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Clustering of Dietary Patterns, Lifestyles, and Overweight among Spanish Children and Adolescents in the ANIBES Study

With the participation of:

Spanish Nutrition and Food Sciences Academy (AEN)

Spanish Nutrition Society (SEN)

Spanish Society of Community Nutrition (SENC)

Spanish Foundation for Nutritional Research (FIN)

Nutrition Studies Association (ASEN)

Improvement of Health by Fitness, Nutrition and Exercise Research Group

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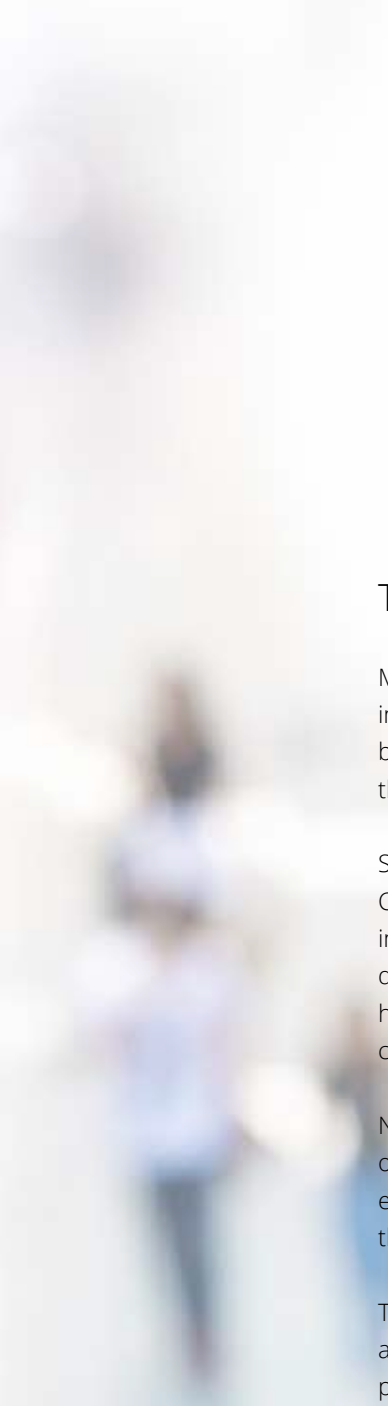
Introduction

The prevalence of overweight and obesity has been steadily increasing in Spain over the past decades. As for children and adolescents, this issue is of particular concern because of the rapid rate of increase of overweight and obesity, and also the potential negative impact on health and well-being in the present and future.

Obesity rates in Spain are amongst the highest in OECD (Organization for Economic Co-Operation and Development) countries. Several good quality studies support an overall leveling off of this epidemic among children and adolescents in Europe, Australia, Japan, and the United States. However, there is scientific evidence that suggests that circumstances may vary across different socioeconomic groups, suggesting less evident leveling off in groups with lower socioeconomic status.

Both overweight and obesity are the main result from an imbalance between energy intake and energy expenditure (on certain occasions, intake should be reduced; sometimes, intake should be reduced and expenditure should be increased; and at other times, only expenditure should be increased), which leads to weight gain. Weight gain has been commonly associated with diet and energy input from foods and beverages, with sedentary lifestyles and with physical inactivity. However, more recently, other circumstances, such as sleeping habits, genetic background, environment, etc., have been also considered as a determinant that may influence energy balance.

Without a shadow of a doubt, identifying behaviors related to energy balance (adequate energy intake and energy expenditure) and their determinants within a specific population group is a key step to design effective overweight and obesity prevention interventions.



The importance of dietary patterns

Most research has focused only on specific nutrients and some foods and beverages intake. Over the past decade, attention has been drawn to overall dietary patterns, because they consider all food and beverages intake, as well as nutrients, and therefore they also consider cumulative and interactive effects between them.

Several studies, such as the enKid study (Feeding Habits and Nutritional Status in Spanish Children and Youth), which was carried out in Spain between 1998 and 2000, have investigated these patterns in children and adolescents, which has enabled to describe dietary patterns among the young population. For instance, a pattern which includes a higher consumption of fruits, vegetables and fish was described, and also another pattern characterized by a higher consumption of snacks and energy-dense food and beverages.

