Workshop "Designing an Epidemiological Study on PFAS Exposed Population in Veneto Region" Venice, 22–23 February 2017

Human Biomonitoring of Perfluorinated Substances (PFAS) in Population Groups of the Veneto Region

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The Human Biomonitoring Study

The HBM study was proposed and carried out under the agreement "Accordo di collaborazione tra Istituto Superiore di Sanità e Regione Veneto (2014 - 2017)" when it became evident that people living in some areas of the Province of Vicenza had been exposed to PFAS through consumption of contaminated water

It was designed to assess PFAS internal dose in subjects living in areas where contamination had occurred vs/ subjects living in "control areas" of the same Province at presumed background contamination level

The study, started in 2015 and still ongoing, was carried out by ISS with support from the Veneto Region and in strict collaboration with the local health and social care structures ULSS 5, 6, 8, 9, 15 e 22

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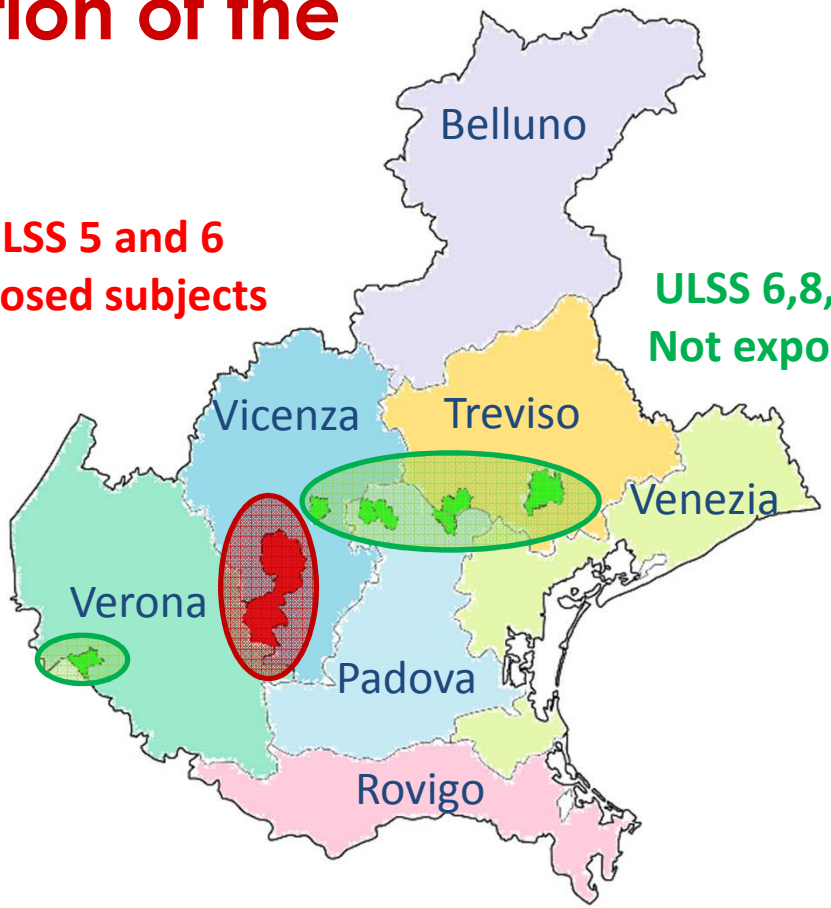
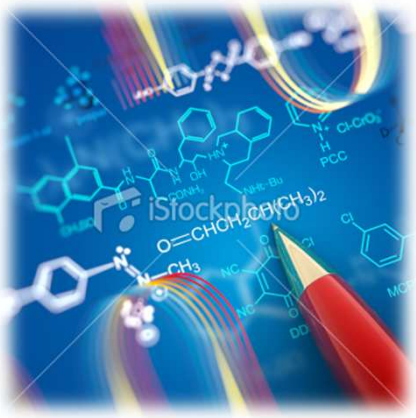
Study design: selection of the areas

ULSS 5 and 6
Exposed subjects

ULSS 6,8,9,15 and 22
Not exposed subjects



Comuni selezionati	
Area di Impatto	Area di controllo
Montecchio Maggiore, Lonigo, Brendola, Creazzo, Altavilla, Sovizzo, Sarego	Mozzecane, Dueville, Carmignano, Fontaniva, Loreggia, Resana, Treviso



