75(0.02)	0.76(0.03)
Butter	0.86(0.04)	0.86(0.04)	0.88(0.03)	**0.80(0.03)[ab]**	**0.94(0.03)[a]**	**1.00(0.04)[b]**
Meat	1.31(0.04)	1.22(0.04)	1.27(0.03)	1.16(0.03)	1.18(0.03)	1.22(0.04)
Fish	0.33(0.02)	0.30(0.01)	0.30(0.01)	0.28(0.01)	0.28(0.01)	0.30(0.01)
Egg	0.36(0.02)	0.34(0.02)	0.35(0.01)	**0.35(0.01)[b]**	0.35(0.01)	**0.39(0.02)[b]**
Bread	1.59(1.31)	1.58(0.04)	1.56(0.04)	1.55(0.04)	1.55(0.04)	1.61(0.05)
Pasta	0.52(0.02)	0.47(0.02)	0.49(0.01)	0.50(0.01)	0.47(0.02)	0.49(0.02)
Cereals	0.59(0.02)	0.62(0.02)	0.63(0.02)	0.55(0.02)	0.56(0.02)	0.58(0.02)
Fast food	**0.40(0.018)[b]**	0.353(0.016)	**0.32(0.014)[b]**	0.363(0.014)	0.337(0.015)	0.323(0.02)
Nuts	0.14(0.01)	0.13(0.01)	0.13(0.01)	0.14(0.01)	0.14(0.01)	0.14(0.011)
Snack	0.16(0.01)	0.15(0.01)	0.15(0.01)	0.14(0.01)	0.13(0.01)	0.13(0.01)
Savory pastries	0.12(0.01)	0.11(0.01)	0.11(0.01)	**0.12(0.01)[b]**	0.10(0.01)	**0.09(0.01)[b]**
Ketchup	0.23(0.01)	0.26(0.01)	0.24(0.01)	0.20(0.01)	0.21(0.01)	0.22(0.01)
Candy	**0.26(0.02)[b]**	0.27(0.02)	**0.33(0.01)[b]**	**0.26(0.01)[b]**	0.29(0.01)	**0.32(0.02)[b]**
Jam	1.59(0.12)	1.64(0.10)	1.57(0.09)	1.39(0.09)	1.48(0.09)	1.60(0.11)
Biscuits	0.35(0.02)	0.35(0.01)	0.33(0.01)	0.31(0.01)	0.32(0.01)	0.30(0.01)
Chocolate	0.53(0.02)	0.58(0.02)	0.55(0.02)	0.54(0.02)	0.54(0.02)	0.53(0.02)
Ice cream	0.27(0.01)	0.25(0.01)	0.24(0.01)	0.26(0.01)	0.24(0.01)	0.26(0.01)
Water	4.56(0.09)	4.57(0.08)	4.41(0.07)	**4.69(0.07)[b]**	4.51(0.08)	**4.330(0.10)[b]**
SSB	0.55(0.05)	0.54(0.04)	0.59(0.04)	**0.45(0.04)[b]**	0.52(0.04)	**0.66(0.05)[b]**

Abbreviation: SE, standard error; SSB, sugar sweetened beverages.

Covariates were age, body mass index and socioeconomic status

[a] Significant difference between 1st and 2nd tertile (Bonferroni post-hoc test).

[b] Significant difference between 1st and 3rd tertile (Bonferroni post-hoc test).

Table 3. Binary logistic regression analysis predicting food group consumption above the median related to tertiles of moderate and vigorous of physical activity.

