Gac Sanit. 2017;31(5):371–381

Original article

Citizens' perceptions of the presence and health risks of synthetic chemicals in food: results of an online survey in Spain

José Pumarega[a,b], Cristina Larrea[b,c,d], Araceli Muñoz[d], Natàlia Pallarès[a,b,e], Magda Gasull[a,b,e], Giselle Rodríguez[a,f], Manel Jariod[a,b,g], Miquel Porta[a,b,e,*]

[a] Hospital del Mar Medical Research Institute (IMIM), Barcelona, Spain
[b] CIBER de Epidemiología y Salud Pública (CIBERESP), Spain
[c] Department of Social Anthropology, University of Barcelona, Barcelona, Spain
[d] Food Observatory (ODELA), University of Barcelona, Barcelona, Spain
[e] School of Medicine, Universitat Autònoma de Barcelona, Spain
[f] Icahn School of Medicine at Mount Sinai, New York, NY, USA
[g] Information Systems, Hospital Universitari de Tarragona Joan XXIII, Tarragona, Spain

ARTICLE INFO

Article history:
Received 11 October 2016
Accepted 30 March 2017
Available online 27 June 2017

Keywords:
Environmental pollutants
Prevention and control
Environmental exposure
Adverse effects
Human biomonitoring
Health survey
Persistent organic pollutants
Toxic substances in food

ABSTRACT

Objective: To explore factors influencing perceptions and viewpoints on the responsibility for the presence of toxic substances in food, on enforcement of laws and regulations that control human exposure to toxic substances in food, and on the effectiveness of such regulations.
Methods: An online survey was completed by 740 individuals from several parts of Spain (median age, 47 years; 67% were women; 70% had completed university studies).
Results: Over 87% of respondents said that it was possible that throughout their lives they could have accumulated in their body toxic substances potentially dangerous to their health. The attribution of the responsibility for toxic substances in food to a larger number of social groups was more frequent among respondents who consulted information about the problem more often (odds ratio [OR]: 1.92), who correctly identified factors that increase the likelihood of toxic substances in food being harmful to human health (OR: 2.86), who better knew the health problems that may be caused by such substances (OR: 2.48), and who recognised more food groups that tend to have concentrations of toxic substances potentially harmful to health (OR: 2.92) (all p values <0.001). Women were 65% less likely than men to answer that regulations on toxic substances in food are effective ($p < 0.001$); and so were participants who identified more food groups with potentially toxic concentrations.
Conclusions: Among study participants there was a widespread scepticism and distrust towards the enforcement and effectiveness of laws and regulations that in Spain aim to control human exposure to toxic substances in food.

Percepciones de la ciudadanía sobre la presencia y los riesgos para la salud de compuestos químicos sintéticos en los alimentos: resultados de un estudio en línea en España

Palabras clave:
Contaminantes ambientales
Prevención y control
Exposiciones ambientales
Efectos adversos
Biomonitorización humana
Encuestas de salud
Compuestos orgánicos persistentes
Sustancias tóxicas en alimentos

RESUMEN

Objetivo: Explorar factores que influyen en las percepciones y puntos de vista de los ciudadanos sobre la responsabilidad de la presencia de sustancias tóxicas en los alimentos, sobre la aplicación de las leyes que en España controlan la exposición humana a dichas sustancias y sobre la efectividad de tales leyes.
Método: 740 personas de varias partes de España (mediana de edad, 47 años; 67% mujeres; 70% con estudios universitarios) completaron una encuesta en línea.
Resultados: Más del 87% de las personas encuestadas consideraron que era posible que a lo largo de su vida hubiesen acumulado en su cuerpo sustancias tóxicas potencialmente peligrosas para su salud. Atribuir la responsabilidad sobre la presencia de sustancias tóxicas en los alimentos a un mayor número de grupos sociales fue más frecuente entre quienes declararon consultar con más frecuencia información sobre el problema (*odds ratio* [OR]: 1,92), quienes identificaron correctamente factores que aumentan la probabilidad de que las sustancias tóxicas en los alimentos sean perjudiciales para la salud humana (OR: 2,86), quienes conocían mejor los problemas de salud que pueden ser causados por dichas sustancias (OR: 2,48) y quienes señalaron más grupos de alimentos que tienden a tener concentraciones de tóxicos que pueden ser perjudiciales para la salud (OR: 2,92) (todos los valores de p <0,001). Las mujeres fueron un 65%

* Corresponding author.
E-mail address: mporta@imim.es (M. Porta).

http://dx.doi.org/10.1016/j.gaceta.2017.03.012

menos propensas que los hombres a responder que las regulaciones legales sobre sustancias tóxicas en los alimentos son efectivas (p <0,001), y también lo fueron las personas que identificaron más grupos de alimentos con concentraciones potencialmente tóxicas.
Conclusiones: Entre los/las participantes en el estudio hubo un amplio escepticismo y desconfianza respecto a la aplicación y la efectividad de la legislación que en España aspira a controlar la exposición humana a sustancias tóxicas en los alimentos.

Introduction

A substantial body of scientific evidence indicates that numerous synthetic environmental chemicals may increase the risk of some human diseases, and that for the general population food is often the main source of exposure to such compounds. Water and air pollution, personal care products, food packaging, and other consumer goods are also sources of exposure. Some types of persistent toxic substances were never intentionally released into the environment (e.g., dioxins), and the manufacture of others was halted decades ago in many countries (e.g., polychlorinated biphenyls, organochlorine pesticides). However, today many such persistent substances remain detectable in animal and human food webs, as well as in most human beings, both at low and high concentrations. Due to frequent exposure, food and human contamination by non-persistent toxic substances is also commonly observed. [1–10]

While research on the potential health effects of environmental chemicals is quite strong in Spain,[6,11] only some in-depth studies exist on perceptions, attitudes, and behaviours of citizens related to food safety; [12–17] and, to our knowledge, few studies have specifically addressed citizens' views on the causes and consequences of the presence of synthetic toxic substances in food. Of course, there is a rich international scientific literature on such issues.[10,12,18–24]

Therefore, the main aim of the study was to explore factors influencing perceptions and views on the responsibility for the presence of toxic substances in food, on *enforcement* of laws and regulations that control human exposure to toxic substances in food, and on the effectiveness of such regulations.

Materials and methods

Study population and opinion survey

This is a cross-sectional study in which an online survey was the main methodological tool. Based on the theoretical framework, and findings from the first phase, of an ongoing research project on sociocultural dimensions of human contamination by persistent toxic substances and other environmental chemical agents,[12,16,17] we designed the online survey "Presence of toxic substances and confidence in food products" (see Appendix 1 online). The Internet platform used was Surveymonkey,[25] and the survey was available to be answered from 15th to 31st May 2013. A short informative cover letter was followed by the informed consent, seven sociodemographic questions, 16 questions regarding knowledge, sources of information, perceptions and opinions about chemicals in food, and a final section for optional comments (see Appendix 1 online). The invitation to participate in the survey was made by snowball sampling via email.[26] The survey was initiated by 949 individuals, and 64 people (6.7%) did not proceed beyond informed consent (the first question, see Appendix 1 online). The present study is thus based on 885 individuals with at least sociodemographic information (Table 1). Of such 885 individuals, 740 (83.6%) answered all 24 questions, 94 (10.6%) only questions about personal characteristics, 38 (4.3%) responded until question 16, and 13 (1.5%) until question 20. People who did not answer all questions were older, had a lower level of formal education, and were more often pensioners or unemployed than the 740 subjects who completed the survey. As one of the purposes of the present study was to obtain information on the knowledge that participants had about the questions in the survey, we kept the maximum number of participants in each analysis.

