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► **To cite this version:**

Sílvia Fraga, Milton Severo, Diogo Costa, Carla Lopes, Elisabete Ramos. Clustering behaviours among 13-year-old Portuguese adolescents. *Journal of Public Health*, 2010, 19 (S1), pp.21-27. 10.1007/s10389-010-0376-0 . hal-00615351

**HAL Id: hal-00615351**

**<https://hal.science/hal-00615351>**

Submitted on 19 Aug 2011

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## CLUSTERING BEHAVIOURS AMONG 13 YEAR-OLD PORTUGUESE ADOLESCENTS

Sílvia Fraga <sup>1,2</sup>; Milton Severo <sup>1,2</sup>; Diogo Costa <sup>1,2</sup>; Carla Lopes <sup>1,2</sup>; Elisabete Ramos <sup>1,2</sup>

<sup>1</sup> Department of Hygiene and Epidemiology, University of Porto Medical School, Portugal

<sup>2</sup> Institute of Public Health, University of Porto, Portugal

Address correspondence to:

Sílvia Fraga

Institute of Public Health-University of Porto

Rua das Taipas, 135-139

4050-600 Porto

Telephone: +351 225513652; Fax: +351 225513653;

E-mail: silfraga@med.up.pt

## **CLUSTERING BEHAVIOURS AMONG 13 YEAR-OLD PORTUGUESE ADOLESCENTS**

## ABSTRACT

*Aim* To identify clustering of behaviours in young adolescents; b) to analyse differences in food intake according clusters.

*Subject and Methods* A cross-sectional study was carried out on adolescents' behaviours comprising 2160 adolescents aged 13 years-old attending schools of Porto, Portugal. We used data of 875 girls and 737 boys with complete information for all variables considered in the cluster definition (tobacco and alcohol use, sport activities, fruit intake, daily sleep hours). The average method was used to find the natural structure of clusters.

*Results* We identified three clusters: Cluster 1 characterized by never smokers and never drinkers represented those with higher intake of fruits and lower intake of soft drinks; cluster 2 comprises essentially tobacco and alcohol experimenters and was almost similar to cluster 1 regarding the other characteristics. Cluster 3 represented mostly regular smokers and drinkers, and those with the lowest daily sport activities, the lowest number of daily sleep hours, the lowest mean of fruits consumption and the highest intake of sweets and soft drinks.

*Conclusion* Our findings show that even in early stages of adolescence there is a cluster of smoking, alcohol use and food intake, providing further evidence of the clustering of unhealthy behaviours.

**Keywords:** health behaviours; adolescents; clustering behaviours; schools

## INTRODUCTION

During the transition from childhood to adulthood, adolescents establish patterns of behaviour and make lifestyle choices that affect both their current and future health (He et al. 2004).

The Centers for Disease Control and Prevention (Eaton et al. 2008) defined six categories of adolescents' unhealthy behaviours based on their contributing to the leading causes of morbidity and mortality among youth. Unhealthy dietary behaviour and physical inactivity are recognized as one of these six (Eaton et al. 2008).

The theory of critical behaviour proposed by Jessor (Jessor 1984) explains that problems of behaviour and health do not occur in isolation, but within a more comprehensive set of behaviours, highlighting an intersection area between these behaviours. This supports that engaging in an unhealthy behaviour may increase the likelihood of engaging in other unhealthy behaviours (Jessor 1984; Burke et al. 1997; Talashek et al. 2003). In the case of unrelated behaviours, programs targeting specific behaviours may be effective, but if adolescents' behaviours are related (to other sets of behaviours), prevention programs focusing on common determinants of unhealthy behaviours may turn more effective and should privilege approaches that take into account different behaviour-problems since they have similar patterns of development, not neglecting their specificity (Guilamo-Ramos et al. 2005; Bartlett et al. 2007). Thus, to know how health behaviours are interrelated is important in designing programs aiming to modify risk behaviours.