No single element has been identified separately as a universal causal factor in the current obesity epidemic, as many distinct habits and determinants influence a more positive energy balance at different levels (energy intake higher than energy expenditure). Many of these behaviors are interrelated and may result in different effects on health.

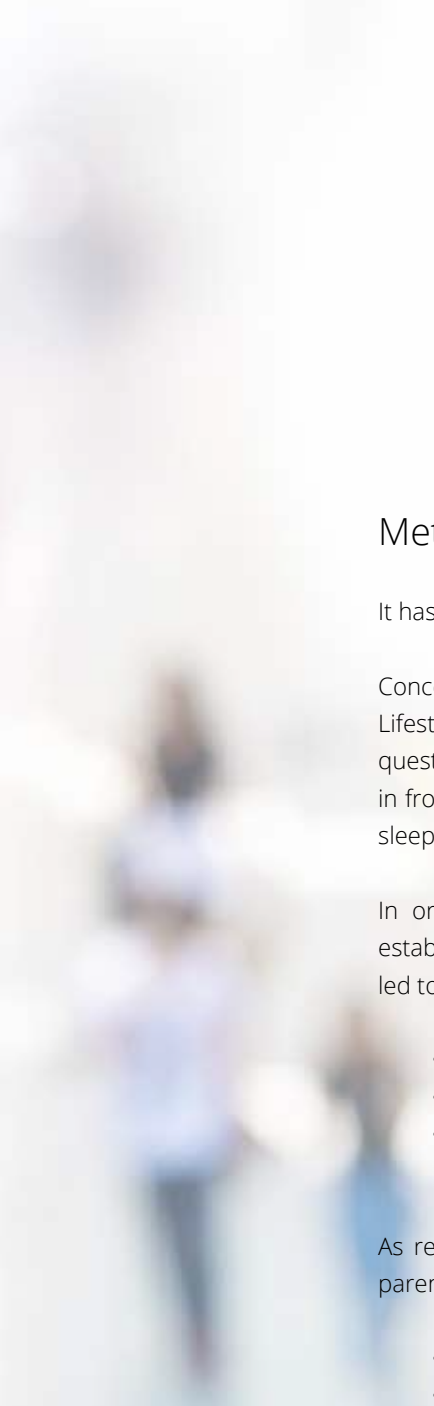
The co-existence of different groups of people who share similar characteristics is a concept that has been successfully applied over the last years to understanding the potential relationships between different lifestyle behaviors. This approach acknowledges that there are multivariate and interactive influences on lifestyles.

Cluster analysis have become an increasingly common research method to investigate lifestyle patterns, mainly to better understand the relationship between food and beverages intake, physical activity, and sedentary behavior among children and adolescents, as well as the possible cumulative effect on the development of overweight and obesity when several behaviors are combined within an unhealthier pattern.

To date, limited information is available on health-related behavior patterns among Spanish children and adolescents.

For this reason, the aims of this study, framed within the ANIBES scientific study (Anthropometry, Intake and Energy Balance in Spain) were:

- To identify dietary patterns among children (9-12 years-old) and adolescents (13-17 years-old).
- To investigate whether energy balance-related behaviors cluster to characterize meaningful patterns in this population group.
- To describe sociodemographic factors associated with the identified patterns.
- To study the potential association between identified patterns, sociodemographic factors and overweight.



Methodology

It has been already described in detail in Ruiz E et al 2015.

Concerning this new specific study, a questionnaire validated in the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study has been considered, which includes questions on the time spent in different sedentary activities, such as the minutes spent in front of a screen and the hours spent studying and doing homework. Moreover, usual sleep duration pattern has been also analyzed.