Over 67% of 885 participants were women. The median age was 47 years, 69.9% had university studies, and 54.5% were employed by others (Table 1). Women were about two years younger, and had a slightly lower educational and occupational status than men. More than one third of respondents lived in the province of Barcelona, and 46% in parts of Spain other than those specifically mentioned in Table 1. For the classification of the occupation, the 10 categories of International Standard Classification of Occupations (ISCO)-08 (1996-2014) were used; in the analyses they were grouped into five categories (Table 1).

Main dependent and independent variables

The three main dependent variables of interest stemmed from three questions of the survey: question 14 ("The *responsibility* of the presence of toxic substances in food belongs to…"); question 15 ("In Spain, laws and regulations that control or should control human exposure to toxic substances are *enforced* in…"); and question 16 ("In Spain, laws and regulations that control or should control human exposure to toxic substances are *effective*") (see Appendix 1 online). Responses to question 14 on responsibility were classified in three groups, according to whether respondent held responsible *a)* between 0 and 3 of the 8 social groups; *b)* 4 to 5 social groups; and *c)* respondents that held responsible 6 to 8 social groups. Responses to question 15 on enforcement were classified in four groups: *a)* 'often', when the responses were mostly always or often; *b)* 'sometimes'; *c)* 'never', when they were mostly rarely or never; and *d)* 'do not know', when they were mostly "do not know". Responses to question 16 on effectiveness were "yes", "no" and "do not know" (see Appendix 1 online).

We created the variable 'main means of information' to consider combinations of responses to questions 9 ("work with or study toxic substances"), 10 ("frequency of consultation of information on toxic substances"), and 11 ("sources of information about toxic substances"). In this new variable, the category of 'experience' was for participants who worked with or studied toxic substances and, in addition, either *a)* consulted information often or sometimes from ≥2 different sources of information, except family and friends, or *b)* consulted information rarely but used three sources, except family and friends. The second category for the variable 'main means of information' was 'interested', and it included participants who did not work with or study toxic substances and *a)* consulted often or sometimes information about toxic substances from ≥2 sources of information, except family and friends, or *b)* consulted information rarely or never from 4 or 5 sources, family and friends included. The third category of 'main means of information' was 'little or not interested', and it grouped participants not classified in the other two categories.

Table 1
Sociodemographic characteristics by gender.

Sociodemographic characteristics	Total		Male		Female		p-value[a]
	N	(%)	N	(%)	N	(%)	
All participants	885	(100)	290	(32.8)	595	(67.2)	
Age (years)							
Mean ± SD	45.8 ± 11.9		47.0 ± 12.4		45.2 ± 11.7		0.035[b]
Median	47.0		48.0		46.0		0.045[c]
Educational level							<0.001
University	619	(69.9)	228	(78.6)	391	(65.7)	
Specialized technical training	108	(12.2)	21	(7.2)	87	(14.6)	
Secondary education	120	(13.6)	32	(11.0)	88	(14.8)	
Primary education	37	(4.2)	8	(2.8)	29	(4.9)	
Without formal education	1	(0.1)	1	(0.3)	0		
University	619	(69.9)	228	(78.6)	391	(65.7)	<0.001
Less than university	266	(30.1)	62	(21.4)	204	(34.3)	
Occupational status							0.006
Self-employed	115	(13.0)	43	(14.8)	72	(12.1)	
Employed by others	482	(54.5)	175	(60.3)	307	(51.6)	
Unemployed	79	(8.9)	25	(8.6)	54	(9.1)	
Retired	98	(11.1)	23	(7.9)	75	(12.6)	
Student and other situations	111	(12.5)	24	(8.3)	87	(14.6)	
Occupation[d]							<0.001
Directors, technicians and administrative staff	294	(33.2)	84	(29.0)	210	(35.3)	
Professional scientists and intellectuals	279	(31.5)	126	(43.4)	153	(25.7)	
Service and sales workers	39	(4.4)	9	(3.1)	30	(5.0)	
Agriculturist, trades andelementary occupations	57	(6.4)	19	(6.6)	38	(6.4)	
Currently not working	216	(24.4)	52	(17.9)	164	(27.6)	
Number of children							0.138
0	368	(41.6)	114	(39.3)	254	(42.7)	
1	157	(17.7)	47	(16.2)	110	(18.5)	
2	275	(31.1)	92	(31.7)	183	(30.8)	
≥3	85	(9.6)	37	(12.8)	48	(8.1)	
Residence							0.161
Province of Barcelona	326	(36.8)	109	(37.6)	217	(36.5)	
Catalonia, excluding province of Barcelona	63	(7.1)	14	(4.8)	49	(8.2)	
Community of Madrid	49	(5.5)	20	(6.9)	29	(4.9)	
Balearic Islands or Canary Islands	39	(4.4)	9	(3.1)	30	(5.0)	
Other parts of Spain	408	(46.1)	138	(47.6)	270	(45.4)	

SD: standard deviation.
[a] Unless otherwise specified, p value derived from Fisher's exact test (two-tail).
[b] Student's *t*-test (two-tail).
[c] Mann-Whitney's *U* test (two-tail).
[d] Groups from the International Standard Classification of Occupations (ISCO-08).

Responses to question 12, about the degree of toxicity for human health of different substances at high concentrations, were categorized according to the number of correct responses (0-4, 5-7, and 8-9); except for vitamin C and folic acid, all the other substances were considered potentially toxic at high body concentrations. When asked about the two most important factors for a substance to be toxic for human health (question 13), 87.9% of participants indicated the concentration of the substance in the body; 77.4%, the toxicity of the substance itself; 77.0%, frequency of exposure to the substance; 32.9%, tolerance to the substance; 31.4%, origin or source of exposure to the substance; and 29.6%, the route of entry into the body. We grouped the responses to question 13 according to the most common pairs of responses, and we show the three most common pairs of responses: frequency of exposure and body concentration (60.9% of responses included both factors), body concentration and toxicity of the substance itself (60.6% of responses), and frequency of exposure and toxicity of the substance (52.4%). Question 18–about the presence of toxic substances in different phases of the food chain–was categorized into 'food production, processing and distribution', 'only food production and processing', and 'other responses'. Question 19 inquired about the types of stores where the respondent expected to find foods containing higher concentrations of toxic substances; responses were categorized as: 'no stores' (no stores sell foods containing high concentrations of toxics), '1-2 food stores (neighbourhood shops included)', '1-2 food stores (neighbourhood shops not included)', and '3-4 food stores'. Answers to question 20 were categorized based on the number of health problems answered correctly (0-3, 4-5, and 6-7); all the 7 health problems were related with the presence of toxic substances in the food. Answers to question 21 were categorized in: 0-2, 3-4, and 5-6 factors answered correctly (all factors included in question 21 increased the likelihood of toxic substances being harmful to human health). Answers to question 22 on food groups were categorized in: 0-2, 3-5, and 6-7 food groups. Finally, question 23 on food packaging was categorized in 'cans and plastic' and 'other responses' (see Appendix 1 online).

