Ultra-processed foods are the major sources of total fat, saturated and trans-fatty acids among Tunisian preschool and school children: a cross-sectional study

Darine Dogui [a]*, Radhouene Doggui[a,b,c,]*, Ayoub Al-Jawaldeh[d], Jalila El Ati[a], Myriam El Ati-Hellal[e]

[a] *Nutrition Surveillance and Epidemiology in Tunisia Research Laboratory, National Institute of Nutrition and Food Technology, Tunis, Tunisia;*

[b] *Centre de Formation Médicale du Nouveau-Brunswick, Université de Sherbrooke, Moncton, Canada,*

[c] *Department of Family and Emergency Medicine, Université de Sherbrooke, Sherbrooke, Canada*

[d] *Regional Office for the Eastern Mediterranean (EMRO), World Health Organization (WHO), Cairo, Egypt.*

[e] *Laboratory Materials Molecules and Applications, Preparatory Institute for Scientific and Technical Studies, University of Carthage, Tunis, Tunisia.*

*corresponding author:

Myriam El Ati-Hellal

Full address : Laboratory Materials Molecules and Applications, Preparatory Institute for Scientific and Technical Studies, University of Carthage, Tunis, Tunisia.

E-mail : mfh22002@yahoo.fr

Tel.: +216-52478680; Fax: +216-71564194

Abstract

Excessive intake of fat and fatty acids is associated with major health hazards such as obesity or chronic diseases. The aim of this study is to provide the first data on total fat, SFA and TFA intakes and their major food sources in Tunisian children. A total of 1200 children, aged 3 to 9 years old, were randomly selected from primary schools and kindergarten under a cross-sectional design. The 24hour recall method and food frequency questionnaire were used to assess dietary intake. The energy percentages of total fat, SFA and TFA in Tunisian children were respectively 29.6, 11.4 and 0.15. No sex differences were found. The WHO recommendations for total fat, SFA and TFA were adopted by 58 %, 39 % and 89 % of the study population, respectively. The leading food groups of fat and fatty acids were ultra-processed foods, bread and cereals and dairy products. The meat, fish, eggs and fish alternatives were the fifth main contributors to the total fat and SFA intakes in Tunisian children. The implementation of a relevant strategy for fat reduction, especially from ultra-processed foods, considered as low nutrient energy-dense products, is needed to promote health among children and prevent diet-related chronic diseases.

Keywords: Dietary fats, food sources, children, Tunisia.

1. Introduction

Fatty acids are carboxylic acids with either saturated or unsaturated aliphatic chains [1-3]. Saturated fatty acids (SFA) have no double bonds, while unsaturated fatty acids have at least one double bond in their *cis* or *trans* configuration [4]. The main sources of SFA in the food supply are animal products, including meat and dairy products [2,5]. Trans fatty acids (TFA) are produced naturally in ruminants' stomachs or industrially by partial hydrogenation of vegetable oils. Hydrogenation increases the melting point of fats, making it possible to convert fats from the liquid state to the semi-solid or solid-state [6,7]. The benefits of such a process are the increase of flavor stability and shelf life of unsaturated fatty acids. Several epidemiologic studies have shown that high dietary intakes of SFA and TFA are associated with an increased risk of cardiovascular disease, diabetes, cancer and dementia in later life [8-14]. Because of these deleterious health effects, the 2018 WHO draft guidelines on saturated fatty acid and trans-fatty acid intake for adults and children recommend reducing the intake of SFA and TFA to less than 10 % and 1 % of total energy intake, respectively. They suggest using polyunsaturated fatty acids as a source of replacement energy, if needed [15].

Given the long-term effect of childhood dietary consumption on adult health and the risks associated with sustained high intake of SFA and TFA, this study aimed to describe eating patterns and find the leading food group sources of these fatty acids in Tunisian preschool and school-age children.

2. Material and methods

2.1 Subject and study design

The subjects of this study were a cohort of 1200 children aged 3-9 years, randomly selected from primary schools and kindergarten in Greater Tunis region from April to May 2019. This urban region includes 4 governorates (Tunis, Manouba, Ariana and Ben

Arous). A two-stage clustered sampling was designed by the National Institute of Statistics. Stratification was made depending on each governorate and urban/rural environments. At the first level, 30 primary schools and 30 kindergartens were selected from the initial sampling frame. At the second level, 20 children were systematically drawn from each educational institution.

