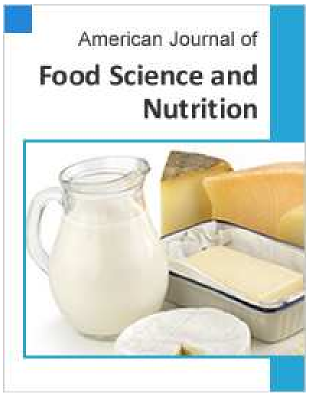
American Journal of Food Science and Nutrition
2015; 2(6): 113-120
Published online December 17, 2015 (http://www.aascit.org/journal/ajfsn)
ISSN: 2375-3935

American Association for Science and Technology



Keywords
Endocrine Disruptors,
Dietary Habits,
School Performance

Received: November 13, 2015
Revised: November 26, 2015
Accepted: November 28, 2015

Consequences of Dietary Habits and Endocrine Disruptors in School Performance of Children Aged 10-12 in Greece

Georgia Koulianidi[1], Efstathios Stefos[2]

[1]Department of Primary Education, University of the Aegean, Rhodes, Greece, Post-graduate of Medical School, University of Athens, Athens, Greece
[2]School of Physical Sciences and Mathematics, Faculty of Exact and Natural Sciences, Pontifical Catholic University of Ecuador, Proyecto Prometeo, Quito, Ecuador

Email address
koulianidi@yahoo.gr (G. Koulianidi), estefos@aegean.gr (E. Stefos)

Citation
Georgia Koulianidi, Efstathios Stefos. Consequences of Dietary Habits and Endocrine Disruptors in School Performance of Children Aged 10-12 in Greece. *American Journal of Food Science and Nutrition*. Vol. 2, No. 6, 2015, pp. 113-120.

Abstract
The aim of this study is to investigate the relationship between food quality, children's mental health and their school performance. Specifically we examine whether chemical substances like food additives, taste enhancers, food dyes or substances that migrate from packaging, which are included in low quality food, act as endocrine disruptors and affect children's mental health and school performance. The literature review revealed the need to conduct research in this area, as not enough studies were found. The study sample consisted of 577 students aged 10-12 from schools located in various places of Greece. The data collection tool was a questionnaire that contained demographic items and variables based upon the aim of the study. The questionnaires were completed by the students and then the data were coded and tables of the emerging findings were created. The data analysis revealed that students who consume more frequently low quality food products, widely known as "junk food" are the ones with the poorest school performance.

1. Introduction

As many as 80000 synthetic chemicals have been developed worldwide since World War II, assuring that children everywhere face certainty of chemical exposure [1]. Specifically, the development and use of synthetic chemicals have grown exponentially since the 1940's, and there are now more than 84.000 different chemicals in commerce [2]. While many of these chemicals have allowed for modern conveniences (e.g., plastics) or were developed to address safety (e.g., flame retardants) and other societal needs (e.g., pesticides) to improve our quality of life, recent advances in the fields of exposure science and analytical chemistry have documented widespread exposure to hundreds of these chemicals among men, women and children throughout the world. Depending on the chemical, exposure can occur through food, drinking water, air, soil, house dust and direct contact with various household materials or consumer products [3]. Children are especially likely to be exposed to the nearly 3.000 high-production-volume (HPV) chemicals that are produced in amounts of 1 million pounds or more per year and are most widely dispersed in the environment. Biomonitoring data on blood and urine levels of over 200 synthetic chemicals obtained by the Centers for Disease Control and

Prevention (CDC) in a sample of the U.S. population through the National Health and Nutrition Examination Survey (NHANES) documented that American children are exposed to a broad array of synthetic chemicals. Many of these chemical substances which are manufactured by humans act as endocrine disruptors.

2. Endocrine Disruptors

In Europe, endocrine disruptors (EDs) have been defined as substances foreign to the body that have deleterious effects on the individuals or their descendants, due to changes in endocrine function. In the United States, EDs have been described as exogenous agents that interfere with the production, release, transport, metabolism, binding, action or elimination of the natural ligands responsible for maintaining homeostasis and regulating body development. These two definitions are complementary, but both indicate that the effects induced by EDs probably involve mechanisms relating in some way to hormonal homeostasis and action. EDs are generally described as substances with anti-oestrogenic, oestrogenic, anti-androgenic or androgenic effects [4]. According to the World Health Organization (WHO) some substances known as endocrine disruptors can alter the function(s) of the human hormonal system increasing the risk of adverse health effects. Some EDs occur naturally, while synthetic varieties can be found in pesticides, electronics, personal care products and cosmetics. They can also be found as additives or contaminants in food. The UN study, which is the most comprehensive report on EDs to date, highlights some associations between exposure to EDs and health problems including the potential for such chemicals to contribute to the development of non-descended testes in young males, breast cancer in women, prostate cancer in men, developmental effects on the nervous system in children and attention deficit/hyperactivity in children [5].