In order to establish measurable parameters of parental education, different levels established in accordance with the Spanish education system have been used, which has led to three categories:

- Low (less than 7 years of education / primary school or less)
- Medium (7-12 years of education / lower to medium secondary education)
- High (13 years or more of education / university studies or higher vocational studies)

As regards Family Socioeconomic Status, three levels have been established based on parental education and occupation:

- Low
- Mid-low
- Mid-mid, Mid-high and High

Four dietary patterns

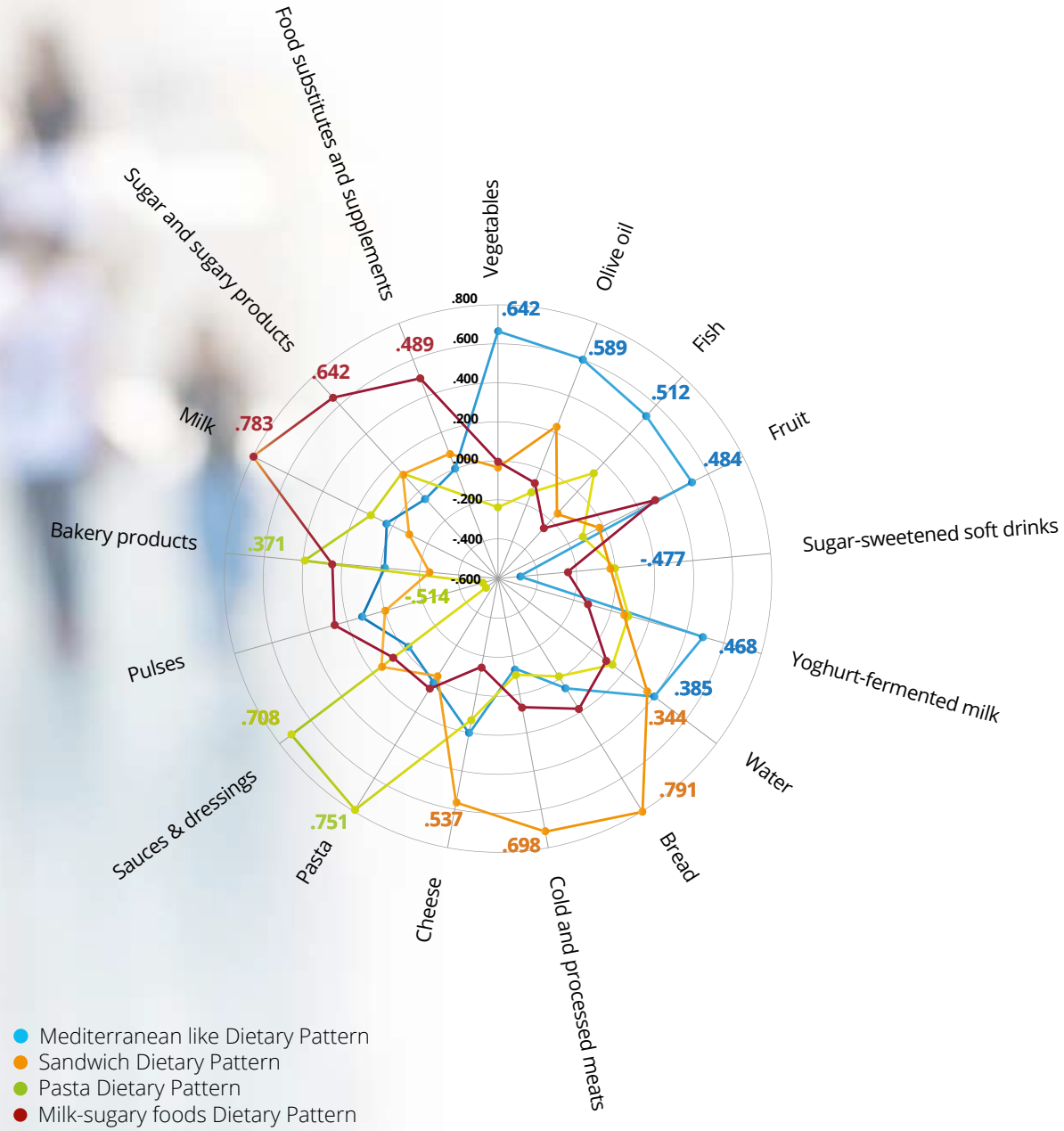
In order to undertake this analysis, data from 415 children and adolescents have been considered (after excluding outliers and participants with incomplete data). No difference has been observed in sociodemographic characteristics between children and adolescent groups, being prevalence of overweight and obesity significantly higher in children.