2.2 Dietary intake assessment

Data on the types and amounts of foods and drinks consumed by children were recorded by trained dieticians. A detailed and precise description of nutriments was made using photos and known weight of food portions. The 24hour recall method and food frequency questionnaire (FFQ) were used to assess dietary intake over a period of one week. The energy and nutritional content of identified food items and recipes were estimated by laboratory analysis, the Tunisian food composition table [16], The USDA table [17] and the food processor software [18]. The revised version of AOAC official method 996.06 was adopted for total fat, SFA and TFA analysis [19].

2.3 Ethics approval and consent to participate

All applicable institutional and governmental regulations concerning the ethical use of human volunteers were respected during this study. The survey protocol was reviewed and approved by the Tunisian National Council of Statistics (Visa n°3/2017) and the Ethical Consultative Committee of the National Institute of Nutrition and Food Technology. After being thoroughly informed on the purpose, requirements, and procedures of the survey, all parents gave their free informed consent. All data were handled anonymously during analysis.

2.4 Data management and statistical analysis

Data entry was carried out in duplicate using Epidata software version 3.1 [20]. Data analysis was performed by Stata 14 software [21], taking into account the sampling design (stratification, clustering and sampling weights). The type I error risk was 0.05.

3. Results

The characteristics of the study population according to gender are presented in table 1.

Table 1. Characteristics of Tunisian children aged 3-9 years old

Physiological characteristics	All		Boys		Girls	
	n	%	n	%	n	%
Boys	582	50				
Girls	582	50				
Age (years)						
3 - 4	350	33.8	191	36.5	159	31.0
5 - 6	334	29.9	162	28.7	172	31.0
7 - 8	307	23.2	149	22.6	158	23.9
9 - 10	173	13.1	80	12.2	93	14.1
Socio-economic factors						
Economic level of the household						
Upper tercile	383	32.2	187	31.5	196	32.9
Medium tercile	392	34.1	197	34.0	195	34.1
Lower tercile	389	33.7	198	34.5	191	33.0
Profession of household head						
Upper/medium	507	44.4	247	42.9	260	45.8
Employee/worker	637	54.0	324	55.3	313	52.8
Not working/retired	20	01.6	11	01.8	9	01.4
Education of household head						
University/Secondary	882	76.4	440	75.9	442	76.9
Primary school or none	282	23.6	142	24.1	140	23.1
Profession of mother						
Upper/medium	332	29.5	160	28.8	172	30.2
Employee/worker	253	22.0	123	21.4	130	22.7
Not working/retired	579	48.5	299	49.8	280	47.1
Education of mother						
University/Secondary	878	76.5	433	75.4	445	77.6
Primary school or none	286	23.5	149	24.6	137	22.4
Anthropometric characteristics						
Stunting	16	01.4	10	01.7	6	01.0
Underweight	37	03.0	19	03.1	18	02.9
Overweight	311	26.0	151	25.2	160	26.7
Obesity	122	09.9	65	10.7	57	09.1

The sample was evenly distributed among household economic levels. Approximately all household heads have a profession, while half of the mothers do not work. Over two-thirds of household heads and mothers have a high school or university education. A proportion of 60 % of the children were of normal body weight, with about 26 % overweight and 10 % obese.

The mean daily total fat, SFA and TFA intakes of boys and girls of all age groups are reported in table 2. The percent total fat energy of Tunisian children aged 3 to 9 years old was 29.6. The mean SFA and TFA intakes of the studied population were 11.4 (% E) and 0.15 (% E), respectively. No sex differences were found. According to age, children aged 3 to 4 years old had significantly higher SFA (11.7 % E) and TFA (0.18 % E) intakes than the other age groups ($p < 0.0001$).

Table 2. Intake of total fat, SFA and TFA according to gender and age among Tunisian children aged 3-9 years