3. Endocrine Disrupting Chemicals

Some examples of chemicals that can act as endocrine disruptors:

1 Persistent organic pollutants (POPs) are lipophilic chemicals with long half-lives that bioaccumulate up the food chain and include polychlorinated biphenyls (PCBs), organochlorine pesticides (e.g., DDT), polybrominated diphenyl ethers (PBDEs) and others.

2 Phthalates are a diverse class of widely used industrial chemicals. They are used as plasticizers to make plastics more flexible and are also used as solubilizing or stabilizing agents. High molecular weight phthalates are found in flexible polyvinyl chloride commonly found in consumer products and food packaging.

3 Bisphenol A (BPA) is a high-production chemical used in the manufacture of polycarbonate plastics, epoxy resins and thermal paper. Polycarbonate is a clear, rigid plastic that has been used for water bottles and other items, while epoxy resins are found in the lining of many canned foods. For most people, exposure to BPA occurs primarily through the diet, and measurable levels of BPA can be found in most people.

Colborn (2004) presents the possibility that PCBs and phthalates contribute to the increasing prevalence of attention deficit hyperactivity disorder, autism and associated neurodevelopmental and behavioral problems in children aged 10-11 years from mothers who were contaminated with these substances through fish consumption during pregnancy [6]. Kim, Ha, Kim, Park, Ha, Kim, Hong, Chang and Kim (2011) also suggest a strong association between prenatal exposure to phthalates and reduced brain and psychomotor development in children 6 months old, especially since phthalates have been shown to decrease the number of midbrain dopaminergic neurons and tyrosine hydroxylase biosynthetic activity [7], [8]. Both prenatal and childhood PBDE exposures were associated with attention problems and decrements in processing speed, perceptual reasoning, verbal comprehension and Full-Scale IQ in 5-7 years old children in California [9]. Another study of Kim, Cho, Kim, Shin, Yoo and Kim (2009) examined the after birth exposure in phthalates and symptoms of ADHD and poorer IQ scores in Korean children, age 8-11 years and found a strong positive association [10].

4. Migration of Substances from Food Packaging

There are numerous chemical substances, and not only the ones mentioned above, that can migrate from the package to the food. Packaging, by definition, must protect the food from any kind of adulteration. Nonetheless, there are many times that the packaging itself becomes the source of product adulteration, due to some chemical substances migrating to food included within the package. Though the migration phenomenon is known for plastic types of packaging, it can also occur with metallic or even paper types. Migration of substances may result in: a) downgrading food quality due to adulteration of some of its sensory characteristics (taste, smell, colour, texture) b) food contamination with toxic or cancerous substances, making the food unsuitable for consumption [11]. The migration of BPA and phthalates from food packaging to food itself and afterwards to human body was shown by Rudel, Gray, Engel, Rawsthorne, Dodson and Ackerman (2011) who measured creatinine, BPA and phthalates metabolites in participants' urine, who ate only canned or packaged foods [12]. Two more researches of Aguiar, Eubig and Schantz (2010) and Wormuth, Scheringer, Vollenweider and Hungerbuhler (2006) conclude that exposure to PCBs and phthalates are high risk factors for ADHD in children [13], [14]. Last but not least, Miodovnik (2011) along with Jurewicz, Polanska and Hanke (2013) agree for the indisputable migration of chemical substances mentioned and their impact on children's developing brain, IQ scores and possible ADHD or autism symptoms. They also refer to the act of food additives [15], [16].

5. Contaminants in Food

Food contaminants are commonly considered to be those substances present in food that serve no technological function and whose presence may lead to adverse health effects. The Codex Alimentarius Commission defines a contaminant as follows: Any substance not intentionally added to food, which is present in such food as a result of production, manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food or as a result of environmental contamination. The term 'environmental' in relation to contaminants generally refers to those substances that enter food as a result of environmental contamination of primary produce or that enter food during production, processing and storage [17]. Besides substances that migrate from packaging to foods and through nutrition probably affect children's mental health and school performance, we also examined another category of substances, food additives.