Statistical analyses

Univariate statistics were computed as customary.[27,28] To assess differences on age by gender and by specific answers to questions of interest, Student's *t*-test, ANOVA, Kruskal-Wallis, and Mann-Whitney's U tests were used. Fisher's exact test for homogeneity was applied to assess the relationship between two categorical variables.[27,28] When a trend was observed, Mantel-Haenszel's χ^2 test for linear trend was used.

To estimate the magnitude of the associations between socioeconomic factors and the survey questions, and our three main questions of interest (on responsibility, enforcement, and effectiveness, see above), multivariate-adjusted odds ratios (ORs) and their corresponding 95% confidence intervals (95%CI) were calculated by unconditional logistic regression with progressive degrees of adjustment. [29] In the final analyses the perception of responsibility was dichotomously categorized (responsibility attributed to ≥6 vs. <6 social groups); enforcement was categorized in 'often' vs. other answers; and effectiveness in 'yes' vs. 'no or do not know'. The main effects of all predictors were independently explored in the base models, and final models were adjusted for age and gender.[28,29] Categorical ordinal variables were analysed for a linear dose-response relation through the multivariate analogue of Mantel's extension test; when a linear trend was not apparent, the probability test was used. The level of statistical significance was set at 0.05 and all tests are two tailed. Analyses were conducted using the Statistical Package for the Social Sciences (SPSS), version 18 (SPSS, Armonk, NY, USA, 2009), and R, version 3.2.1 (R Core Team, 2015).

Results

About 23% of the participants worked with or studied toxic substances. Sixty-three percent often or sometimes consulted information about toxic substances, and 75% received this information through mass media, among another sources (Table 2). When asked about the degree of toxicity of different substances at high body concentrations, 39% of participants (significantly more men than women) identified correctly all or almost all options (Table 2). Over 71% of men and 66% of women (p value = 0.008) identified the body concentration and the toxicity of the substance as the two most important factors for a substance to be toxic (Table 2).

Women held responsible a larger number of groups than men for the presence of toxic substances in food (p for trend = 0.032) (Table 2). Only 16.5% of respondents (significantly more men than women) considered that laws and regulations to control human exposure to toxic substances are effective. The information about toxic substances in food provided by clinicians, technicians, scientists or associations was considered of good quality by 609 subjects (80.9% of respondents), while only 19.1% deemed the information provided by the mass media of good quality (Table 2). Over 27% of women and 35% of men considered of good quality the information provided in the workplace (p value = 0.009). Of the 753 participants who answered the question about substances in food that may cause health problems, 278 (37%) identified correctly 6 to 7 such health problems (40% of women and 31% of men, p value = 0.044) (Table 2). Over 68% of participants (73% of women and 58% of men, p value <0.001) considered that cans and plastic food packaging may have adverse health effects. Over 87% of subjects (with no gender difference) answered it was possible that throughout their life they could have accumulated in their body toxic substances potentially dangerous to their health in the mid- or long-term (Table 2).

Regarding occupational status, the percentage of subjects who considered that laws and regulations on exposure to toxic substances are effective ranged from 10.5% among self-employed participants to 20% among subjects employed by others (i.e., low figures, and a difference of 10 percentage points only) (see Table I in Appendix 2 online). Almost 19% of participants who worked with or studied toxic substances and 16% of participants who did not work with or study responded that laws are effective. Half of participants who never sought information about toxics responded 'do not know' when asked about the effectiveness of regulations, whereas 68% of participants who sought it 'often or sometimes' considered regulations ineffective. Regulations were also deemed ineffective by over 65% of participants who considered that foods with higher concentrations of toxic substances are available in almost all types of food stores, of participants who identified correctly 6 to 7 health problems caused by toxic substances in food, and of participants who identified 6 to 7 food groups with concentrations of toxic substances harmful to human health.

Only 38% of participants considered that laws and regulations about toxic substances in food were 'often' enforced in the different parts of the food production chain, whereas 17% indicated that they 'never' were (see Table II in Appendix 2 online). 47% of men, 46% of participants employed by others, 41% of subjects that often consulted information about toxic substances, and 48% of individuals that considered that no stores sell food with high concentrations of toxics answered that regulations about toxic substances in food are 'often' enforced (all p values <0.001). Over 42% of participants who worked with or studied toxic substances and 37% of subjects who did not also considered that regulations are 'often' enforced.

Subjects who considered 6 to 8 social groups responsible for the presence of toxic substances in food answered in a lower proportion "do not know" to the question on the effectiveness of regulations (compared to subjects who considered responsible less than 6 groups). Subjects who held responsible less social groups also tended to consider that laws were effective (p value = 0.009) (Table 3). Regarding the relationship between law enforcement and effectiveness, 50% of subjects who answered that laws were always or often enforced and 76% of those who considered that sometimes they were, nevertheless answered that such laws were not effective. Over 65% of subjects who answered that laws were enforced rarely or never responded "do not know" when asked about the effectiveness of the laws (p value <0.001) (Table 3).

Multivariate analyses that adjusted for age and gender showed that consulting information about toxic substances was positively associated with attributing the responsibility for toxic substances in food to 6 or more social groups (vs. <6 social groups). Working with or studying toxic substances was not (Table 4). Subjects who often or sometimes consulted information were almost twice as likely to make such attribution as subjects who sought information rarely or never or did not know (OR = 1.92 for the adjusted model, p value = 0.001). Three other factors were even more strongly linked with attributing responsibility to 6 or more social groups: identifying more health problems that may be caused by such substances (OR for the upper category: 2.48); identifying correctly most factors that increase the likelihood of toxic substances in food being harmful to human health (OR: 2.86); and identifying more food groups with toxic concentrations harmful to human health (OR: 2.92). All p for trend <0.001 for these three factors. Such attribution was not more frequent among respondents who worked with or studied toxic substances (Table 4). Men without college education had an OR: 2.05 (95%CI: 1.03-4.09) (adjusted for age) of attributing the responsibility for toxic substances in food to 6 or more social groups (vs. <6 social groups) than men with college education.