Nutrient	Unit		Total	Gender			Age groups				
				Boys	Girls	*p* value	3-4 y	5-6 y	7--8 y	9-10	*p* value [a]
Fat total	(g/d)	Mean (s.e.) [b]	49.8 (0.5)	50.5 (0.7)	48.9 (0.6)	0.084	46.3 (0.8)	51.0 (1.0)	52.3 (0.9)	50.9 (1.2)	**0.000**
		95 % CI	48.7 – 49.7	49.1 - 51.9	47.6 - 50.1		44.7 - 47.8	49.0 - 52.9	50.6 - 54.1	48.5 - 53.3	
	(% E)[c]	Mean (s.e.)	29.6 (0.3)	29.6 (0.6)	29.6 (0.3)	0.931	29.2 (0.3)	30.4 (1.0)	29.3 (0.4)	29.2 (0.5)	0.968
		95 % CI	28.9 - 30.2	28.5 - 30.8	29.0 - 30.1		28.5 – 29.9	28.5 – 32.3	28.6 – 30.1	28.3 – 30.2	
SFA	(g/d)	Mean (s.e.)	19.2 (0.2)	19.6 (0.3)	18.8 (0.3)	0.070	18.5 (0.4)	19.7 (0.4)	19.6 (0.4)	19.4 (0.6)	0.110
		95 % CI	18.8 – 19.7	19.0 - 20.2	18.2 - 19.4		17.8 - 19.2	18.9 - 20.5	18.7 - 20.4	18.1 - 20.7	
	(% E)	Mean (s.e.)	11.4 (0.1)	11.3 (0.1)	11.4 (0.2)	0.887	11.7 (0.2)	11.5 (0.2)	10.9 (0.2)	11.0 (0.3)	**0.008**
		95 % CI	11.2 - 11.6	11.1 - 11.6	11.1 - 11.7		11.3 – 12.0	11.2 – 11.9	10.5 – 11.3	10.5 – 11.5	
TFA	(g/d)	Mean (s.e.)	0.24 (0.01)	0.26 (0.02)	0.23 (0.02)	0.158	0.29 (0.03)	0.25 (0.03)	0.24 (0.03)	0.13 (0.02)	**0.000**
		95 % CI	0.22 – 0.27	0.22 - 0.30	0.19 - 0.26		0.23 - 0.34	0.20 - 0.30	0.18 - 0.29	0.08 - 0.18	
	(% E)	Mean (s.e.)	0.15 (0.01)	0.16 (0.01)	0.14 (0.01)	0.219	0.18 (0.02)	0.15 (0.02)	0.14 (0.02)	0.08 (0.01)	**0.000**
		95 % CI	0.13 - 0.16	0.13 - 0.18	0.11 - 0.16		0.15 - 0.22	0.12 - 0.18	0.10 - 0.17	0.05 - 0.10	

[a] - Comparison between sexes adjusted for age. [b]- Mean value (standard error). [c]- Energy percent

Table 3 presents the percentage of children meeting the WHO recommendations for total fat, SFA and TFA according to gender. Up to 58 % of the study population adhered to the WHO recommendations for total fat intake. In 41 % of the children, total fat intake was higher than 30 % E. Only 39 % of the children were in compliance with the SFA

recommendations. A high proportion of the children aged 3-9 years (89 %) had an adequate TFA intake (<1 % E). No gender differences were observed.

Table 3. Percentage of Tunisian children adhering to WHO recommendations for fat, SFA and TFA by gender

Nutrient (% E)	Total (n = 1164)	Boys (n=582)	Girls (n=582)	*p* value
Total fat				
< 15	<1	<1	<1	
15-30[a]	58	59	57	0.759
> 30	41	40	42	
SFA				
<10[a]	39	40	38	0.42
≥ 10	61	60	62	
TFA				
<1[a]	89	89	89	0.945
≥ 1	11	11	11	

[a] Recommended levels of total fat, SFA and TFA according to WHO

The percentage contributions of the major food groups to the fat and fatty acids intake in the total study population can be found in table 4.

Ultra-processed foods (mainly cheese and cakes, pies and biscuits) were the major food sources of total fat, SFA and TFA intakes in Tunisian children with respective percentage contributions of 32.5, 28.9 and 48.4. Bread and cereals were the second and the third main contributors to the total fat and SFA consumption, respectively. Dairy products were classified at the second and the fourth rank respectively for fatty acids and total fat intakes. Beverages and industrial juices didn't contribute to the fat and fatty acids intake.