6. Food Additives

Under European regulation (EC) No. 1333/2008, food additives are defined as any substances 'not normally consumed as food itself', which are added to a food to perform a technological purpose, e.g. preservation [18]. There are twenty-six categories of food additives outlined in this regulation, which fall broadly into two main categories depending on their purpose (i) safety and prevention of degradation of food by bacteria, oxidation or chemical reactions or (ii) improvement of the taste, appearance or mouth-feel of the product. The main aim of the food industry is to produce a variety of consistently safe, appealing and nutritious products; the use of additives is a key factor in achieving this [19]. In recent decades, there have been rapid developments in food science and technology, leading to an increase in the number and variety of substances used to perform functions in food or 'food additives'. Currently 322 food additives are approved for use in the European Union [20]. Currently in Europe, there is a complex framework of guidelines regulating the use of additives, their purity, the foods to which they can be added, the maximum amounts to be used and labeling of such products. E numbers are a standard coding system used to indicate that these food chemicals have been evaluated and approved for use.

7. Effects of Food Additives

Despite the complex framework of regulation and the ongoing safety assessments regarding the use of additives in food, there remains a high level of interest in the use of these chemicals in foods and in some cases concern and confusion about their use. The main concerns are related to intolerances and carcinogenicity. Safe and adequate nutrition is crucial for the proper development of children. As outlined earlier, the safety of additive-containing foods is ensured via legislation and safety assessments. However, some studies have suggested that children may have increased exposure and consumption of certain food additives, in comparison with adults and are therefore an important subgroup that should be addressed by exposure assessments [19]. One of the most frequently investigated potential hazards associated with young children and food additives, particularly food colours, surrounds their suggested effects on behaviour. In 1973, Dr Ben Feingold postulated that the consumption of food additives and natural salicylates were an important factor in the development and maintenance of hyperkinesis and hyperactivity in children [21]. Artificial food colours are the additive category most widely associated with behavioural effects in children. Tartrazine is the colour most strongly associated with this effect in several studies. There are also studies that included a blend of colours and a preservative, sodium benzoate with similar effects. More specifically, McCann, Barrett and Cooper (2007) compared the effects of two combinations of food additives and found that Mix A (Sunset Yellow 5mg; Tartrazine 7,5 mg; Carmoisine 2,5mg; Ponceau 4R 5mg; sodium benzoate 45mg) had significant adverse effects on hyperactivity in comparison with the placebo [22]. This food additive mix is similar to that of Bateman, Warner and Hutchinson (2004) (Sunset Yellow 5mg; Tartrazine 5 mg; Carmoisine 5mg; Ponceau 4R 5mg; sodium benzoate 45mg) who found a similar response [23]. Bellisle (2004) suggests a potential role of sucrose and additives in children's hyperactivity, while research in Australia in school-aged children who consumed beverages with artificial colour and taste enhancers, instead of milk beverages, showed a positive association with poorest short-term memory and cognitive function [24], [25]. Two more studies of Florence, Asbridge and Veugelers (2008) in Canada and Fu, Cheng, Tu and & Pan (2007) in Taiwan conclude that unhealthful eating patterns, which include sweets, fried food and junk food in general, are the main causes for an unfavorable overall school performance [26], [27]. Watts (2011) also mentions an evidential link between children with learning and behavioural disorders such as ADHD, dyslexia, dyspraxia and the autistic spectrum and consumption of foods and drinks which include additives, sweeteners and food colours [28]. At the same time Crispim, Geelen, Le Donne, de Vries, Sette and Raffro (2010) notice that human's exposure to four flavourings-raspberry ketone, glycyrrhizinic acid, coumarin and caffeine- through non-alcoholic beverages and sweets, exceeded the safety limits with unknown consequences, especially for children [29], [30].

8. Methodology

In order to investigate the relationship between food quality, children's mental health and their school performance, we used the Multidimensional Data Analysis to show the differentiation criteria of 577 students aged 10-12 from schools located in various places of Greece and their classification into groups according to their common characteristics. The methods that we used are the Multiple Correspondence Analysis, which defined the differentiation criteria and the Hierarchical Clustering that showed the groups of the students according to their common characteristics [31].

We investigated the relationship between the variables "School performance", "Do you eat sweets?", "Do you eat junk food?" and "Do you drink soft drinks?" with the use of chi-square test ($\chi2$). We also calculated the odds ratio and relative risk for the same variables.

In order to extract the results of the Multidimensional Data Analysis we used the statistical software SPAD v.4.5 offered by the Faculty of Humanities of the University of the Aegean.