Women were 40% less likely than men (OR: 0.60, p value = 0.001) to respond 'often' (vs. other answers) to the question on the frequency of law enforcement; and so were participants who identified more food groups with toxic concentrations potentially harmful to human health (see Table III in Appendix 2 online). In gender-stratified analyses, the responses of both women and men to question 22 on food groups with toxic substances were very similarly unrelated to responding 'often' (vs. other answers) to the question about the frequency of law enforcement (i.e., there was no effect modification by gender). By contrast, among men, an answer different to "yes" to question 24 about lifelong accumulation of toxic substances (vs. an affirmative answer) was associated (OR: 2.36; 1.08-5.14) with responding 'often' (vs. other answers) to the question about the frequency of law enforcement, whereas for women there was no significant relation.

Table 2
Responses to the main study questions about toxic substances by gender.

	Total		Male		Female		
	N	(%)	N	(%)	N	(%)	p-value[a]
All participants	885	(100)	290	(32.8)	595	(67.2)	
Work with or study toxic substances							0.853
Yes	183	(23.1)	66	(24.3)	117	(22.5)	0.595[b]
No	565	(71.4)	192	(70.6)	373	(71.9)	
Do not know	43	(5.4)	14	(5.1)	29	(5.6)	
Frequency of consultation of information on toxic substances							0.450
Often	180	(22.8)	63	(23.2)	117	(22.5)	0.604[c]
Sometimes	318	(40.2)	104	(38.2)	214	(41.2)	
Rarely	231	(29.2)	86	(31.6)	145	(27.9)	
Never	61	(7.7)	18	(6.6)	43	(8.3)	
Do not know	1	(0.1)	1	(0.4)	0		
Often and sometimes	498	(63.0)	167	(61.4)	331	(63.8)	0.536
Rarely and never and do not know	239	(37.0)	105	(38.6)	188	(36.2)	0.582[c]
Sources of information about toxic substances							
Mass media	593	(75.0)	200	(73.5)	393	(75.7)	0.545
Clinicians, technicians, scientists or associations	543	(68.6)	184	(67.6)	359	(69.2)	0.687
Government	178	(22.5)	70	(25.7)	108	(20.8)	0.128
Workplace	308	(38.9)	117	(43.0)	191	(36.8)	0.092
Family and friends	471	(59.5)	146	(53.7)	325	(62.6)	0.018
Main means of information							0.793
Experience	175	(22.1)	64	(23.5)	111	(21.4)	0.764[d]
Interest	254	(32.1)	86	(31.6)	168	(32.4)	
Little or no interest	362	(45.8)	122	(44.9)	240	(46.2)	
Number of correct answers about toxicity of certain substances[e]							0.003
0-4	66	(8.3)	11	(4.0)	55	(10.6)	
5-7	413	(52.2)	144	(52.9)	269	(51.8)	
8-9	312	(39.4)	117	(43.0)	195	(37.6)	
The two most important factors for a substance to be toxic for humans							
Frequency of exposure and body concentration	539	(68.1)	179	(65.8)	360	(69.4)	0.769
Body concentration and toxicity of the substance itself	536	(67.8)	194	(71.3)	342	(65.9)	0.008
Frequency of exposure and toxicity of the substance itself	464	(58.7)	162	(59.6)	302	(58.2)	0.173
Attribution of responsibility							0.032[i]
≤3 groups[f]	266	(34.6)	105	(39.3)	161	(32.1)	
4–5 groups[g]	318	(41.3)	107	(40.1)	211	(42.0)	
6–8 groups[h]	185	(24.1)	55	(20.6)	130	(25.9)	
Enforcement of laws							0.003
Often[j]	298	(38.8)	126	(47.2)	172	(34.3)	0.010[c]
Sometimes[k]	266	(34.6)	85	(31.8)	181	(36.1)	
Never[l]	131	(17.0)	39	(14.6)	92	(18.3)	
Do not know[m]	74	(9.6)	17	(6.4)	57	(11.4)	
Effectiveness of laws							<0.001
Yes	127	(16.5)	71	(26.6)	56	(11.2)	<0.001[c]
No	453	(58.9)	137	(51.3)	316	(62.9)	
Do not know	189	(24.6)	59	(22.1)	130	(25.9)	
Good quality of information by source							
Mass media	144	(19.1)	48	(18.5)	96	(19.4)	0.923
Clinicians, technicians, scientists or associations	609	(80.9)	207	(79.9)	402	(81.4)	0.279
Government	229	(30.4)	84	(32.4)	145	(29.4)	0.164
Workplace	228	(30.3)	91	(35.1)	137	(27.7)	0.009
Family and friends	195	(25.9)	59	(22.8)	136	(27.5)	0.437
More presence of toxic substances in							
Food production, processing and distribution	189	(25.1)	45	(15.5)	144	(24.2)	<0.001
Only food production and processing	435	(57.8)	169	(58.3)	266	(44.7)	
Other responses	129	(17.1)	76	(26.2)	185	(31.1)	
Foods with higher concentrations of toxic substances are available in							0.749
No stores	118	(15.7)	45	(17.4)	73	(14.8)	
1-2 food stores (neighbourhood shops included)	102	(13.5)	32	(12.4)	70	(14.2)	
1-2 food stores (neighbourhood shops not included)	230	(30.5)	77	(29.7)	153	(31.0)	
3-4 food stores	303	(40.2)	105	(40.5)	198	(40.1)	
Toxic substances in food may cause health problems							0.044
0-3 problems identified correctly	200	(26.6)	76	(29.3)	124	(25.1)	
4-5 problems identified correctly	275	(36.5)	103	(39.8)	172	(34.8)	
6-7 problems identified correctly	278	(36.9)	80	(30.9)	198	(40.1)	

Table 2
(*Continued*)

	Total		Male		Female		
	N	(%)	N	(%)	N	(%)	p-value[a]
Factors that increase the likelihood of toxic substances in food being harmful to human health							0.800
0-2 factors identified correctly	179	(24.2)	58	(23.0)	121	(24.8)	
3-4 factors identified correctly	393	(53.1)	138	(54.8)	255	(52.3)	
5-6 factors identified correctly	168	(22.7)	56	(22.2)	112	(23.0)	
Food groups with concentrations of toxic substances harmful to health							0.394
0-2 food groups	125	(16.9)	49	(19.4)	76	(15.6)	
3-5 food groups	349	(47.2)	117	(46.4)	232	(47.5)	
6-7 food groups	266	(35.9)	86	(34.1)	180	(36.9)	
Food packaging that may contain substances potentially toxic to health							<0.001
Cans and plastic	504	(68.1)	146	(57.9)	358	(73.4)	
Other responses	236	(31.9)	106	(42.1)	130	(26.6)	
Throughout life you may have accumulated toxic substances potentially harmful to your health							0.907
Yes	648	(87.6)	220	(87.3)	428	(87.7)	
No or do not know	92	(12.4)	32	(12.7)	60	(12.3)	

[a] Unless otherwise specified, p-value derived from Fisher's exact test (two-tail).
[b] Work with/study toxic substances in two categories, "Yes" and "No or do not know".
[c] Excluding the "do not know".
[d] Main means of information in two categories, "Informed by experience or interest" and "Little or no interest".
[e] Number of correct answers about toxicity degree for human health of certain substances at high body concentrations.
[f] Individuals who held responsible of the presence of toxic substances in food between 0 and 3 of the 8 social groups of the question.
[g] Individuals who held responsible 4 to 5 social groups.
[h] Individuals who held responsible 6 to 8 social groups.
[i] Mantel-Haenszel's χ^2 test for linear trend.
[j] Individuals who consider that the laws and regulations are always or often enforced.
[k] Individuals who consider that the laws and regulations are enforced occasionally.
[l] Individuals who consider that the laws and regulations are rarely or never enforced.
[m] Individuals who do not know if laws and regulations are enforced.