4. Discussion

In the present study, we reported for the first time, the intake of total, saturated and trans-fatty acids and their major food sources among 3-9 y Tunisian children using a cross-sectional survey. We found that the mean intake of total fat falls within the WHO recommendations but a large proportion of the population (41 %) exceeded the recommended limit of 30 % E. SFA intake in almost the two-third of the children was

greater than 10 % E. However, the TFA consumption was under the WHO recommendations for nearly all of them [15]. Compared to findings on total fat and SFA intake of children and adolescents in other countries, our results are higher than those reported in Korea [22], Mexico [23] or Japan [24], similar to those found in Guatemala [25] or US [26] and lower than results registered in European countries where the mean total fat intake was 33.3 % E, with a mean SFA intake of 13.8 % E [27]. The consumption of TFA by Tunisian children was very low in comparison with data registered elsewhere. Monge-Rojas et al. [2013] reported mean TFA intake of 1.3 % E in Costa Rican adolescents [28], while the average dietary intake of TFA in Spanish children aged 4-5 y was 1.36 g/d which corresponds to 0.77 % E [29]. Results from Canadian children aged 5-6 y showed a mean TFA intake of 0.71 % E [30]. These results are expected because the overall levels of TFA in most processed food products available on the Tunisian market are low (<1 g/100g of sample), except in margarine (5.56 g/100g).

Table 4. Percentage contributions of the major food groups to the total fat, SFA and TFA intakes in Tunisian children

Total fat			SFA			TFA		
Rank	Food group	%[a]	Rank	Food group	%	Rank	Food group	%
1	Ultra-processed foods	32.5	1	Ultra-processed foods	29.0	1	Ultra-processed foods	48.4
2	Bread and cereals	20.5	2	Dairy products	22.7	2	Dairy products	47.1
3	Vegetables, legumes and fruits	16.1	3	Bread and cereals	17.3	3	Fat and oils	04.4
4	Dairy products	11.7	4	Vegetables, legumes and fruits	12.9	4	Bread and cereals	00.1
5	Meat, fish and eggs	10.7	5	Meat, fish and eggs	10.8	5	Beverages and industrial juices	00.0
6	Fat and oils	05.8	6	Fat and oils	05.2	6	Meat, fish and eggs	00.0
7	Potatoes and grains	02.0	7	Potatoes and grains	01.6	7	Potatoes and grains	00.0
8	Beverages and industrial juices	00.2	8	Beverages and industrial juices	00.2	8	Vegetables, legumes and fruits	00.0

[a] Percentage contributions of food groups

Our results revealed that ultra-processed foods (mainly cheese and cakes, pies and biscuits) were the greatest source of fat and fatty acids in Tunisian children, followed by bread and cereals for total fat and dairy products for fatty acids. Ultra-processed foods are food products formulated mainly or entirely from processed ingredients, including little or no whole foods [31]. The early consumption of these products could lead to adverse health effects such as obesity or chronic diseases [32,33]. Therefore, it is important to understand the role of food processing and to formulate public health strategies to reduce the consumption of ultra-processed products early in life. Comparing food sources of fat and fatty acids is not easy because food groupings differ between the research studies. The definition of the food groups in the present study was based on the Tunisian food composition table and the USDA table [16,17]. The important contributions of ultra-processed foods, bread and cereals, and dairy products in children and adolescents' fat and fatty acids intake were also found elsewhere. Asakura and Sasaki (2017) reported that meat, dairy products, and confectioneries were the three major sources of SFA in Japanese schoolchildren (26.4 %, 25.7 % and 11.3 % of total SFA intake) [24]. According to Wang et al. (2018), the meat, poultry and fish, the milk and the mixtures mainly grain were the leading food sources of saturated fats in US children [26]. The Korean study revealed that milk was the major food source of total fat and SFA in 3-5 years children, with respective percentages contributions of 15.6 and 29.5, followed by pork and eggs [22]. In Costa Rica, bakery products, red meat and dairy products were the main contributors to SFA and TFA intakes in adolescents [28], while fried eggs, whole milk, sweet bread and fresh cheese were among the major food sources of total fat and SFA in diets of Guatemalan schoolchildren [25]. The principal food groups contributing to the total TFA intake in Spanish children were milks (21 %), processed baked goods (16 %), sweets (12 %), fast food (12 %) and white bread (10 %) [29]. They were comparable to

those reported in the Canadian study [30]. Generally, the top three food groups contributing to the total fat and SFA intakes in European adolescents were the meat, fish, eggs and meat alternatives (mainly meat), the low-nutrient, energy-dense foods (mainly cakes, pies and biscuits) and the dairy and soya products (mainly cheese) [27]. In our study, the meat, fish, eggs and fish alternatives were the fifth main contributors to the total fat and SFA intakes in Tunisian children, with respective percentages of 10.7 and 10.8. This result is probably due to differences in dietary habits between Tunisian population and the other world populations. The average annual meat consumption per capita in Tunisia is around 32.5 kg in 2015, close to the global average of 34.3 kg, but far from 69 kg in the European Union and 98.3 kg in the United States [34,35]. On the other hand, the mean annual consumption of lean meat in 2015 (19.4 kg for poultry and white meat) is much more important than the consumption of fatty meat (7.1 kg for sheepmeat and 3.1 kg for bovine meat) [34]. The general food price index which makes sheep and bovine meat proportionately more expensive than the other food products, could explain this trend of meat consumption among Tunisian people [36].