9. The Results of the Multidimensional Data Analysis

We used the Multiple Correspondence Analysis that is based on the correlation of all the variables at the same time. The results set the three factorial axes which simultaneously are the differentiation criteria of the young students. We also used the Hierarchical Classification looking for a classification of the students. This method offers the advantage of representing the centroids of the clusters on the factor levels aiming to a detailed interpretation of the differences between the clusters.

9.1. The Results of the Multiple Correspondence Analysis

The differentiation criteria correspond to the axes of the Multiple Correspondence Analysis which are presented in order of significance [32].

First differentiation criterion (First factor axis – inertia percentage 7.06%)

The first differentiation criterion is consisted on one hand of students who eat meat, sweets, junk food, spaghetti, rice and potatoes more than 5 times a week. These students drink soft drinks more than 5 times a week and their grades are good. On the other hand, there are students whose grades are excellent, do not eat potato chips and croissants at school and drink soft drinks 1-2 times a week. These students eat fish, junk food, sweets, meat and legumes 1-2 times a week.

Second differentiation criterion (Second factor axis – inertia percentage 4.91%)

The second differentiation criterion is consisted on one hand of students who do not eat fruits at school, do not eat breakfast every day, eat vegetables 1-2 times a week and do not drink milk. These students eat legumes 1-2 times a week and sweets 3-5 times a week and their grades are very good. On the other hand, there are students who eat vegetables and fruits more than 5 times a week, drink milk more than 5 times a week, eat breakfast every day and eat fish 3-5 times a week. These students eat legumes more than 5 times a week and their grades are excellent.

Third differentiation criterion (Third factor axis – inertia percentage 4.72%)

The third differentiation criterion is consisted on one hand of students who eat cake, cheese pie, croissant, toast, fruits and potato chips at school and eat junk food 1-2 times a week. These students eat vegetables 1-2 times a week, drink soft drinks 1-2 times a week and their grades are good. On the other hand, there are students who do not eat cake, cheese pie, croissant, toast, potato chips and junk food at school. These students do not drink soft drinks, do not eat sweets and their grades are excellent.

9.2. The Results of the Hierarchical Classification

The Hierarchical Classification led to the formation of four clusters which are presented in Figure 1.

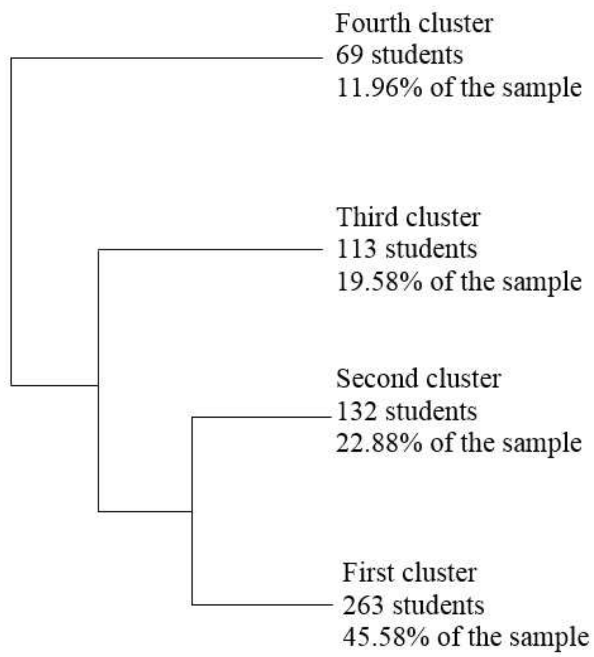


Figure 1. *The Classification Chart.*

First cluster (263 students, 45.58% of the sample)

The first cluster consists of students who eat junk food, sweets, fish and meat 1-2 times a week and drink soft drinks 1-2 times a week. These students eat spaghetti, rice, potatoes and fruits 3-5 times a week, eat cheese cake pie at school, drink milk more than 5 times a week, eat breakfast every day and their grades are excellent.

Second cluster (132 students, 22.88% of the sample)

The second cluster consists of students who do not drink milk, do not eat breakfast every day, do not eat toast and fruits at school and do not eat fish. These students eat sweets more than 5 times a week and vegetables 1-2 times a week, drink soft drinks 3-5 times a week and milk 1-2 a week and their grades are very good.