Table 3
Relationship between the attribution of responsibility and the enforcement of laws, and the effectiveness of laws.

	Effectiveness of laws						
	Yes		No		Do not know		
	N	(%)	N	(%)	N	(%)	p-value[a]
All participants	127	(16.5)	453	(58.9)	189	(24.6)	
Attribution of responsibility							0.009
≤3 groups[b]	52	(19.5)	135	(50.8)	79	(29.7)	
4-5 groups[c]	44	(13.8)	198	(62.3)	76	(23.9)	
6-8 groups[d]	31	(16.8)	120	(64.9)	34	(18.4)	
Enforcement of laws							<0.001
Often[e]	96	(32.2)	149	(50.0)	53	(17.8)	
Sometimes[f]	21	(7.9)	202	(75.9)	43	(16.2)	
Never[g]	7	(5.3)	38	(29.0)	86	(65.6)	
Do not know[h]	3	(4.1)	64	(86.5)	7	(9.5)	

Total N = 769.
[a] Fisher's exact test (two-tail).
[b] Individuals who held responsible of the presence of toxic substances in food between 0 and 3 of the 8 social groups of the question.
[c] Individuals who held responsible 4 to 5 social groups.
[d] Individuals who held responsible 6 to 8 social groups.
[e] Individuals who consider that the laws and regulations are always or often enforced.
[f] Individuals who consider that the laws and regulations are enforced sometimes.
[g] Individuals who consider that the laws and regulations are rarely or never enforced.
[h] Individuals who do not know if laws and regulations are enforced.

Women were 65% less likely than men to answer that regulations about toxics in food are effective (OR: 0.35; p-value <0.001) (Table 5). The corresponding age- (and in these instances, sex-) adjusted OR for participants employed by others (vs. self-employed) was 2.17 (1.10-4.27); for participants informed by experience or interest (vs. little or not interested), it was 1.53 (1.03-2.29); and for subjects who answered that laws were enforced sometimes or never (vs. always/often), they were 0.19 (0.11-0.32) and 0.13 (0.06-0.28), respectively. Considering that foods with higher concentrations of toxic substances are available in more types of food stores was also inversely associated with responding that laws were effective (Table 5). Such judgements about law effectiveness were generally not associated with working or studying toxic substances. The only exception was: the attribution of responsibility to more groups was inversely related to responding that laws were effective among subjects who worked or studied toxic substances (OR: 0.27; 0.08-0.89), whereas it was positively related to responding that laws were effective among subjects who did not work or study such substances (OR: 1.59; 0.87-2.90).

Table 4
Associations between sociodemographic characteristics and questions about toxic substances, and attributing responsibility for the presence of toxic substances in food to 6 or more social groups (vs. <6 social groups).

	OR[a]	(95% CI)	p-value[b]
Age (years)	0.99	(0.97-1.00)	0.072
Gender			
Male	1.00	Ref	0.148
Female	1.30	(0.91-1.87)	
Occupational status			
Self-employed	1.00	Ref	0.027
Employed by others	0.58	(0.36-0.91)	
Unemployed	0.45	(0.22-0.93)	
Retired	0.84	(0.42-1.69)	
Student and other situations	0.37	(0.19-0.73)	
Work with or study toxic substances			
Yes	1.00	Ref	0.169
No or do not know	0.77	(0.52-1.12)	
Frequency of consultation of information about toxic substances			
Rarely or never or do not know	1.00	Ref	0.001
Often or sometimes	1.92	(1.32-1.85)	
Main means of information			
Little or no interest	1.00	Ref	0.009
Informed by experience or interest	1.58	(0.91-1.88)	
More presence of toxic substances in			
Food production, processing and distribution	1.00	Ref	<0.001
Only food production and processing	0.39	(0.26-0.57)	
Other responses	0.41	(0.24-0.67)	
Foods with higher concentrations of toxic substances are available in			
No stores	1.00	Ref	0.003
1-2 food stores (neighbourhood shops included)	1.27	(0.64-2.53)	
1-2 food stores (neighbourhood shops not included)	1.29	(0.72-2.32)	
3-4 food stores	2.26	(1.30-3.91)	
Toxics in food may cause			
0-3 health problems	1.00	Ref	<0.001[c]
4-5 health problems	1.24	(0.77-2.00)	
6-7 health problems	2.48	(1.58-3.89)	
Factors that increase the likelihood of toxic substances in food being harmful to health			
0-2 factors identified correctly	1.00	Ref	<0.001[c]
3-4 factors identified correctly	1.32	(0.84-2.09)	
5-6 factors identified correctly	2.86	(1.73-4.70)	
Food groups with concentrations of toxic substances harmful to health			
0-2 food groups	1.00	Ref	<0.001[c]
3-5 food groups	1.29	(0.74-2.26)	
6-7 food groups	2.92	(1.68-5.06)	

OR: odds ratio; CI: confidence interval; Ref: reference category (OR: 1.00).
[a] All models adjusted for age and gender.
[b] Unless otherwise specified, p-value derived from Wald's test.
[c] Test for linear trend (multivariate analogue of Mantel's extension test).

Discussion

We found several statistically significant and socially relevant associations; notably, attributing the responsibility for toxic substances in food to a larger number of social groups was more frequent among subjects who consulted information about the problem more often, who correctly identified factors that increase the likelihood of toxic substances in food being harmful to human health, who better knew the health problems caused by such substances, and who recognized more food groups that tend to have concentrations of toxic substances harmful to human health; such attribution was not more frequent among respondents who worked or studied toxic substances. Women were significantly less likely than men to respond that laws and regulations are often enforced; and so were participants who identified more food groups with potentially toxic concentrations. Women were also significantly less likely than men to respond that regulations about toxics in food are effective. With due caution, it seems reasonable to suggest that some of the observed associations between factors might also exist in the general population, although probably with some differences in magnitude.

However, the study was not based on a representative sample of the general population due to the sampling design and, therefore, results should not be generalized to the general population of Spain; in particular, the univariate and bivariate results summarized in Table 2. Within the same theoretical framework, the study design and results complement our previous qualitative studies.[12,16,17] Although we did not target for participation any specific group of people, a portion of respondents was probably comprised by citizens concerned about the study issues, and by subjects with college education. Yet, the majority of respondents were unlikely to be experts (e.g., when asked about the degree of toxicity for human health of different substances at high body concentrations, only 39% of participants answered correctly all or almost all options). Also, the educational level was not an important predictor of responses when age and gender were also considered.