In this respect, four different dietary patterns were defined:

- **Mediterranean like Dietary Pattern:** characterized by a greater presence of vegetables, olive oil, fish, fruits, yoghurt and fermented milk products, as well as water, and a lower intake of processed meat products, sauces, bakery products, sugar-sweetened soft drinks and food supplements. This pattern is more similar to the traditional Mediterranean diet.
- **Sandwich Dietary Pattern:** characterized by high positive loadings on bread, processed meat products and cheese.
- **Pasta Dietary Pattern:** with high positive loadings on pasta, sauces and dressings, as well as baked goods, but with high negative loadings on legumes.
- **Milk-sugary foods Dietary Pattern:** with high positive loading on milk, sugar, sugary foods and food supplements.

Taking into account age and total energy intake, the Mediterranean like Dietary Pattern obtained a significantly higher score in girls than boys.

Dietary patterns in the ANIBES scientific study



Lifestyle Patterns

This study shows that, according to dietary patterns, physical activity (minutes/day of moderate and vigorous activity), sedentary behaviors and sleep time on weekdays (not during the weekend), Spanish children and adolescents who participated in the ANIBES scientific study are classified in two different groups:

- **Unhealthier lifestyle pattern:** characterized by low physical activity and less adequate diet.

- **Healthier lifestyle pattern:** characterized by high levels of physical activity, lower time spent in sedentary activities, higher sleep duration and healthier diet.

Even though differences were not statistically significant, unhealthier lifestyle pattern *(less physical activity and less adequate diet)* includes a higher proportion of obese people and low socioeconomic status families compared to healthier dietary habits and lifestyles pattern.

Gender, age group, education and socioeconomic level and BMI status by lifestyle patterns

		Unhealthier Lifestyle Pattern		Healthier Lifestyle Pattern	
	Sample	319	76.9 %	96	23.1 %
GENDER	Boys	186	58.3 %	72	75.0 %
	Girls	133	41.7 %	24	25.0 %
AGE GROUP	Children (9-12 years)	152	47.6 %	55	57.3 %
	Adolescents (13-17 years)	167	52.4 %	41	42.7 %
PARENTAL EDUCATION LEVEL	Primary or less education	107	33.5 %	28	29.2 %
	Secondary or Medium education	157	49.2 %	54	56.3 %
	Higher education	55	17.2 %	14	14.6 %
SOCIOECONOMIC LEVEL	Low	71	22.3 %	14	14.6 %
	Mid-low	79	24.8 %	28	29.2 %
	Mid, Mid-high and High	169	53.0 %	54	56.3 %
BODY MASS INDEX STATUS (BMI)	Normal weight	202	63.3 %	64	66.7 %
	Overweight	89	27.9 %	27	28.1 %
	Obese	28	8.8 %	5	5.2 %

Findings from the cluster analysis are in line with the results from other studies that have also identified behavioral patterns associated with a healthier energy balance, which combines healthier dietary habits with high levels of physical activity and low levels of sedentary behavior in children and adolescents from different countries. Other authors have also identified several combinations of sedentary behaviors and healthier dietary patterns.

Furthermore, this approach has been used in previous studies that have also identified lifestyle patterns referred to as healthy or traditional in children and adolescents, with a higher consumption of fruits and vegetables and a lower intake of energy-dense foods and beverages, similar to the Mediterranean like Dietary Pattern that has been identified in this study.

Regarding the ANIBES scientific study, longer sleep duration has been considered positively in the healthier lifestyle pattern. Other scientific studies have correlated longer sleep duration with lower physical activity.

However, sleep quality is also an issue that deserves further research in addition to sleep duration.