Third cluster (113 students, 19.58% of the sample)

The third cluster consists of students who do not drink soft drinks, do not eat junk food and sweets and do not eat cheese pie, potato chips and croissants at school. These students eat vegetables more than 5 times a week and spaghetti, rice and potatoes 1-2 times a week, eat breakfast every day, drink milk more than 5 times a week and their grades are excellent.

Fourth cluster (69 students, 11.96% of the sample)

The fourth cluster consists of students who drink soft drinks more than 5 times a week and eat spaghetti, rice, potatoes, meat, junk food and sweets more than 5 times a week. These students, eat potato chips and croissants at school and their grades are good.

These differentiations are presented in Figure 2 of the Correspondence Analysis where the centroids of the four clusters are presented on the level of the first two axes. The positions of the clusters regarding to the two axes showcase the differences and the similarities of the characteristics demonstrated in each cluster.

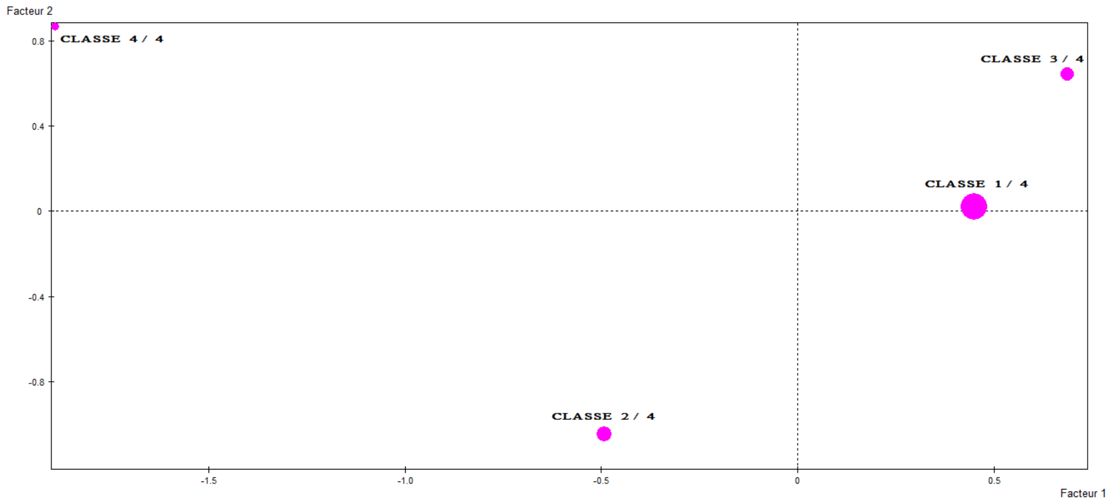


Figure 2. *The Correspondence Analysis.*

10. The Chi-Square Test

The correlation between the variable "School performance" and the variables "Do you eat sweets?", "Do you eat junk food?" and "Do you drink soft drinks?" was investigated with the use of chi-square test ($\chi2$). The correlations in which the Valor Test (V.TEST) is greater than or equal to two are statistically interesting. The larger than two the V.TEST, the greater the correlation between two variables [33].

The possible answers to the variable "School performance" are the following:

- Good
- Very good
- Excellent

The possible answers to the variable "Do you eat sweets?" are the following:

- No
- 1-2 times per week
- 3-5 times per week
- More than 5 times per week

The possible answers to the variable "Do you eat junk food?" are the following:

- No
- 1-2 times per week
- 3-5 times per week
- More than 5 times per week

The possible answers to the variable "Do you drink soft drinks?" are the following:

- No
- 1-2 times per week
- 3-5 times per week
- More than 5 times per week

The results of chi-square test showed that there is a significant correlation between the variables under investigation:

- Do you eat sweets? * School performance : $\chi2$ = 19.78 / 9 degrees of freedom / V.TEST = 2.07
- Do you eat junk food? * School performance : $\chi2$ = 50.30 / 12 degrees of freedom / V.TEST = 4.71
- Do you drink soft drinks? * School performance : $\chi2$ = 69.29 / 12 degrees of freedom / V.TEST = 6.13

11. Odds Ratio and Relative Risk

An odds ratio is a measure of association between an exposure and an outcome. An odds ratio of one implies that there is no association between the exposure and the outcome. An odds ratio greater than one indicates that the odds of exposure are positively associated with the outcome. An odds ratio less than one implies that the odds of exposure are negatively associated with the outcomes [34].

Relative risk is used to compare the risk in two different groups. A relative risk of one implies there is no difference in risk between the two groups. A relative risk less than one indicates that there is less risk in the exposed group compared to the unexposed group. A relative risk greater than one indicates that there is greater risk in the exposed group compared to the unexposed group [35].