Table 5
Associations between sociodemographic characteristics and questions about toxic substances, and the probability of answering that laws are effective (vs. "no or do not know").

	OR[a]	(95%CI)	p-value[b]
Age (years)	1.00	(0.99−1.02)	0.621
Gender			
Male	1.00	Ref	<0.001
Female	0.35	(0.24-0.52)	
Occupational status			
Self-employed	1.00	Ref	0.097
Employed by others	2.17	(1.10-4.27)	
Unemployed	1.16	(0.44-3.09)	
Retired	1.49	(0.57-3.92)	
Student and other situations	1.39	(0.56-3.47)	
Work with or study toxic substances			
Yes	1.00	Ref	0.375
No or do not know	0.82	(0.52-1.28)	
Frequency of consultation of information of toxic substances			
Rarely or never or do not know	1.00	Ref	0.704
Often or sometimes	0.93	(0.62-1.38)	
Main means of information			
Little or no interest	1.00	Ref	0.036
Informed by experience or interest	1.53	(1.03-2.29)	
Attribution of responsibility			
≤3 groups[c]	1.00	Ref	0.264
4-5 groups[d]	0.70	(0.45-1.09)	
6-8 groups[e]	0.93	(0.56-1.54)	
Enforcement of laws			
Often[f]	1.00	Ref	<0.001[j,k]
Sometimes[g]	0.19	(0.11-0.32)	
Never[h]	0.13	(0.06-0.28)	
Do not know[i]	0.10	(0.03-0.33)	
More presence of toxic substances in			
Food production, processing and distribution	1.00	Ref	0.150
Only food production and processing	0.93	(0.56-1.52)	
Other responses	1.49	(0.83-2.66)	
Foods with higher concentrations of toxic substances are available in			
No stores	1.00	Ref	0.014
1-2 food stores (neighbourhood shops included)	0.57	(0.29-1.11)	
1-2 food stores (neighbourhood shops not included)	0.41	(0.23-0.73)	
3-4 food stores	0.48	(0.29-0.82)	
Toxic substances in food may cause			
0-3 health problems	1.00	Ref	0.891[j]
4-5 health problems	0.98	(0.60-1.61)	
6-7 health problems	0.97	(0.58-1.60)	
Factors that increase the likelihood of toxic substances in food being harmful to human health			
0-2 factors identified correctly	1.00	Ref	0.514[j]
3-4 factors identified correctly	0.85	(0.53-1.36)	
5-6 factors identified correctly	0.83	(0.47-1.48)	
Food groups with harmful concentrations of toxic substances			
0-2 food groups	1.00	Ref	0.141[j]
3-5 food groups	0.88	(0.52-1.49)	
6-7 food groups	0.67	(0.38-1.18)	

OR: odds ratio; CI: confidence interval; Ref: reference category (OR: 1.00).
[a] Adjusted for age and gender.
[b] Unless otherwise specified, p-value derived from Wald's test.
[c] Individuals who held responsible of the presence of toxic substances in food between 0 and 3 of the 8 social groups of the question.
[d] Individuals who held responsible 4 to 5 social groups.
[e] Individuals who held responsible 6 to 8 social groups.
[f] Individuals who consider that the laws and regulations are always or often enforced.
[g] Individuals who consider that the laws and regulations are enforced occasionally.
[h] Individuals who consider that the laws and regulations are rarely or never enforced.
[i] Individuals who do not know if laws and regulations are enforced.
[j] Test for linear trend (multivariate analogue of Mantel's extension test).
[k] Excluding the "do not know".

Associations were similar among participants who worked with or studied toxic substances than in participants who did not. The present study and project[12,16,17] provide a basis for new and more complex studies, which could use representative samples of the general population or target specific subgroups through qualitative and quantitative methodologies.

Even if clearly not stemming from a representative sample, in our view results do provide 'food for thought': to authorities (notably, those whose policies influence public health, the safety of food and related consumer products, or chemical hazards), industries (agriculture, chemistry, food processing and packaging, distribution, marketing), social organisations, and other citizens. In the societal sectors reflected in the study, there seems to be a rather wide scepticism and distrust towards the enforcement and effectiveness of regulations that control or should control human exposure to toxic substances in food. Over 58% of participants responded that laws and regulations are not effective. And more than 87% said it was possible that throughout their life they could have accumulated substances potentially dangerous to their health; this proportion was identical in women and men.

We are not aware of the existence of survey questionnaires validated to address the specific study questions. The accuracy, reliability, reproducibility, interpretability, and other properties[26] of the questionnaire used in the study were untested, and this is another study limitation. Nevertheless, no major inconsistencies were apparent; e.g., half of participants who never sought information about toxics responded 'do not know' when asked about the effectiveness of regulations, whereas most participants who sought it 'often or sometimes', but not all, considered regulations ineffective. It is also important to notice that some of the issues assessed in the survey are quite novel in Spain and other countries; thus, a sizable number of study participants (from about 0.1% to 38%) answered "do not know" to some questions. Over 45% of participants reported having little knowledge on synthetic toxic substances, their presence in food, and their possible health effects. Between 22% and 37% of participants identified correctly health problems that toxic substances in food may cause, and factors that increase the likelihood of toxic substances in food being harmful to human health.

When assessing the limitations and strengths of the present study it should be noted that it is part of a research project that has already published a synthesis of its theoretical framework and initial results from a qualitative ethnoepidemiologic study.[12,16,17] Social processes of perceiving, facing, attributing meaning, and coping with risk are diverse and multifaceted; and more complex than enabled by some frameworks, as Beck's 'risk society'.[12,16,19,30–35] While the survey was conducted some three years ago, we think the results reflect long-term and profound underlying processes in Spain's society, which did not materially change in recent years.

Women were significantly less likely than men to respond that laws and regulations about toxics in food are enforced and effective. Women also tended to attribute the responsibility of the presence of toxic substances in food to more groups than men, and they more frequently considered that the responsibility belonged to groups not involved in the food production chain. Men were less likely to identify correctly health problems that may be caused by toxic substances in food, but more likely to answer correctly the degree of toxicity of certain substances. Gender differences in risk perception have been described in numerous studies, with women more often reporting higher levels of concern, higher sensitivity and lower tolerance to risk than men.[18,20] The analysis of gender differences ought to take into account the sociocultural context and processes involved in this perception.[20]