Among adults, it has been shown that clustering of adverse health behaviours is common and increases the morbidity and mortality (Boden-Albala and Sacco 2000; Cardi et al. 2009). It was also demonstrated that unhealthy behaviours tend to aggregate since early ages (Jessor 1984; Talashek et al. 2003; Gorely et al. 2007; te Velde et al. 2007), but it is still unknown if dietary habits cluster together with other known unhealthy behaviours in early adolescence, since it may be expected that at this age dietary choices are still under a relative high parental control (Birch and Fisher 1998; Savage et al. 2007).

Health behaviours of schoolchildren are a challenge for worldwide policy-makers, and understanding the relationship between health behaviours in early ages may lead to the development of more effective strategies for promoting health (Nelson et al. 2005; Gorely et al. 2007).

Although health promotion programs focusing on tobacco, alcohol and drugs make use of a combined approach, few of them take into account healthy dietary choices as part of an integrated approach.

Thus, this study aims a) to identify clustering of behaviours in young adolescents; b) and to analyse differences in food intake according to the identified clusters.

## METHODS

The Epidemiological Health Investigation of Teenagers in Porto (EPITeen) cohort intends to follow adolescents from initial adolescence to adulthood stage, in order to study behaviours and chronic diseases like cardiovascular diseases in a life course approach. During the 2003/2004 school year, participants were selected as part of the assembling procedure of the EPITeen cohort (Ramos and Barros 2007), which intends to follow adolescents born in 1990 and registered at every public and private schools of Porto, a large urban centre in the north-west of Portugal. To identify eligible students, every appropriated school in Porto (26 public and 24 private) were contacted. All public and 19 private schools agreed to participate, allowing the contact with parents and adolescents. In those schools we identified 2787 students (2126 public and 661 private). Forty-four (1.6%) adolescents could not be reached (missing classes frequently) and 2160 (77.5%) agreed to participate. A similar participation proportion in public (77.7%) and private (76.7%) schools ( $p=0.603$ ) was observed.

The Ethical Committee of the University Hospital of São João, Porto, approved the study. Parents and children received written information explaining the purpose and the design of the study. Additionally, the study steps were described in each school during special meetings arranged according to parents' convenience. Written informed consent was obtained both from parents and children.

The baseline evaluation required extensive data collection, comprising two self-administered questionnaires (one completed at home, another at school).

The home questionnaire was completed by adolescents with their parents' help and comprised information on demographic, social, and behavioural characteristics. The home questionnaire also evaluated dietary intake using a semi-quantitative food frequency questionnaire (FFQ) validated for the Portuguese adult population (Lopes 2000 (in Portuguese); Lopes et al. 2007), and adapted for adolescents adding some food items more frequently used at this age. Respondents were asked to report how often they usually eat each particular food over the prior 12-month period as the number of times per day, week, or month. FFQ has 92 food items and for this specific work we used the information of the following groups: *sweets and pastry* (other biscuits beyond simple, croissants, pastry, donut, cakes, chocolates, chocolate snacks, dairy desserts, ice creams, marmalade, compote, jelly, honey, sugar and candy), *soft drinks* (soda and carbonated juices), *vegetables* (cabbages, spinach, broccoli, onion, carrot, lettuce, peppers, tomato, cucumbers), *fruits* (all fresh fruits, including tropical fruit) and *soup* (vegetable soup). In addition to FFQ the specific question "how many fruit portions do you eat a week?" was asked as part of the global questionnaire. Information

from this question assessing the number of fruit portions was used in the cluster definition since it had fewer missing information than the FFQ. For those with both information (fruits of FFQ and fruits in the single question) the correlation between them was 0.518.

Wakening-up and bedtime hours were recorded to compute daily sleeping hours.

We asked separately about time spent per week watching TV, playing computer and reading per week. Then we computed the total time spent on sedentary activities.

The school questionnaire was answered at school only by the adolescent. It collected information about sports practice, tobacco and alcohol use.