	Boys			Girls		
	MVPA			MVPA		
	Tertile 1	Tertile 2	Tertile 3	Tertile 1	Tertile 2	Tertile 3
	OR.(95% CI)	OR.(95% CI)	OR	OR.(95% CI)	OR.(95% CI)	OR
Vegetable	0.86 (0.72-1.02)	0.90(0.76-1.06)	1	**0.68(0.57-0.82)**	**0.81(0.67-0.98)**	1
Legumes	1.07(0.65-1.76)	0.93(0.60-1.46)	1	1.01(0.631-1.61)	0.95(0.62-1.47)	1
Potatoes	0.99(0.83-1.17)	1.06(0.90-1.24)	1	1.09(0.91-1.30)	1.06(1.02-1.10)	1
Soy products	0.87(0.53-1.43)	1.05(0.67-1.63)	1	0.85(0.50-1.43)	1.19(0.72-1.95)	1
Fruit	**0.81(0.67-0.97)**	0.97(0.82-1.15)	1	0.91(0.76-1.10)	0.90(0.76-1.10)	1
Fruit juices	0.99(0.84-1.19)	0.99(0.85-1.17)	1	1.00(0.84-1.20)	0.89(0.75-1.07)	1
Milk	0.85(0.72-1.02)	0.91(0.78-1.08)	1	0.99(0.78-1.12)	1.06(0.88-1.27)	1
Cheese	1.19(0.84-1.68)	1.22(0.89-1.68)	1	1.18(0.80-1.74)	1.09(0.73-1.63)	1
Yoghurt	**0.68(0.56-0.81)**	**0.73(0.61-0.86)**	1	**0.80(0.66-0.96)**	1.08(0.90-1.31)	1
Butter	1.03(0.87-1.24)	0.91(0.77-1.08)	1	**0.67(0.56-0.81)**	**0.82(0.68-0.99)**	1
Meat	0.89(0.72-1.09)	**0.82(0.68-0.98)**	1	**0.74(0.60-0.92)**	0.87(0.71-1.08)	1
Fish	0.93(0.77-1.13)	0.92(0.78-1.10)	1	0.93(0.77-1.13)	0.99(0.81-1.20)	1
Egg	1.01(0.83-1.21)	1.03(0.87-1.23)	1	**0.82(0.67-0.99)**	0.86(0.70-1.06)	1
Bread	0.95(0.80-1.13)	0.96(0.81-1.12)	1	1.00(0.84-1.20)	1.03(0.86-1.24)	1
Pasta	**0.59(0.44-0.82)**	**0.64(0.48-0.87)**	1	**0.65(0.47-0.91)**	0.86(0.61-1.21)	1
Cereals	**0.71(0.58-0.87)**	0.90(0.75-1.09)	1	0.89(0.72-1.10)	0.97(0.78-1.21)	1
Fast food	**1.57(1.31-1.87)**	**1.35(1.15-1.58)**	1	**1.30(1.09-1.56)**	1.09(0.91-1.31)	1
Nuts	0.86(0.72-1.03)	0.96(0.82-1.14)	1	0.87(0.72-1.04)	1.00(0.83-1.21)	1
Snack	**0.81(0.68-0.96)**	0.90(0.77-1.05)	1	1.04(0.87-1.25)	1.09(0.91-1.31)	1
Savory pastries	1.11(0.93-1.34)	1.03(0.87-1.22)	1	1.16(0.96-1.41)	1.15(0.94-1.39)	1
Ketchup	**0.79(0.66-0.94)**	0.90(0.77-1.06)	1	**0.79(0.61-0.94)**	0.90(0.75-1.08)	1
Candy	**0.55(0.46-0.66)**	**0.68(0.58-0.80)**	1	**0.70(0.58-0.84)**	0.99(0.83-1.19)	1
Jam	1.09(0.88-1.34)	1.11(0.90-1.36)	1	1.16(0.96-1.40)	1.05(0.85-1.29)	1
Biscuits	0.89(0.75-1.07)	0.93(0.78-1.09)	1	0.89(0.74-1.07)	1.05(0.87-1.26)	1
Chocolate	0.90(0.76-1.11)	0.98(0.81-1.19)	1	0.96(0.77-1.18)	1.11(0.89-1.38)	1
Ice cream	1.03(0.86-1.25)	0.95(0.81-1.11)	1	1.03(0.86-1.22)	0.95(0.79-1.13)	1
Water	1.14(0.96-1.36)	1.13(0.96-1.33)	1	**1.25(1.05-1.50)**	1.14(0.95-1.36)	1
SSB	0.98(0.83-1.17)	0.86(0.73-1.01)	1	**0.82(0.68-0.98)**	0.91(0.75-1.08)	1

Abbreviations: MVPA, moderate and vigorous physical activity; OR, odds ratio; IC, interval confidence; SSB, sugar sweetened beverages.

Covariates were age, body mass index and socioeconomic status.

APENDIX.

Table A. Foodstuff included into 28 new food groups.

Vegetable	Cooked vegetable, potatoes, beans and raw vegetable
Potatoes	Fried potatoes and potatoes croquettes
Legumes	Legumes
Fruit	Fresh fruit without added sugar and with added sugar
Water	Water
Fruit juices	Fruit juices
Sugar Sweetened beverages	Sweetened drinks and diet drinks
Cereal	Breakfast cereals, muesli, sweetened and unsweetened
Milk	Plain unsweetened milk and sweetened milk
Yoghurt	Plain unsweetened yoghurt and sweetened yoghurt and fermented milk beverages
Fish	Fresh or frozen fish, not fried, fried fish and fish fingers
Meat	Cold cut, preserved, ready to cook meat products, fresh meat, not fried and fried
Egg	Fried, scrambled, boiled or poached eggs and mayonnaise or mayonnaise based products
Soy replacement	Tofu, tempe, quorm, soy milk
Cheese	Sliced cheese, spreadable cheese and greated
Chocolate	Chocolate or nut based spread and chocolate, candy bars
Butter	Butter, margarine on bread and reduced fat products
Honey	Jam and Honey
Ketchup	Ketchup
Bread	White bread, white roll, white crispbread, whole meal bread, dark roll, dark crispbread
Pasta	Pasta, noodles, rices and dish of milled cereals
Fast food	Pizza as main dish and hamburger, hot dog, kebab, wrap and falafel
Nuts	Nuts, seeds, dried fruits
Snack	Crisps, corn crisps, popcorn
Savory Pastries	Savory pastries and fritters
Candy	Candies, loose candies, marshmallows
Biscuits	Biscuits, packaged cakes, pastries, pudding
Ice cream	Ice cream, milk or fruit based bars