Lifestyle factors and dietary patterns (Z-score) in lifestyle patterns (children boys and adolescent boys)

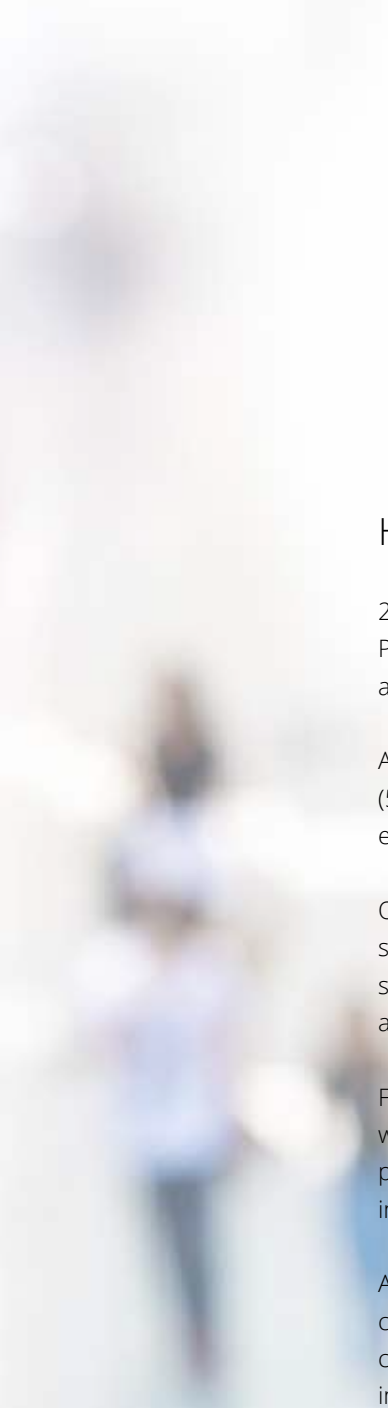
	Children boys		Adolescent boys	
	Unhealthier Lifestyle Pattern*	**Healthier Lifestyle Pattern***	**Unhealthier Lifestyle Pattern***	**Healthier Lifestyle Pattern***
Age (years-old)	10.3 ± 1.1	10.3 ± 1.1	15.2 ± 1.5	14.9 ± 1.5
Sleep time on weekdays (h/d)	8.9 ± 0.9	9.1 ± 1.1	8.0 ± 0.8	8.4 ± 1.1
Sedentary screen time (min/d)	233.0 ± 141	214.0 ± 107	313.0 ± 147	294.0 ± 204
Vigorous Physical Activity (min/d)	29.0 ± 25	93.0 ± 50**	30.0 ± 31	72.0 ± 57**
Moderate Physical Activity (min/d)	27.0 ± 24	114.0 ± 51**	18.0 ± 21	103.0 ± 50**
Walking (min/d)	37.0 ± 29	105.0 ± 60**	37.0 ± 33	103.0 ± 57**
Biking (min/d)	5.0 ± 11	8.0 ± 14	2.0 ± 5	18.0 ± 38**
Total Physical Activity (min/d)	111.0 ± 51	385.0 ± 175**	99.0 ± 53	328.0 ± 127**
Mediterranean like Dietary Pattern (Z-score)	-0.08 ± 0.86	0.45 ± 0.95***	-0.28 ± 0.88	0.23 ± 1.35***
Sandwich Dietary Pattern (Z-score)	0.01 ± 0.94	-0.11 ± 0.95	0.24 ± 1.05	0.12 ± 1.38
Pasta Dietary Pattern (Z-score)	0.08 ± 0.92	0.03 ± 1.19	0.09 ± 1.16	0.05 ± 1.05
Milk-sugary foods Dietary Pattern (Z-score)	0.17 ± 0.81	0.08 ± 0.80	0.19 ± 1.35	-0.17 ± 1.09

*Mean (± standard deviation) **Statistically significant difference ***P < 0.01

Lifestyle factors and dietary patterns (Z-score) in lifestyle patterns (children girls and adolescent girls)