To evaluate the frequency of sport activities we considered only those activities taking at least 20 minutes a week and not included in school curriculum. To assess this information we used an five-option question (never,  $\leq 1$  time per month, 1 time per month to 1 time per week, 2 to 6 times per week, every day). Adolescents were classified regarding their use of alcohol and tobacco as never users, if they had never drunk alcoholic drinks and if they have never smoked; experimenters, if they reported only experimented those substances and used them less than one time per month; and drinkers if they drunk one drink at least one time per month or smokers if they smoke either occasionally or regularly.

To define clusters we used 1612 participants (875 girls and 737 boys) with complete information for all variables that were considered in the cluster definition (tobacco and alcohol use, sport activities, fruit intake per week and daily sleep hours). Compared to the excluded participants, the 1612 enrolled had a higher proportion of females, adolescents with higher parental educational level, and those reporting more frequency of sports activity ( $p$ -value  $< 0.001$ ). No statistically significant differences were found according to tobacco and alcohol use (table 1). After to perform the analysis of clusters' definition, we have to consider one participant as outlier because he did not match with the characteristics of any of the clusters defined.

*(Please, insert table 1 here)*

## **Statistical Analysis**

Quantitative continuous variables were presented as median (1<sup>st</sup> quartile-3<sup>rd</sup> quartile) and they were compared using Kruskal-Wallis test. Nominal and ordinal variables were described using proportions and compared by Chi-squared test.

Hierarchical cluster methods were used to find the natural structure of data. We compared Ward's, complete and average methods, and since the average method showed the highest prediction it was considered the final solution. Considering that the variables used to define clusters were a mixture of nominal, ordinal and interval variables, the dissimilarity between individuals was measured with the Gower coefficient (Kaufman and Rousseeuw 1990). Information on tobacco and alcohol use, sport activities, fruit intake per week and daily sleep hours were used to predict the classification of each method and define the clusters. The Rousseeuw's Silhouette internal cluster quality index was used to estimate the number of clusters (Kaufman and Rousseeuw 1990). Classification trees, using Gini index (Breiman et al. 1984), were used to determine which variables were the most important to define the clusters.

Generalized linear models with log link function were used to estimate the frequency of consumption of sweets and pastry, vegetables, soft drinks and soup by cluster, adjusted for total energy intake and parents' education by cluster. To perform this analysis log transformation was applied to the dependent variable.

The software "R 2.8.0 version" was used to analyse data (R Development Core Team 2008).

## RESULTS

Regarding tobacco and alcohol use, sport activities, fruit intake and daily sleep hours, tobacco and alcohol were the most important in the cluster definition as observable in the classification tree (figure 1).

*(Please, insert here figure 1)*

We should note that of 86 adolescents in the drinker category, 20 reported alcohol use at least one time per week. And regarding the 44 smokers, 25 adolescents reported daily tobacco smoking. Our cluster analysis allowed us to identify 3 clusters: cluster 1 (n=735) was characterized by a high proportion of never smokers (89.0%) and never drinkers (100.0%). Cluster 2 (n=832) presented the experimenters of tobacco (27.9%) and alcohol (90.5%). Cluster 3 (n=44) represents all smokers (100%) and some drinkers (15.9%).

Results showed that cluster 1 also presented those adolescents with other healthiest behaviours, such as a high median of daily sleep hours (median= 9.0 hours (1<sup>st</sup>Q -3<sup>rd</sup>Q=8.5-9.5)) and lower median of time spend at sedentary activities (median= 10.0 hours (1<sup>st</sup>Q -3<sup>rd</sup>Q=9.6-10.5)). These results are similar in the cluster 2. Moreover, cluster 3 represented those with a lower median (1<sup>st</sup>Q -3<sup>rd</sup>Q) of fruits consumption (5 fruits (2-10)) and lower number of daily sleeping hours (8.8 hours (8.3-9.5)) (table 2). However no significant differences were found according frequency of sports practice.

Regarding sedentary activities according to the three clusters there is a direct dose-effect relation (P-value for trend=0.045), and cluster 3 showed a high median (1<sup>st</sup>Q -3<sup>rd</sup>Q) of sedentary activities (11.2 hours (9.4-12.9)) (table 2).