Given the result that a large proportion of Tunisian children exceeded the recommended levels of total fat and SFA intake, the implementation of several policy actions is necessary to prevent diseases and promote health in Tunisia. In this context, the WHO regional office has developed policy guidance with recommended actions for countries in the Eastern Mediterranean Region to reduce national fat intake. These recommendations include establishing mandatory labelling schemes for saturated fatty acid content that are easily understandable for most consumers and replacing industrially-produced TFA with healthier oils and fats [37]. Future health policies should focus primarily on reducing the children's intake of ultra-processed foods and increasing access

to high nutritive quality foods such as vegetables, fruits, whole-grain products and animal source foods with health-promoting fats (e.g., fish) [38].

Conclusions

Since 41 % and 61 % of Tunisian children consumed excess fat and SFA respectively, there is a need of rapid intervention for fat reduction in Tunisian population. Intake of TFA was relatively low compared to other research studies. Nevertheless, elimination of industrial TFA is strongly recommended due to its association with increased risk of heart attack and death. The major dietary sources of total fat, SFA and TFA in Tunisian children, were ultra-processed foods, bread and cereals and dairy products. As ultra-processed foods are considered as low nutrient, dense energy foods, public health nutrition efforts should continue to reduce the consumption of these products and promote the intake of healthy diets.

The authors declare that they have no competing interests

Author contributions: Conceptualization, M.E.A.-H., R.D. and J.E.A.; formal analysis, D.D. and R.D. funding acquisition, A.A.-J and J.E.A.; methodology, D.D., M.E.A.-H. and R.D.; project administration, A.A.-J and J.E.A.; software, D.D. and R.D.; supervision, A.A.-J and J.E.A.; Writing—Original draft, D.D., M.E.A.-H., and R.D.; Writing—Review & editing, D.D., M.E.A.-H. and J.E.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data availability statement: The data is available from the corresponding author upon a reasonable request.

Acknowledgements: The authors thank all members of the INNTA study and planning team for their valuable contribution to fieldwork and data entry.

Conflicts of Interest: The authors declare that they do not have any conflict of interest.