	Children girls		Adolescent girls	
	Unhealthier Lifestyle Pattern*	**Healthier Lifestyle Pattern***	**Unhealthier Lifestyle Pattern***	**Healthier Lifestyle Pattern***
Age (years-old)	10.5 ± 1.2	10.4 ± 1.2	14.9 ± 1.5	15.9 ± 1.0****
Sleep time on weekdays (h/d)	9.0 ± 0.9	9.1 ± 1.0	7.9 ± 1.0	8.3 ± 1.2
Sedentary screen time (min/d)	211.0 ± 107	245.0 ± 148	291.0 ± 185	259.0 ± 145
Vigorous Physical Activity (min/d)	18.0 ± 30	57.0 ± 58**	9.0 ± 14	90.0 ± 69**
Moderate Physical Activity (min/d)	23.0 ± 25	121.0 ± 48**	13.0 ± 14	98.0 ± 38**
Walking (min/d)	42.0 ± 30	90.0 ± 54**	43.0 ± 36	80.0 ± 53**
Biking (min/d)	1.0 ± 4	9.0 ± 18	1.0 ± 4	1.0 ± 2
Total Physical Activity (min/d)	98.0 ± 51	385.0 ± 175**	77.0 ± 47	292.0 ± 89**
Mediterranean like Dietary Pattern (Z-score)	0.13 ± 1.0	0.35 ± 0.95***	-0.16 ± 0.96	0.62 ± 0.47***
Sandwich Dietary Pattern (Z-score)	-0.18 ± 0.95	-0.26 ± 0.95	-0.30 ± 0.80	0.01 ± 0.96
Pasta Dietary Pattern (Z-score)	-0.09 ± 0.87	0.09 ± 1.19	-0.20 ± 0.81	-0.19 ± 0.64
Milk-sugary foods Dietary Pattern (Z-score)	-0.01 ± 0.76	0.08 ± 0.80	-0.24 ± 0.89	-0.59 ± 0.55

*Mean (± standard deviation) **Statistically significant difference ***P < 0.01 ****P < 0.05



Healthier Lifestyle Pattern

23.1 % of the ANIBES population aged 9-17 years-old is included in the Healthier Lifestyle Pattern. Amongst them, 75.0 % are boys and 25.0 % are girls. According to age range, 57.3 % are children aged between 9 and 12 years and 42.7 % are adolescents aged 13-17 years-old.

A large majority of parents of these two population groups of children and adolescents (56.3 %) have secondary education level, 14.6 % have university studies and higher education and 29.2 % have, at the most, primary education level.

On the other hand, 56.3 % of this group have a medium or high family socioeconomic status (SES), whereas 29.2 % have a mid-low SES and 14.6 % are placed in the lowest stratum. Taking into account the BMI, 66.7 % have a normal weight, 28.1 % are overweight and 5.2 % suffer from obesity.

Furthermore, data indicate that children and adolescents with a healthier lifestyle, which were included in the ANIBES scientific study, sleep between 8.4 ± 1.1 and 8.3 ± 1.2 hours per day (adolescent boys and girls, respectively) and 9.1 ± 1.1 in children boys and 9.1 ± 1.0 in children girls.

According to age groups, the younger ones have the lowest sedentary behavior, being children boys those who spend 214 ± 107 minutes per day in sedentary screen time and children girls those spending 245 ± 148 minutes per day. During adolescence, this index increases, as children boys spend 294 ± 204 minutes in sedentary activities, in comparison with 259 ± 145 of children girls.

Children boys and adolescent boys spend 385 ± 175 minutes per day practicing any type of physical activity, whereas this figure drops to 328 ± 127 minutes per day in children girls and adolescent girls, and falls even more to 292 ± 89 minutes per day in adolescent girls. These results support those from other studies such as the PERSEO project (Pilot Reference School Program for Health and Physical Activity against Obesity), which showed that girls practice lower physical activity than boys, especially during adolescence. In the ANIBES scientific study analysis, girls were closer to the Mediterranean like Dietary Pattern. This finding is in line with the results of other studies that show that girls obtain higher scores in traditional dietary patterns.

Unhealthier Lifestyle Pattern

76.9 % of children and adolescents of the ANIBES scientific study are included in the unhealthier lifestyle pattern. Amongst them, 58.3 % are boys and 41.7 % are girls. According to age range, 47.6 % are children aged between 9 and 12 years-old and 52.4 % are adolescents (13-17 years-old).

Concerning almost half of the sample (49.2 %), parents have secondary education level, only 17.2 % of them have higher education and 33.5 % only have primary education level. On the other hand, more than half of them (53.0 %) have a medium or high socioeconomic status, whereas 22.3 % are placed in the lowest stratum, and 24.8 % in the mid-high level.