Study design: selection of subjects

General population

- Subjects residing in areas where drinking water contamination had occurred (Exposed subjects)
- Subjects residing in areas where no contamination of drinking water had been documented (Comparison Group, Not exposed subjects)

480 subjects

Farmers

Subjects working in and/or residing in farms in areas where water contamination had occurred

120 subjects

The general population

480 subjects
(507 enrolled)

240 exposed
(257 enrolled)

- females
  - Age 20-29 years
  - Age 30-39 years
  - Age 40-50 years
- males
  - Age 20-29 years
  - Age 30-39 years
  - Age 40-50 years

240 not exposed
(250 enrolled)

- females
  - Age 20-29 years
  - Age 30-39 years
  - Age 40-50 years
- males
  - Age 20-29 years
  - Age 30-39 years
  - Age 40-50 years

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The Farmers

120 subjects

- 60 females
  - 20 age 20-29 years
  - 20 age 30-39 years
  - 20 age 40-50 years
- 60 males
  - 20 age 20-29 years
  - 20 age 30-39 years
  - 20 age 40-50 years

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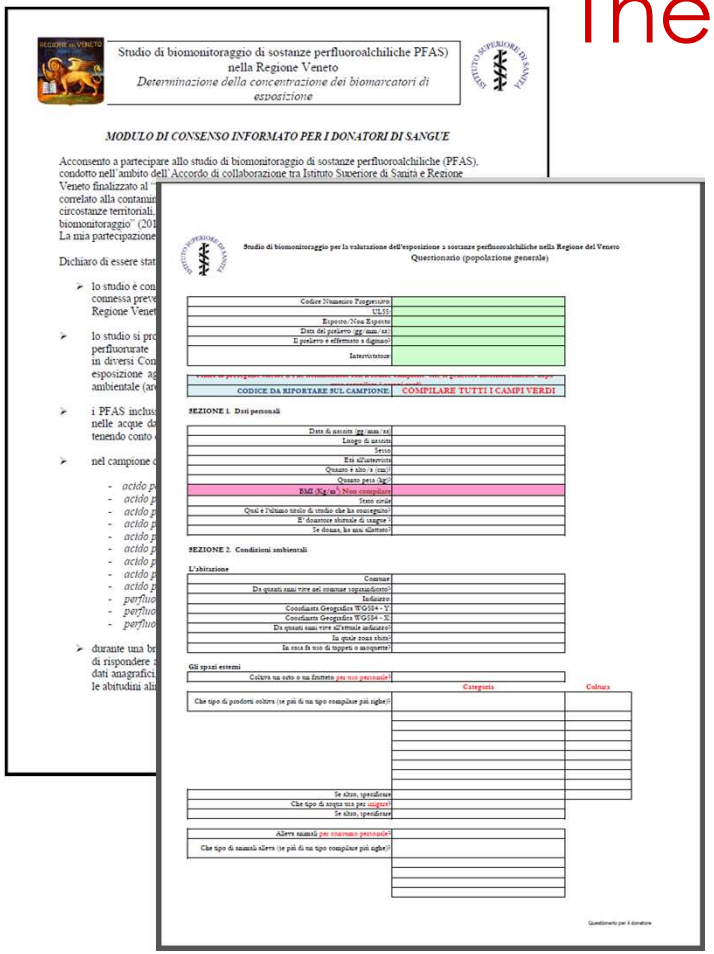
The Questionnaire


Studio di biomonitoraggio di sostanze perfluoroalchiliche PFAS) nella Regione Veneto
Determinazione della concentrazione dei biomarcatori di esposizione

MODULO DI CONSENSO INFORMATO PER I DONATORI DI SANGUE

Acconsento a partecipare allo studio di biomonitoraggio di sostanze perfluoroalchiliche (PFAS), condotto nell'ambito dell'Accordo di collaborazione tra Istituto Superiore di Sanità e Regione Veneto finalizzato al

Studio di biomonitoraggio per la valutazione dell'esposizione a sostanze perfluoroalchiliche nella Regione del Veneto
Questionario (popolazione generale)

Codice Numerico Progressivo	
ULSS	
Esposto/Non Esposto	
Data del prelievo (gg/mm/aa)	
Il prelievo è effettuato a digiuno?	
Intervistatore	

CODICE DA RIPORTARE SUL CAMPIONE	COMPILARE TUTTI I CAMPI VERDI

SEZIONE 1. Dati personali

Data di nascita (gg/mm/aa)	
Luogo di nascita	
Sesso	
Età all'intervista	
Quanto è alto/a (cm)?	
Quanto pesa (kg)?	
BMI (Kg/m²) Non compilare	
Stato civile	
Qual è l'ultimo titolo di studio che ha conseguito?	
E' donatore abituale di sangue ?	
Se donat, ha mai allattato?	