Table 1. *Cross tabulation: Do you eat sweets? - School performance.*

Count		School performance		Total
		Not excellent	Excellent	
Do you eat sweets?	Three or more times per week	122	69	191
	Twice or less than twice per week	220	166	386
Total		342	235	577

The odds ratio is 1.334 that indicates that students who eat sweets three or more times per week have 1.334 times the risk of *not having* excellent school performance compared to students who eat sweets twice or less than twice per week. The relative risk is 1.121 that means that students who eat sweets three or more times per week have a 12.1% higher risk of *not having* excellent school performance than students who eat sweets twice or less than twice per week (Table1, Table 2).

Table 2. *Risk Estimate: Do you eat sweets? - School performance.*

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for "Do you eat sweets?" (Three or more times per week / Twice or less than twice per week)	1.334	.933	1.907
For cohort "School performance = Not excellent"	1.121	.977	1.286
For cohort "School performance = Excellent"	.840	.674	1.048
N of Valid Cases	577		

Table 3. *Cross tabulation: Do you eat junk food? - School performance.*

Count		School performance		Total
		Not excellent	Excellent	
Do you eat junk food?	Three or more times per week	67	10	77
	Twice or less than twice per week	275	225	500
Total		342	235	577

The odds ratio is 5.482 that indicates that students who eat junk food three or more times per week have 5.482 times the risk of *not having* excellent school performance compared to students who eat junk food twice or less than twice per week. The relative risk is 1.582 that means that students who eat junk food three or more times per week have a 58.2% higher risk of *not having* excellent school performance than students who eat junk food twice or less than twice per week (Table3, Table 4).

Table 4. *Risk Estimate: Do you eat junk food? - School performance.*

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for "Do you eat junk food?" (Three or more times per week / Twice or less than twice per week)	5.482	2.757	10.901
For cohort "School performance = Not excellent"	1.582	1.407	1.779
For cohort "School performance = Excellent"	.289	.161	.519
N of Valid Cases	577		

Table 5. *Cross tabulation: Do you drink soft drinks? - School performance.*

Count		School performance		Total
		Not excellent	Excellent	
Do you drink soft drinks?	Three or more times per week	133	69	202
	Twice or less than twice per week	209	166	375
Total		342	235	577

The odds ratio is 1.531 that indicates that students who drink soft drinks three or more times per week have 1.531 times the risk of *not having* excellent school performance compared to students who drink soft drinks twice or less than twice per week. The relative risk is 1.181 that means that students who drink soft drinks three or more times per week have a 18.1% higher risk of *not having* excellent school performance than students who drink soft drinks twice or less than twice per week (Table5, Table 6).

Table 6. *Risk Estimate: Do you drink soft drinks? - School performance.*

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for "Do you drink soft drinks?" (Three or more times per week / Twice or less than twice per week)	1.531	1.073	2.184
For cohort "School performance = Not excellent"	1.181	1.033	1.351
For cohort "School performance = Excellent"	.772	.618	.964
N of Valid Cases	577		

12. Conclusion

In the frame of the present investigation, we examined whether chemical substances like food additives, taste enhancers, food dyes or substances that migrate from packaging, which are included in low quality food, act as endocrine disruptors and affect children's mental health and school performance. The aim of this study was to investigate the relationship between food quality, children's mental health and their school performance [36].

The Multidimensional Data Analysis and the cross tabulation showed that students who consume more frequently low quality food products, widely known as "junk food" are the ones with the poorest school performance [37].

We used the chi-square test that showed that there is a significant correlation between the variable "School performance" and the variables "Do you eat sweets?", "Do you eat junk food?" and "Do you drink soft drinks?" [38].

The analysis also showed that students who eat sweets three or more times per week have a 12.1% higher risk of *not having* excellent school performance than students who eat sweets twice or less than twice per week, students who eat junk food three or more times per week have a 58.2% higher risk of *not having* excellent school performance than students who eat junk food twice or less than twice per week and students who drink soft drinks three or more times per week have a 18.1% higher risk of *not having* excellent school performance than students who drink soft drinks twice or less than twice per week [39].

Acknowledgement

We would like to express our deepest gratitude to Prometeo Project of the Secretariat for Higher Education, Science, Technology and Innovation of the Republic of Ecuador that funded the work of Efstathios Stefos in the Pontifical Catholic University of Ecuador. We would also like to express our sincere gratitude to the Medical School of the University of Athens, the Pontifical Catholic University of Ecuador and the University of the Aegean that supported our research.