As regards their anthropometric data, it should be highlighted that 63.3 % of the total sample, including children and adolescents, have a normal weight, 27.9 % are overweight and 8.8 % suffer from obesity.

As indicated by the results of the ANIBES scientific study, unhealthier lifestyle patterns cover a high percentage of low family socioeconomic status (22.3 %).

In this group, which covers unhealthier lifestyle patterns, sleep time is between 7.9 ± 1.0 and 8 ± 0.8 hours per day in adolescent girls and boys, respectively, and 8.9 ± 0.9 and 9 ± 0.9 hours in children (boys and girls), which is lower than the results obtained in the healthier lifestyle pattern.

On the other hand, adolescents spend more time in front of a screen, being boys those who spend more minutes (313 ± 147 minutes per day), whereas girls spend 291 ± 185 minutes per day in sedentary activities. Children boys, for their part, spend a mean of 233 ± 141 minutes per day in sedentary activities and children girls spend 211 ± 107 minutes per day.

Concerning total physical activity per day, children boys and girls practice 111 ± 51 and 98 ± 51 minutes per day of any type of physical activity. During adolescence, total physical activity per day is 99 ± 53 minutes for boys and 77 ± 47 minutes for girls. It was observed in all cases that the time spent practicing physical activity is more than three times lower than in the healthier lifestyle group.

Even though all of them are disassociated from the Mediterranean like Dietary Pattern, girls are those that could have more similarities. This can be observed in boys' and girls' intake of different food groups.

It should be noted that boys' and girls' intake is respectively 117 ± 1.0 and 128 ± 1.2 grams per day of vegetables, 88.7 ± 2.1 and 106 ± 2.0 grams per day of fruits, 12.9 ± 0.1 and 13.2 ± 0.1 grams per day of pulses and 37.8 ± 0.3 and 41.9 ± 0.2 grams per day of fish.

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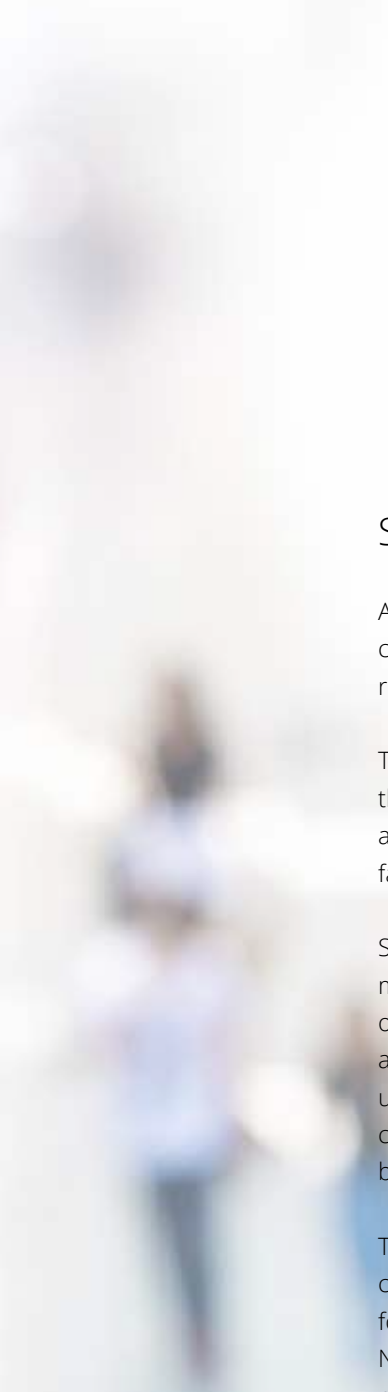
Mean consumption of food and beverages groups by lifestyle patterns