Also significant differences in gender, type of school and parents' education were found between clusters (table 2). Cluster 1 had a higher proportion of males and cluster 3 had a higher proportion of females. Cluster 2 had the highest proportion of adolescents from private schools and a higher proportion (table 2).

*(Please, insert table 2 here)*

Concerning data from the FFQ, after adjustment for total energy intake and parents' education, cluster 3 showed a high mean of daily intake of soft drinks. Although without statistically significance, this cluster also presented the highest intake of sweets and pastry (table 3).

(Please, insert table 3 here)

## DISCUSSION

Few studies have focused in the way unhealthy behaviours cluster together on early adolescence. Our results show tobacco and alcohol as the most powerful in clustering unhealthy behaviours even in these young adolescents, which is in line with other studies that described tobacco and alcohol use as the “gateway” to other risk behaviours common during adolescence (Burke et al. 1997; Ma et al. 2000).

Our study shows that not only tobacco and alcohol are related, but also adolescents who smoke and drink (cluster 3) were characterized by longer periods spent in sedentary activities, lower consumption of fruit and a higher consumption of soft drinks. This results are particularly important since it is known that parents have a crucial role in the dietary behaviour of their children (Savage et al. 2007), however in early adolescence, peer pressure begins to usurp parental authority and unhealthy diets may be initiated (Gidding et al. 2006), reinforcing the need for early interventions. The majority of studies show that males are more prone to engage in unhealthy behaviours (Burke et al. 1997; Ma et al. 2000; Wu et al. 2006). However, recent research showed no differences among genders in health behaviours (Lawlor et al. 2005) or even that the situation begins to reverse regarding some unhealthy behaviours (Miller et al. 2007). Thus it is interesting to note that in cluster 3, which represents the unhealthiest pattern, the proportion of females is higher. This information reinforces the need for a constant updating of knowledge about the changes in the population that is targeted for intervention.

It is also interesting to observe that the healthier cluster (Cluster 1) does not have the highest proportion of adolescents from an upper social class (highest parental education) which supports that, indeed an increased knowledge (of parents) does not mean, by itself, proneness to the adoption of healthy behaviours. Nevertheless, our results on food intake were adjusted to parents’ education and differences according clusters remained. However in our study, the prevalence of tobacco and alcohol use was very low, but the cluster analysis allowed discrimination of these features as a different group. And this cluster showed differences also for the other behaviours analysed, which reinforces the evidence that in this age, even a lower use of tobacco and alcohol represents an important sign to potential behavioural risk.

Food intake is difficult to measure, particularly in young ages. However, it has already been described that adolescents of 13 years old are able to answer alone to the FFQ (Rockett et al. 1997; Papadopoulou et al. 2007). To improve the quality of answers, we decided to get this information from both adolescents and parents. This option may have influenced some responses. However we expected that if any effect was presented it tend to minimize differences between clusters because it

is expected that those with healthier intake report their actual intake but those with unhealthier intake tend to underestimate unhealthy consumption and to overestimate healthier food.

Despite the significant results obtained, we recognize that one important limitation of our study lies in the exclusion of 548 individuals who had no complete information for our analysis. Differences were observed in gender, type of school and sport activities. Girls and participants with a higher socioeconomic level tend to better fill questionnaires which may explain these differences. Since students of private schools belong to a higher social class and reported more frequently to be involved in extra-curricular sport activities, this could explain why we have a large proportion of physical active adolescents. But it is important to note that no statistically significant differences were found according to tobacco and alcohol use, which are the most powerful predictors. However the number of girls and adolescents whose parents have higher education is overestimated in our sample. Nevertheless, we do not expect a different clustering pattern of behaviours for those participants lost or excluded from analysis. Although reducing analytic power, interpretation of results would most likely be similar.

Despite these limitations, the study has the advantage of having a homogeneous group of adolescents regarding their age (all with 13-year-old). Other studies tend to aggregate adolescents with different ages in the same category. In this stage of the life cycle, marked by transition and constant change, some behaviour vary within short periods of time, particularly the types of behaviours under analysis. Thus, the age homogeneity of our sample could make this cross-sectional picture more accurate. Another important advantage lies in the use of school as a sampling source, since school attendance is compulsory at this age in Portugal.