Until a few decades ago, in the Western world most food problems were basically related to malnourishment, hunger, famine and the difficulties of achieving adequate nutrition due to food scarcity, plagues, and economic constraints.[21] Modern progress in feeding populations has been immense. However, this has not happened at zero cost: adverse health, social, and environmental consequences must be acknowledged.[11,36–38] Thus, our 'risk societies' have also long endured problems and reasonable concerns related to food and chemical risks, partly due to the vast industrialisation of food processing and the distance between food production and consumption.[12] Some studies focusing on social representations of food risks have unveiled rather negative perceptions of citizens about the dangers of technological interventions in food production at an industrial scale.[13] Some authors consider chemical hazards to human health as elements of risk safety.[7,22] Such hazards are partly seen to stem from the presence of synthetic chemical substances (as pesticides, growth control hormones, feed conversion enhancers and feed contaminants, or antibiotics) that pollute food during the processes of production, storage, packaging and distribution.[22] The literature also reflects positive views about agricultural successes, as well as social concerns about global poverty and undernutrition, or about social policies and individual behaviours to prevent obesity. Such views coexist – often, in a quite balanced and nuanced way – with the fact that for many people the presence of synthetic chemical compounds in processed food is also a problem.[23] For example, some studies show how people who experience chronic illnesses express a greater concern about man-made chemicals and toxic residues in food.[23]

Therefore, the scientific and social (un)certainties about the effects that some food contaminants can have on human health are part of contemporary debates on food (in)security; e.g., on the strengths and weaknesses of *glocal*[11,38–41] food systems. Such debates are also clearly related to economically- and culturally-shaped processes of risk perception and tolerance, the industrial scale of food processing, or a dysregulated globalisation of markets.[11–17] Discussions on social media and networks thus abound on highly relevant (both material and symbolic) issues as, for example, the socio-political causes of 'mad cow disease' (bovine spongiform encephalitis) or the effects of genetically modified organisms on human health and food sovereignty.[13,21,36–38,42] The frequent distrust of citizens in the production chain and its managers, or in regulatory agencies and institutions, is also partly due to actual shortcomings (e.g., failure to regulate conflicts of interests, 'revolving doors' and lobbying), and to the systems of risk communication, which have all significant impacts on the perception that consumers have about food benefits and risks.[14–17,22,24,36,43]

Hence, there currently is a broad shift from concerns basically focused on access to food, with quite a high level of tolerance to short-term microbiological risks and little regard for long-term risks, to other views which (though still worried about access to food) are more attentive to the possible negative health consequences of eating chemically contaminated foods.[11,13,24,44] In influential segments of many Western societies there is thus increasing awareness of such non-microbiological, multifactorial, cumulative, and long-term risks.[11,37,44] Such realities also imply changes in the relationships of trust on food governance of citizens and societal organisations towards institutions and companies.[19,24,44] Food safety and public health authorities also ought to ponder the study findings.

Conclusions

Among study participants there was a rather wide concern about chemical contaminants in food, and distrust towards the enforcement and effectiveness of regulations that in Spain should control exposure to toxic substances in food. Respondents had a low level of trust on the results of the work performed by the different societal actors, companies, and institutions that must protect citizens from

the potential adverse health effects of synthetic chemicals that are often present in food products.

What is known about the topic?

In Spain only some scientific studies exist on views, perceptions, attitudes, and behaviours of citizens related to food safety, and few studies have specifically addressed citizens' views on the causes and consequences of the presence of synthetic toxic substances in food.

What does this study add to the literature?

The study shows a wide concern about food chemical contaminants, and distrust towards the enforcement and effectiveness of regulations that in Spain should control human exposure to toxic substances in food. Citizens' organizations, companies, and institutions–particularly, food safety and public health authorities–should take into account the study findings to reassess their current policies.

Editor in charge

Cristina Linares Gil.

Transparency declaration

The corresponding author on behalf of the other authors guarantee the accuracy, transparency and honesty of the data and information contained in the study, that no relevant information has been omitted and that all discrepancies between authors have been adequately resolved and described.

Authorship contributions

M. Porta, C. Larrea and A. Muñoz conceived and designed the study, with assistance from J. Pumarega and M. Gasull. J. Pumarega, M. Jariod, G. Rodriguez, and N. Pallarès carried out the analyses, supervised by M. Porta, with contributions from all other authors. All authors participated in the interpretation of results. The main versions of the manuscript were written by M. Porta and J. Pumarega, with contributions from all other authors. All authors approved the final version and are jointly responsible for adequate revision and discussion of all aspects included in the manuscript.

Acknowledgements

The authors gratefully acknowledge scientific advice and technical assistance provided by members of the "Toxic Body" Research Group of the Food Observatory of the University of Barcelona (ODELA), as well as by Francisco Lupiáñez-Villanueva, Tomàs López and Yolanda Rovira.

Funding

This study is part of the interdisciplinary project "Cuerpos Tóxicos y Etnoepidemiología Sociocultural de la Contaminación Interna por Compuestos Tóxicos Persistentes (CTP) en España" ("Toxic Bodies and Sociocultural Ethnoepidemiology of the Internal Contamination by Persistent Toxic Substances in Spain"), led by C. Larrea and M. Porta, partly funded by Programa Nacional de Proyectos de Investigación Fundamental (National Programme for Fundamental Research Projects), Ministry of Science and Innovation, Spain (CSO 2010/18661). Funding was also provided by research grants from Instituto de Salud Carlos III–FEDER (FIS PI13/00020 and CIBER de Epidemiología y Salud Pública – CIBERESP), Government of Spain; the Hospital del Mar Medical Research Institute (IMIM), Barcelona; the Government of Catalonia (2009 SGR 1350 and 2014 SGR 1012); and Fundació La Marató de TV3 (20132910).

Conflicts of interest

None.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.gaceta.2017.03.012.