	Boys		Girls	
	Unhealthier Lifestyle Pattern*	**Healthier Lifestyle Pattern***	**Unhealthier Lifestyle Pattern***	**Healthier Lifestyle Pattern***
Olive oil (ml/d)	15.4 ± 0.1	17.7 ± 0.2**	15.5 ± 0.2	13.5 ± 0.5**
Vegetables (g/d)	117.0 ± 1.0	137.0 ± 1.7**	128.0 ± 1.2	148.0 ± 3.3**
Fruit (g/d)	88.7 ± 2.1	122.0 ± 2.8**	106.0 ± 2.0	147.0 ± 6.1**
Pulses (g/d)	12.9 ± 0.1	13.3 ± 0.2	13.2 ± 0.1	13.4 ± 0.2
Fish (g/d)	37.8 ± 0.3	55.2 ± 0.5**	41.9 ± 0.2	80.4 ± 0.7**
Bread (g/d)	95.5 ± 1.8	96.7 ± 3.1	80.8 ± 1.6	79.0 ± 4.5
Pasta (g/d)	24.7 ± 0.8	23.8 ± 0.6	19.1 ± 0.2	15.5 ± 0.6
Bakery products (g/d)	48.3 ± 1.3	46.1 ± 2.3	41.1 ± 0.8	48.4 ± 2.4
Sugar and sugary products (g/d)	23.8 ± 0.3	20.8 ± 0.6**	24.0 ± 0.6	24.1 ± 1.8
Milk (g/d)	274.0 ± 2.8	247.0 ± 4.8**	208.0 ± 2.6	209.0 ± 7.8
Cheese (g/d)	16.0 ± 0.4	17.2 ± 0.6	15.0 ± 0.4	21.9 ± 0.9**
Yoghurt and fermented milk (g/d)	51.8 ± 1.3	73.3 ± 2.2**	50.2 ± 1.6	69.1 ± 4.8**
Meats (g/d)	105.0 ± 1.0	117.0 ± 1.5**	88.6 ± 1.2	79.4 ± 2.7**
Cold and processed meats (g/d)	59.4 ± 0.9	51.4 ± 1.6	48.7 ± 0.9	50.6 ± 2.9
Water (g/d)	582.0 ± 5.2	627.0 ± 9.3**	526.0 ± 0.8	629.0 ± 2.3**
Sugared soft drinks (g/d)	143.0 ± 3.8	98.1 ± 5.2**	95.6 ± 2.9	66.8 ± 6.8**
Juices (g/d)	115.0 ± 1.9	126.0 ± 3.5**	114.0 ± 1.9	159.0 ± 5.3**
Sauces and dressings (g/d)	15.4 ± 0.2	15.8 ± 0.4**	14.0 ± 0.2	15.4 ± 0.7

*Mean (± standard error) **P < 0.05



Strengths and weaknesses

A significant increased risk of being overweight or obese across both lifestyle patterns in children and adolescents was not observed. In fact, scientific evidence is inconsistent with respect to a cumulative effect of these factors on overweight and obesity.

These results can likely be attributed to the cross-sectional design of the studies, but they also reflect the complexity of behaviors related to an inadequate energy intake and an imbalance in energy expenditure, socioeconomic correlates, and other determinant factors and their influence on overweight and obesity.

Some of the strengths of this study are focused on the careful design, protocol and methodology of the ANIBES scientific study, conducted among a representative sample of the Spanish population aged 9-75 years-old, with a food and beverages consumption assessment by using digital tablets and including a thorough quality control process. The use of factor analysis allowed to identify dietary patterns without any a priori defined criteria and their inclusion in cluster analysis together with physical activity, sedentary behaviors and sleep time provided a broader perspective.

The cross-sectional design of this study has provided evidence for association, but not causal relationships, which could be considered as a limitation, as well as possibly biased food and beverages consumption and physical activity self-reports made by participants. Nevertheless, this handicap has been minimized by implementing a careful quality control procedure of the data provided.

Further prospective research to identify specific issues

Factor analysis and cluster analysis that were used in this study are two tools widely used to identify dietary patterns and clusters with similar lifestyle patterns.

Following this research, next steps should be focused on developing prospective research to further examine how lifestyle patterns of energy balance-related behaviors may influence the development of overweight and obesity. These patterns are very helpful to identify specific issues, and also to suggest potential intervention strategies.

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The final protocol of the ANIBES scientific study was previously approved
by the Clinical Research Ethics Committee of the Autonomous Region of Madrid (Spain).


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