References

[1] Landrigan, P. J. & Forman, J. (2011). Chemical Pollutants. In Kliegman R., Stanton B., Geme J., Schor N., Behrman R. *Nelson Textbook of Pediatrics*. (19th ed): Elsevier.

[2] Landrigan, P. J. & Goldman, L. R. (2011). Children's vulnerability to toxic chemicals: a challenge and opportunity to strengthen health and environmental policy. *Health Aff (Millwood),* 30(5):842-850.

[3] Meeker, J. D. (2012). Exposure to environmental endocrine disruptors and child development. *Arch. Pediatr. Adolesc Med*., Oct; 166(10):952-8. Review.

[4] Cravedi, J. P., Zalko, D., Savouret, J.F., Menuet, A. & Jégou, B. (2007). The concept of endocrine disruption and human health. *Med Sci (Paris)*, Feb., 23(2):198-204. Review. French.

[5] World Health Organization - WHO (2013). *Effects of human exposure to hormone-disrupting chemicals examined in landmark UN report*. http://www.who.int/mediacentre/news/releases/2013/hormone_disrupting_20130219/en/ accessed 5/2/2014.

[6] Colborn, T. (2004). Neurodevelopment and endocrine disruption. *Environ Health Perspect.*, 112 (9):944-949.

[7] Kim, Y., Ha, E. H., Kim, E. J., Park, H., Ha, M., Kim, J. H., Hong, Y. C., Chang, N. & Kim, B. N. (2011). Prenatal exposure to phthalates and infant development at 6 months: Prospective Mothers and Children's Environmental Health (MOCEH) study. *Environ Health Perspect.*, Oct; 119(10):1495-500. doi: 10.1289/ehp.1003178, Epub 2011 Jul 7.

[8] Tanida, T., Warita, K., Ishihara, K., Fukui, S., Mitsuhashi, T. & Sugawara, T. (2009). Fetal and neonatal exposure to three typical environmental chemicals with different mechanisms of action: mixed exposure to phenol, phthalate and dioxin cancels the effects of sole exposure on mouse midbrain dopaminergic nuclei. *Toxicol Lett.,* 189(1):40-47.

[9] Eskenazi, B., Chevrier, J., Rauch, S. A., Kogut, K., Harley, K. G., Johnson, C., Trujillo, C., Sjödin, A. & Bradman, A. (2013). In utero and childhood polybrominated diphenyl ether (PBDE) exposures and neurodevelopment in the CHAMACOS study. *Environ Health Perspect.,* Feb; 121(2):257-62. doi: 10.1289/ehp.1205597. Epub 2012 Nov 7.

[10] Kim, B. N., Cho, S. C., Kim, Y., Shin, M. S., Yoo, H. J. & Kim, J. W. (2009). Phtalates exposure and attention-deficit/hyperactivity disorder in school-aged children. *Biol. Psychiatry*, 66(10):958-963.

[11] Papadakis, S. E. (2010). *Food Packaging*. Thessaloniki: Tziolas Publications.

[12] Rudel, R. A., Gray, J. M., Engel, C. L., Rawsthorne, T., Dodson, R. & Ackerman, J. (2011). Food packaging and bisphenol A and bis(2-ethyhexyl) pthalate exposure: findings from a dietary intervention. *Environ. Health Perspect*., 119(7): 914-920.

[13] Aguiar, A., Eubig, P. A., Schantz, S. L. (2010). Attention deficit/hyperactivity disorder: a focused overview for children's environmental health researchers. *Environ Health Perspect.*, 118(12):1646-1653, Review.

[14] Wormuth, M., Scheringer, M., Vollenweider, M. & Hungerbuhler, K. (2006). What are the sources of exposure to eight frequently used phthalic acid esters in Europeans? *Risk Anal.*, 26(3): 803-824.

[15] Miodovnik, A. (2011). Environmental neurotoxicants and developing brain. *Mt Sinai j Med.,* 78(1):58-77.

[16] Jurewicz, J., Polańska, K. & Hanke, W. (2013). Exposure to widespread environmental toxicants and children's cognitive development and behavioral problems. *Int. J. Occup. Med. Environ Health,* Apr; 26(2):185-204. doi: 10.2478/s13382-013-0099-x. Epub 2013 May 28, Review.

[17] Moffat, C. & Whittle, K. (2000). *Environmental Contaminants in food.* CRC Press.