References

1. Prüss-Ustün A, Vickers C, Haefliger P, et al. Knowns and unknowns on burden of disease due to chemicals: a systematic review. Environ Health. 2011;10:9 (Accessed on 28 March 2017.) Available at: https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-10-9
2. World Health Organization. In: Bergman Å, Heindel JJ, Jobling S, et al., editors. State of the science of endocrine disrupting chemicals–2012. Geneva: United Nations Environment Programme and the World Health Organization; 2013, 296 p. (Accessed on 28 March 2017.) Available at: http://www.who.int/ceh/publications/endocrine/en/
3. Vandenberg LN, Colborn T, Hayes TB, et al. Hormones and endocrine-disrupting chemicals: low-dose effects and nonmonotonic dose responses. Endocr Rev. 2012;33:378–455.
4. Department of Health and Human Services. National report on human exposure to environmental chemicals. Atlanta: Centers for Disease Control and Prevention; 2009 (Accessed on 28 March 2017.) Available at: http://www.cdc.gov/exposurereport/index.html
5. Den Hond E, Govarts E, Willems H, et al. First steps toward harmonized human biomonitoring in Europe: demonstration project to perform human biomonitoring on a European scale. Environ Health Perspect. 2015;123:255–63.
6. Ibarluzea J, Aurrekoetxea JJ, Porta M, et al. La biomonitorización de sustancias tóxicas en muestras biológicas de población general. Gac Sanit. 2016;30 (Supl 1):45–54.
7. Muncke J, Myers JP, Scheringer M, et al. Food packaging and migration of food contact materials: will epidemiologists rise to the neotoxic challenge? J Epidemiol Community Health. 2014;68:592–4.
8. Aylward LL, Green E, Porta M, et al. Population variation in biomonitoring data for persistent organic pollutants (POPs): an examination of multiple population-based datasets for application to Australian pooled biomonitoring data. Environ Int. 2014;68:127–38.
9. Pumarega J, Gasull M, Lee DH, et al. Number of persistent organic pollutants detected at high concentrations in blood samples of the United States Population. PLoS One. 2016;1:e0160432 (Accessed on 28 March 2017.) Available at: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0160432
10. Domingo JL, Martí-Cid R, Castell V, et al. Human exposure to PBDEs through the diet in Catalonia, Spain: temporal trend. A review of recent literature on dietary PBDE intake. Toxicology. 2008;248:25–32.
11. Porta M, Puigdomènech E, Ballester F, editors. Nuestra contaminación interna: concentraciones de compuestos tóxicos persistentes en la población española. Madrid: Los Libros de la Catarata; 2009, 264 p.
12. Larrea-Killinger C, Muñoz A, Mascaró J, et al. Discourses on the toxic effects of internal chemical contamination in Catalonia, 36. Spain: Med Anthropol; 2017. p. 125–40 (Accessed on 28 March 2017.) Available at: http://dx.doi.org/10.1080/01459740.2016.1182999
13. Contreras J, Gracia M. Alimentación y cultura. Perspectivas antropológicas. Barcelona: Ariel; 2005, 505 p.
14. Cáceres J, Espeitx E. Exploración de las percepciones sociales sobre la seguridad alimentaria en Cataluña. Barcelona: Agència Catalana de Seguretat Alimentària, Generalitat de Catalunya; 2007 (Accessed on 28 March 2017.) Available at: http://acsa.gencat.cat/web/.content/Documents/eines_i_recursos/estudi_acsa.pdf
15. Espeitx E, Medina FX, Cantarero L, et al. Alimentarnos o desalimentarnos: representaciones sociales sobre toxicidad y nuevas tecnologías alimentarias. Quaderns-e de l'Institut Català d'Antropologia. 2013;18:201–16 (Accessed on 28 March 2017.) Available at: http://raco.cat/index.php/QuadernselCA/article/view/274304/362370
16. Begueria A, Larrea C, Muñoz A, et al. Social discourses concerning pollution and contamination in Spain: an analysis of online comments by digital press readers. Contributions to Science. 2014;10:35–47 (Accessed on 28 March 2017.) Available at: http://revistes.iec.cat/index.php/CtS/article/view/136947/135666

and http://issuu.com/institut-destudis-catalans/docs/cs10-1_tot_7.8mb_?e=0/14441827
17. Muñoz A, Larrea C, Zafra E, et al. Las responsabilidades sobre las sustancias químicas y los compuestos tóxicos persistentes (CTP): una perspectiva antropológica sobre los riesgos. In: Periferias, fronteras y diálogos, editor. Actas del XIII Congreso de Antropología de la Federación de Asociaciones de Antropología del Estado Español. Tarragona: Universitat Rovira i Virgili; 2014. p. 4386–406 (Accessed on 28 March 2017.) Available at: http://digital.publicacionsurv.cat/index.php/purv/catalog/book/123
18. Barrett ES, Sathyanarayana S, Janssen S, et al. Environmental health attitudes and behaviors: findings from a large pregnancy cohort study. Eur J Obstetric Gynecol Repr Biol. 2014;176:119–25.
19. Jensen M, Blok A. Pesticides in the risk society: the view from everyday life. Current Sociology. 2008;56:757–78.
20. Hitchcock JL. Gender differences in risk perception: broadening the contexts. Risk Health Safety Environ. 2001;12:179–204.
21. Knox B. Consumer perception and understanding of risk from food. Br Med Bull. 2000;56:97–109.
22. Yeung RMW, Morris J. Food safety risk. Br Food J. 2001;103:170–87.
23. Lupton DA. Lay discourses and beliefs related to food risks: an Australian perspective. Sociol Health Illness. 2005;27:448–67.
24. Devaney L. Good governance? Perceptions of accountability, transparency and effectiveness in Irish food risk governance. Food Policy. 2016;62:1–10.
25. Surveymonkey. (Accessed on 28 March 2017.) Available at: https://es.surveymonkey.com
26. Porta M, editor. A dictionary of epidemiology. 6th ed. New York: Oxford University Press; 2014. p. 376 p.
27. Armitage P, Berry G, Matthews JNS. Statistical methods in medical research. 4th ed. Blackwell: Oxford; 2002, 832 p.
28. Kleinbaum DG, Kupper LL, Muller KE, et al. Applied regression analysis and other multivariable methods. 3rd ed. CA: Pacific Grove: Duxbury; 1998, 798 p.
29. Rothman KJ, Greenland S, Lash TL, editors. Modern epidemiology. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2008, 758 p.
30. Beck U. Risk society: towards a new modernity. London: Sage; 1992, 272 p.
31. Beck U. Políticas ecológicas en la edad del riesgo. Barcelona: El Roure; 1998, 365 p.
32. Flynn R. Health and risk. In: Mythen G, Walklate S, editors. Beyond the risk society: critical reflections on risk and human security. Maidenhead: Open University Press; 2006. p. 77–95.
33. Giddens A. Modernity and self-identity: self and society in the late modern age. Cambridge: Polity Press; 1991, 256 p.
34. Luhmann N. Risk: a sociological theory. Berlin: Walter de Gruyter; 1993, 236 p.
35. Lupton D, editor. Risk and sociocultural theory: new directions and perspectives. Cambridge: Cambridge University Press; 1999, 191 p.
36. Moodie R, Stuckler D, Monteiro C, et al. Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. Lancet. 2013;381:670–9.
37. Porta M. Bovine spongiform encephalopathy, persistent organic pollutants and the achievable utopias. J Epidemiol Community Health. 2002;56:806–7.
38. Porta M. Persistent toxic substances: exposed individuals and exposed populations. J Epidemiol Community Health. 2004;58:534–5.
39. Kickbusch I. Global+local=glocal public health. J Epidemiol Community Health. 1999;53:451–2.
40. Milne EM. Governance for health -grasping at the levers of glocal health. Public Health. 2015;129:870–1.
41. Porta M, Kogevinas M, Zumeta E, et al. Concentraciones de compuestos tóxicos persistentes en la población española: el rompecabezas sin piezas y la protección de la salud pública. Gac Sanit. 2002;16:257–66.
42. Porta M, Álvarez-Dardet C. Epidemiology: bridges over (and across) roaring levels. J Epidemiol Community Health. 1998;52:605.
43. Robinson C, Holland N, Leloup D, et al. Conflicts of interest at the European Food Safety Authority erode public confidence. J Epidemiol Community Health. 2013;67:717–20.
44. Callejo J. La reorganización del sistema de confianza tras la crisis: el proceso en el campo de la alimentación. Rev Esp Sociol. 2009;12:39–65.