References

1. Kremmyda, L.S.; Tvrzicka, E.; Stankova, B.; Zak, A. Fatty acids as biocompounds: their role in human metabolism, health and disease: a review. part 2: fatty acid physiological roles and applications in human health and disease. *Biomedical papers of the Medical Faculty of the University Palacky, Olomouc, Czechoslovakia* **2011**, *155*, 195-218, doi:10.5507/bp.2011.052.
2. Tvrzicka, E.; Kremmyda, L.S.; Stankova, B.; Zak, A. Fatty acids as biocompounds: their role in human metabolism, health and disease--a review. Part 1: classification, dietary sources and biological functions. *Biomedical papers of the Medical Faculty of the University Palacky, Olomouc, Czechoslovakia* **2011**, *155*, 117-130, doi:10.5507/bp.2011.038.
3. Hunter, J.E. Food fats and oils. *Prog Clin Biol Res* **1986**, *222*, 153-184.
4. Mensink, R. *Effects of saturated fatty acids on serum lipids and lipoproteins: a systematic review and regression analysis*; World Health Organization: Geneva, 2016.
5. Valsta, L.M.; Tapanainen, H.; Mannisto, S. Meat fats in nutrition. *Meat Sci* **2005**, *70*, 525-530, doi:10.1016/j.meatsci.2004.12.016.
6. Ascherio, A.; Willett, W.C. Health effects of trans fatty acids. *Am J Clin Nutr* **1997**, *66*, 1006S-1010S, doi:10.1093/ajcn/66.4.1006S.
7. Craig-Schmidt, M.C. World-wide consumption of trans fatty acids. *Atheroscler Suppl* **2006**, *7*, 1-4, doi:10.1016/j.atherosclerosissup.2006.04.001.
8. Zong, G.; Li, Y.; Wanders, A.J.; Alssema, M.; Zock, P.L.; Willett, W.C.; Hu, F.B.; Sun, Q. Intake of individual saturated fatty acids and risk of coronary heart disease in US men and women: two prospective longitudinal cohort studies. *BMJ* **2016**, *355*, i5796, doi:10.1136/bmj.i5796.
9. Briggs, M.A.; Petersen, K.S.; Kris-Etherton, P.M. Saturated Fatty Acids and Cardiovascular Disease: Replacements for Saturated Fat to Reduce Cardiovascular Risk. *Healthcare (Basel)* **2017**, *5*, doi:10.3390/healthcare5020029.
10. Ruiz-Nunez, B.; Dijck-Brouwer, D.A.; Muskiet, F.A. The relation of saturated fatty acids with low-grade inflammation and cardiovascular disease. *J Nutr Biochem* **2016**, *36*, 1-20, doi:10.1016/j.jnutbio.2015.12.007.
11. Huang, L.; Lin, J.S.; Aris, I.M.; Yang, G.; Chen, W.Q.; Li, L.J. Circulating Saturated Fatty Acids and Incident Type 2 Diabetes: A Systematic Review and Meta-Analysis. *Nutrients* **2019**, *11*, doi:10.3390/nu11050998.
12. Barnard, N.D.; Bunner, A.E.; Agarwal, U. Saturated and trans fats and dementia: a systematic review. *Neurobiol Aging* **2014**, *35 Suppl 2*, S65-73, doi:10.1016/j.neurobiolaging.2014.02.030.
13. de Souza, R.J.; Mente, A.; Maroleanu, A.; Cozma, A.I.; Ha, V.; Kishibe, T.; Uleryk, E.; Budylowski, P.; Schunemann, H.; Beyene, J., et al. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. *BMJ* **2015**, *351*, h3978, doi:10.1136/bmj.h3978.
14. Li, C.; Cobb, L.K.; Vesper, H.W.; Asma, S. Global Surveillance of trans-Fatty Acids. *Prev Chronic Dis* **2019**, *16*, E147, doi:10.5888/pcd16.190121.
15. WHO. Draft guidelines on saturated fatty acid and trans-fatty acid intake for adults and children. World Health Organisation: Geneva, 2018.
16. El Ati J., B.C., Farhat A., Haddad S., Cherif S., Trabelsi T., Danguir J., Gaigi S., Le Bihan Geneviève, Landais E., Eymard Duvernat S., Maire Bernard, Delpeuch Francis, Rhidha Kechrid M. Table de composition des aliments tunisiens. INNTA, IRD: Tunis, Montpellier, 2007.