[18] European Commission (2008). Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008R1333&rid=1, accessed 20/10/2014

[19] Martyn, D. M., McNulty, B. A., Nugent. A. P. & Gibney, M. J. (2013). Food additives and preschool children. *Proc. Nutr. Soc*., Feb; 72(1):109-16, Review.

[20] European Commission (2011). Regulation (EU) No.1129/2011 of 11 November 2011 amending Annex II to Regulation (EC) No.1333/2008 of the European Parliament and of the Council by Establishing a Union List of Food Additives. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011R1129&rid=41, accessed 10/10/2014

[21] Feingold, B. F. (1973). Food additives and child development [Editorial]. *Hosp. Pract*., 8,11.

[22] McCann, D., Barrett, A. & Cooper, A. (2007). Food additives and hyperactive behavior in 3-year-old and 8/9-year-old children in the community: a randomized, double-blinded, placebo-controlled trial. *Lancet,* 370:1560-1567.

[23] Bateman, B., Warner, J. & Hutchinson, E. (2004). The effects of a double blind, placebo controlled artificial food colourings and benzoate preservative challenge on hyperactivity in a general population sample of preschool children. *Arch Dis Child*, 89:506-511.

[24] Bellisle, F. (2004). Effects of diet on behaviour and cognition in children. *Br J Nutr* (suppl.2): S227-32.

[25] Brindal, E., Baird, D., Slater, A., Danthiir, V., Wilson, C., Bowen, J. & Noakes, M. (2013). The effect of beverages varying in glycaemic load on postprandial glucose responses, appetite and cognition in 10-12-year-old school children. *Br J Nutr*. Aug 28: 110(3): 529-37. doi: 10.1017/S0007114512005296. Epub 2012 Dec 17.

[26] Florence, M. D., Asbridge, M. & Veugelers, P. J. (2008). Diet quality and academic performance. *J. Sch. Health,* Apr; 78(4):209-215.

[27] Fu, M. L., Cheng, L., Tu S. H. & Pan, W. H. (2007). Association between unhealthful eating patterns and unfavorable overall school performance in children. *J. Am. Diet Assoc.,* Nov; 107(11):1935-43.

[28] Watts, M. K. (2011). Nutritional therapy in practice for learning, behavioural and mood disorders. *Nutr Health*, 20(3-4):239-54, Review.

[29] Crispim, S. P., Geelen, A., Le Donne, C., de Vries, J. H., Sette, S. & Raffro, A. (2010). Dietary exposure to flavouring substances: from screening methods to detailed assessments using food consumption data collected with EPIC-Soft software. *Food Addit Contam* Part A Chem Anal Control Expo Risk Assess 27, 433-446.

[30] Bryan, J., Osendarp, S., Hughes, D., Calvaresi, E., Baghurst, K. & Klinken, J. (2004). Nutrients for cognitive development in school-aged children. *Nutr Rev.*, 62:295-306.

[31] Benzécri, P. (1992). *Correspondence Analysis Handbook*. New York: Dekker.

[32] Martin, O. (2008). *The analysis of quantitative data*, Transl. Athanasiadis, I. (pp.86-88). Athens: Topos.

[33] Morineau, A. (1984). Note sur la Caractérisation Statistique d'une Classe et les Valeurs-tests. *Bulletin Technique du Centre de Statistique et d'Informatique Appliquées*, Vol 2, no 1-2, p.20-27.

[34] McHugh, M. L. (2009). The odds ratio: calculation, usage, and interpretation. *Biochemia Medica*, 19(2): 120-6. http://dx.doi.org/10.11613/BM.2009.011

[35] Morris, J. A. & Gardner, M. J. (1988). Calculating confidence intervals for relative risk (odds ratios) and standardised ratios and rates. *British Medical Journal*, 296, 1313-1316.

[36] Stefos, E. (2015). *Eating habits among High School students in Dodecanese. Impacts of the economic crisis in Greece*. p.125. Rhodes: Evdimos Editions.

[37] Athanasiadis, I. (1995). *Correspondence Analysis and Hierarchical Classification*. New Technologies Editions, pp.51-56.

[38] Stefos, E., Athanasiadis I., Gialamas, B. & Tsolakidis, C. (2011). The Use of New Technologies and the Project Method in Teaching Statistics: A Case Study in Higher Education. *HMS i JME*, Volume 3. 2010-2011. pp.84-100.

[39] Stefos, E. & Papapostolou, I. (2013). *Research Methodology. Processes and suggestions.* p.406. Rhodes: Evdimos Editions.