## **CONCLUSION**

Our findings show that even in early stages of adolescence there is a cluster of smoking, alcohol use and food intake, providing further evidence of the clustering of unhealthy behaviours. Our results reinforce the need for prevention programs to begin earlier in life. Prevention programs may benefit in effectiveness if these characteristics are considered.

## **ACKNOWLEDGEMENTS**

We gratefully acknowledge grants from Fundação para a Ciência e Tecnologia (POCTI/SAU-ESP/62399/2004). Sílvia Fraga (SFRH/BD/44408/2008) and Diogo Costa (SFRH/BD/66388/2009) have a PhD grant from Fundação para a Ciência e Tecnologia.

The authors declare that they have no conflict of interest.

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**Table 1** – Comparison of the distribution of complete available information to clusters' definition by demographic and behavioural characteristics of adolescents (The EPITeen cohort of Porto, Portugal, 2003/2004).

	Considered in analysis		<i>p-value</i>
	n (%)		
	No 548	Yes 1612	
<b>Gender</b>			
Female	242 (44.2)	875 (54.3)	
Male	306 (55.8)	737 (45.7)	<0.001
<b>Type of school</b>			
Public	453 (82.7)	1198 (74.3)	
Private	95 (17.3)	414 (25.7)	<0.001
<b>Parents' Education (years)</b>			
0-4	85 (21.3)	218 (14.1)	
5-6	61 (15.3)	178 (11.5)	
7-9	70 (17.5)	313 (20.2)	
9-12	102 (25.6)	422 (27.3)	
≥13	81 (20.3)	416 (26.9)	<0.001
<b>Tobacco use</b>			
Never	273 (74.0)	1254 (77.8)	
Experimenter	80 (21.7)	314 (19.5)	
Smoker	16 (4.3)	44 (2.7)	0.145
<b>Alcohol use</b>			
Never	179 (49.3)	746 (46.3)	
Experimenter	160 (44.1)	780 (48.4)	
Drinker	24 (6.6)	86 (5.3)	0.271
<b>Sport Activities</b>			
Never	101 (26.4)	320 (19.9)	
≤ 1 time/month	36 (9.4)	177 (11.0)	
1 time/month-1 time/week	36 (9.4)	185 (11.5)	
2-6 times/week	135 (35.3)	696 (43.2)	
Every day	74 (19.4)	234 (14.5)	0.002
	<b>Median (1<sup>st</sup>Q-3<sup>rd</sup>Q)</b>	<b>Median (1<sup>st</sup>Q-3<sup>rd</sup>Q)</b>	
<b>Fruits/week</b>	7 (4-10)	7 (4-10)	0.179
<b>Daily sleep hours</b>	9.2(8.7-9.5)	9.0(8.5-9.5)	0.001

**Table 2** – Social and behavioural characteristics according to different clusters (The EPITeen cohort of Porto, Portugal, 2003/2004).