17. USDA. In *USDA Nutrient Data Laboratory*, Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 21.: 2008.
18. ESHA-Research-Inc *Food Processor Software Version 8.3*, Salem, Oregon, USA, 2003.
19. AOAC. 18th Ed. AOAC International. Gaithersburg, MD, Method 996.06 Fat (Total, Saturated, and Unsaturated). In *Foods. Hydrolytic extraction gas chromatography method, First Action 1996, revised 2001.*, Official Method of Analysis: 2005.
20. Epidata *The Epidata Association*, Odense, Denmark., 2008.
21. StataCorp. *Stata Statistical Software: Release 14.0*, College Station, TX: StataCorp LP., 2015.
22. Baek, Y.; Shim, J.E.; Song, S. Dietary intake of fat and fatty acids by 1-5-year-old children in Korea: a cross-sectional study based on data from the sixth Korea National Health and Nutrition Examination Survey. *Nutr Res Pract* **2018**, *12*, 324-335, doi:10.4162/nrp.2018.12.4.324.
23. Ramirez-Silva, I.; Villalpando, S.; Moreno-Saracho, J.E.; Bernal-Medina, D. Fatty acids intake in the Mexican population. Results of the National Nutrition Survey 2006. *Nutr Metab (Lond)* **2011**, *8*, 33, doi:10.1186/1743-7075-8-33.
24. Asakura, K.; Sasaki, S. SFA intake among Japanese schoolchildren: current status and possible intervention to prevent excess intake. *Public Health Nutr* **2017**, *20*, 3247-3256, doi:10.1017/S1368980017002592.
25. Bermudez, O.I.; Toher, C.; Montenegro-Bethancourt, G.; Vossenaar, M.; Mathias, P.; Doak, C.; Solomons, N.W. Dietary intakes and food sources of fat and fatty acids in Guatemalan schoolchildren: a cross-sectional study. *Nutr J* **2010**, *9*, 20, doi:10.1186/1475-2891-9-20.
26. Wang, Y.; Guglielmo, D.; Welsh, J.A. Consumption of sugars, saturated fat, and sodium among US children from infancy through preschool age, NHANES 2009-2014. *Am J Clin Nutr* **2018**, *108*, 868-877, doi:10.1093/ajcn/nqy168.
27. Vyncke, K.E.; Libuda, L.; De Vriendt, T.; Moreno, L.A.; Van Winckel, M.; Manios, Y.; Gottrand, F.; Molnar, D.; Vanaelst, B.; Sjostrom, M., et al. Dietary fatty acid intake, its food sources and determinants in European adolescents: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Br J Nutr* **2012**, *108*, 2261-2273, doi:10.1017/S000711451200030X.
28. Monge-Rojas, R.; Aragon, M.C.; Chinnock, A.; Campos, H.; Colon-Ramos, U. Changes in dietary intake and food sources of saturated and cis and trans unsaturated fatty acids in Costa Rican adolescents: 1996 versus 2006. *Nutrition* **2013**, *29*, 641-645, doi:10.1016/j.nut.2012.10.004.
29. Scholz, A.; Gimenez-Monzo, D.; Navarrete-Munoz, E.M.; Garcia-de-la-Hera, M.; Fernandez-Somoano, A.; Tardon, A.; Santa Marina, L.; Irazabal, A.; Romaguera, D.; Guxens, M., et al. Dietary Intake of Trans Fatty Acids in Children Aged 4-5 in Spain: The INMA Cohort Study. *Nutrients* **2016**, *8*, doi:10.3390/nu8100625.
30. Mulder, K.A.; Ferdinands, A.R.; Richardson, K.J.; Innis, S.M. Sources of trans and saturated fatty acids in the diets of Vancouver children. *Can J Diet Pract Res* **2013**, *74*, 7-13, doi:10.3148/74.1.2013.7.
31. Costa, C.S.; Del-Ponte, B.; Assuncao, M.C.F.; Santos, I.S. Consumption of ultra-processed foods and body fat during childhood and adolescence: a systematic review. *Public Health Nutr* **2018**, *21*, 148-159, doi:10.1017/S1368980017001331.
32. Tavares, L.F.; Fonseca, S.C.; Garcia Rosa, M.L.; Yokoo, E.M. Relationship between ultra-processed foods and metabolic syndrome in adolescents from a Brazilian Family Doctor Program. *Public Health Nutr* **2012**, *15*, 82-87, doi:10.1017/S1368980011001571.
33. Canella, D.S.; Levy, R.B.; Martins, A.P.; Claro, R.M.; Moubarac, J.C.; Baraldi, L.G.; Cannon, G.; Monteiro, C.A. Ultra-processed food products and obesity in Brazilian households (2008-2009). *PLoS One* **2014**, *9*, e92752, doi:10.1371/journal.pone.0092752.

34. NIC. Survey on meat consumption in Tunisia (in french). National Institute of Consumption.http://inc.nat.tn/sites/default/files/document-files/%D8%A8%D8%AD%D8%AB%20%D8%AD%D9%88%D9%84%20%D8%A5%D8%B3%D8%AA%D9%87%D9%84%D8%A7%D9%83%20%D8%A7%D9%84%D9%84%D8%AD%D9%88%D9%85%20%D9%81%D9%8A%20%D8%AA%D9%88%D9%86%D8%B3.pdf. **2017**.
35. OECD. Agriculture Statistics. https://data.oecd.org/agroutput/meat-consumption.htm. **2018**.
36. NIS. Added values of the sector, Contribution of the transport and trade sectors to GDP (in french). National Institute of Statistics. http://www.ins.nat.tn/. **2019**.
37. WHO. *Technical consultation on salt and fat reduction strategies in the Eastern Mediterranean Region. Tunis, Tunisia*; 2015.
38. Ebbeling, C.B.; Young, I.S.; Lichtenstein, A.H.; Ludwig, D.S.; McKinley, M.; Perez-Escamilla, R.; Rimm, E. Dietary Fat: Friend or Foe? *Clin Chem* **2018**, *64*, 34-41, doi:10.1373/clinchem.2017.274084.