	<b>Cluster 1</b>	<b>Cluster 2</b>	<b>Cluster 3</b>	<i>p-value</i>
<b>BEHAVIOURAL CHARACTERISTICS, n (%)</b>				
<b>Tobacco use</b>				
Never	654 (89.0)	600 (72.1)	0 (0.0)	
Experimenter	81 (11.0)	232 (27.9)	0 (0.0)	
Smoker	0 (0.0)	0 (0.0)	44 (100.0)	<0.001
<b>Alcohol use</b>				
Never	735 (100)	0 (0.0)	11 (25.0)	
Experimenter	0 (0.0)	753 (90.5)	26 (59.1)	
Drinker	0 (0.0)	79 (9.5)	7 (15.9)	<0.001
<b>Sport Activities</b>				
Never	160 (21.8)	150 (18.0)	9 (20.5)	
≤ 1 time/month	86 (11.7)	84 (10.1)	7 (15.9)	
1 time/month-1 time/week	86 (11.7)	94 (11.3)	5 (11.4)	
2-6 times/week	288 (39.2)	392 (47.1)	16 (36.4)	
Every day	115 (15.6)	112 (13.5)	7 (15.9)	0.140
<b>Median (1<sup>st</sup>Q-3<sup>rd</sup>Q)</b>				
<b>Fruits/week</b>	7 (4-10)	7 (4-12)	5 (2-10)	0.078
<b>Daily sleep hours</b>	9.0 (8.5-9.5)	9.0 (8.5-9.5)	8.8 (8.3-9.5)	0.002
<b>Sedentary activities (hours) *</b>	10.0 (9.6-10.5)	10.6 (10.2-11.0)	11.2 (9.4-12.9)	0.045 †
<b>SOCIAL AND DEMOGRAPHIC CHARACTERISTICS, n (%)</b>				
<b>Gender</b>				
Female	383 (52.1)	459 (55.2)	33 (75.0)	
Male	352 (47.9)	373 (44.8)	11 (25.0)	<0.001
<b>Type of school</b>				
Public	594 (80.8)	570 (68.5)	34 (77.3)	
Private	141 (19.2)	262 (31.5)	10 (22.7)	<0.001
<b>Parents' Education (yrs)</b>				
0-4	123 (17.3)	90 (11.4)	5 (12.3)	
5-6	103 (14.5)	71 (8.9)	4 (9.7)	
7-9	148 (20.9)	157 (19.7)	8 (19.5)	
9-12	184 (25.9)	226 (28.4)	11 (26.8)	

≥13

151 (21.4)

252 (31.6)

13 (31.7)

<0.001

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\* Total hours watching TV, playing computer and reading

† *p-trend=0.045*

**Table 3** –Frequency of food intake measured by FFQ according to different clusters (The EPITeen cohort of Porto, Portugal, 2003/2004).

	Cluster 1	Cluster 2	Cluster 3
Frequency of daily intake	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)
	CRUDE		
Sweets and pastry	2.08 (1.94-2.22)	1.98 (1.84-2.12)	2.08 (1.53-2.63)
Soft drinks	1.07 (0.97-1.17)	1.20 (1.10-1.30)	1.37 (0.96-1.77)
Fruits	2.56 (2.41-2.70)	2.56 (2.42-2.70)	2.18 (1.59-2.76)
Vegetables	2.11 (1.95-2.27)	2.32 (2.16-2.48)	2.05 (1.40-2.70)
Soup	0.82 (0.77-0.87)	0.90 (0.85-0.95)*	0.85 (0.64-1.06)
	ADJUSTED †		
Sweets and pastry	1.96 (1.86-2.06)	1.87 (1.77-1.97)	2.08 (1.64-2.51)
Soft drinks	0.95 (0.87-1.03)	1.16 (1.08-1.23)*	1.31 (0.96-1.66)*
Fruits	2.52 (2.38-2.65)	2.52 (2.39-2.65)	2.23 (1.69-2.77)
Vegetables	2.06 (1.91-2.21)	2.25 (2.11-2.39)	2.09 (1.48-2.70)
Soup	0.81 (0.76-0.86)	0.90 (0.85-0.95)*	0.86 (0.66-1.06)
	ADJUSTED ‡		
Sweets and pastry	1.95 (1.84-2.06)	1.91 (1.86-2.01)	2.10 (1.66-2.53)
Soft drinks	0.92 (0.84-1.01)	1.18 (1.09-1.26) *	1.29 (0.95-1.63) *
Fruits	2.53 (2.40-2.67)	2.47 (2.33-2.59)	2.21 (1.69-2.74)
Vegetables	2.06 (1.91-2.22)	2.18 (2.03-2.33)	2.06 (1.47-2.65)
Soup	0.81 (0.75-0.85)	0.85 (0.80-0.90)	0.86 (0.62-0.99)

\*  $p < 0.001$

† Adjusted for total energy intake (the log transformation was applied to the dependent variable)

‡ Adjusted for total energy intake and parents' education.

**Figure 1** – Classification tree for clusters.