SEZIONE 2. Condizioni ambientali

L'abitazione

Comune	
Da quanti anni vive nel comune sopradetto?	
Indirizzo	
Coordinata Geografica WGS84 - Y	
Coordinata Geografica WGS84 - X	
Da quanti anni vive all'attuale indirizzo?	
In quale zona abita?	
In casa fa uso di tappeti o anaquette?	

Gli spazi esterni

Coltiva un orto o un frutteto per uso personale?	

Che tipo di prodotti coltiva (se più di un tipo compilare più righe)?	Categoria	Coltura

Se altro, specificare	
Che tipo di acqua usa per irrigare?	
Se altro, specificare	

Alleva animali per consumo personale?	
Che tipo di animali alleva (se più di un tipo compilare più righe)?	

Questionario per il donatore

The study was approved by the local Ethical Committees and each participant signed an informed consent

Enrollment began in July 2015 and was completed in April 2016

Enrollment of farmers was completed in early 2017

Questionnaire with questions on anthropometric and socio-demographic characteristics, lifestyle, use of water, drinking-water consumption and dietary habits was administered to each participant

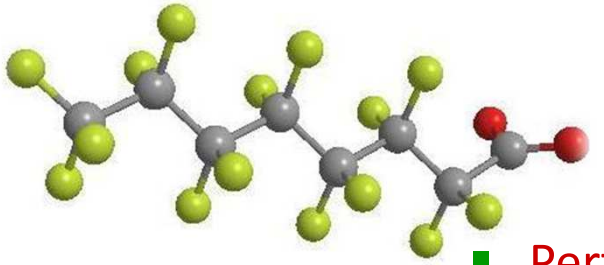
Analysis

Spiking

Extraction

Instrumental analysis

HPLC-MS/MS



- Perfluorobutanoic Acid (PFBA)
- Perfluoropentanoic Acid (PFPeA)
- Perfluorohxanoic Acid (PFHxA)
- Perfluoroheptanoic Acid (PFHpA)
- Perfuorooctanoic Acid (PFOA)
- Perfuorononanoic Acid (PFNA)
- Perfluorodecanoic Acid (PFDeA)
- Perfluoroundecanoic Acid (PFUnA)
- Perfluorododecanoic Acid (PFDoA)
- Perfluorobutan sulfonate (PFBS)
- Perfluorohexane sulfonate (PFHxS)
- Perfluorooctan sulfonate (PFOS)

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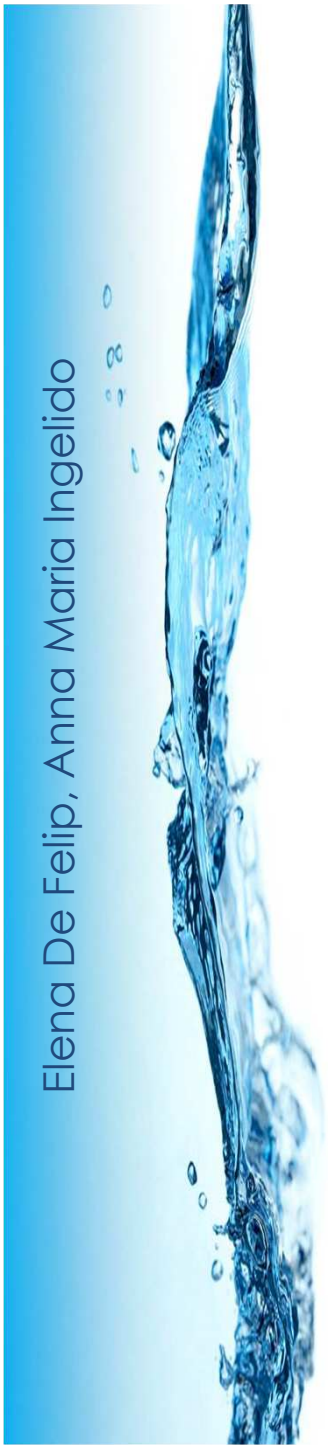
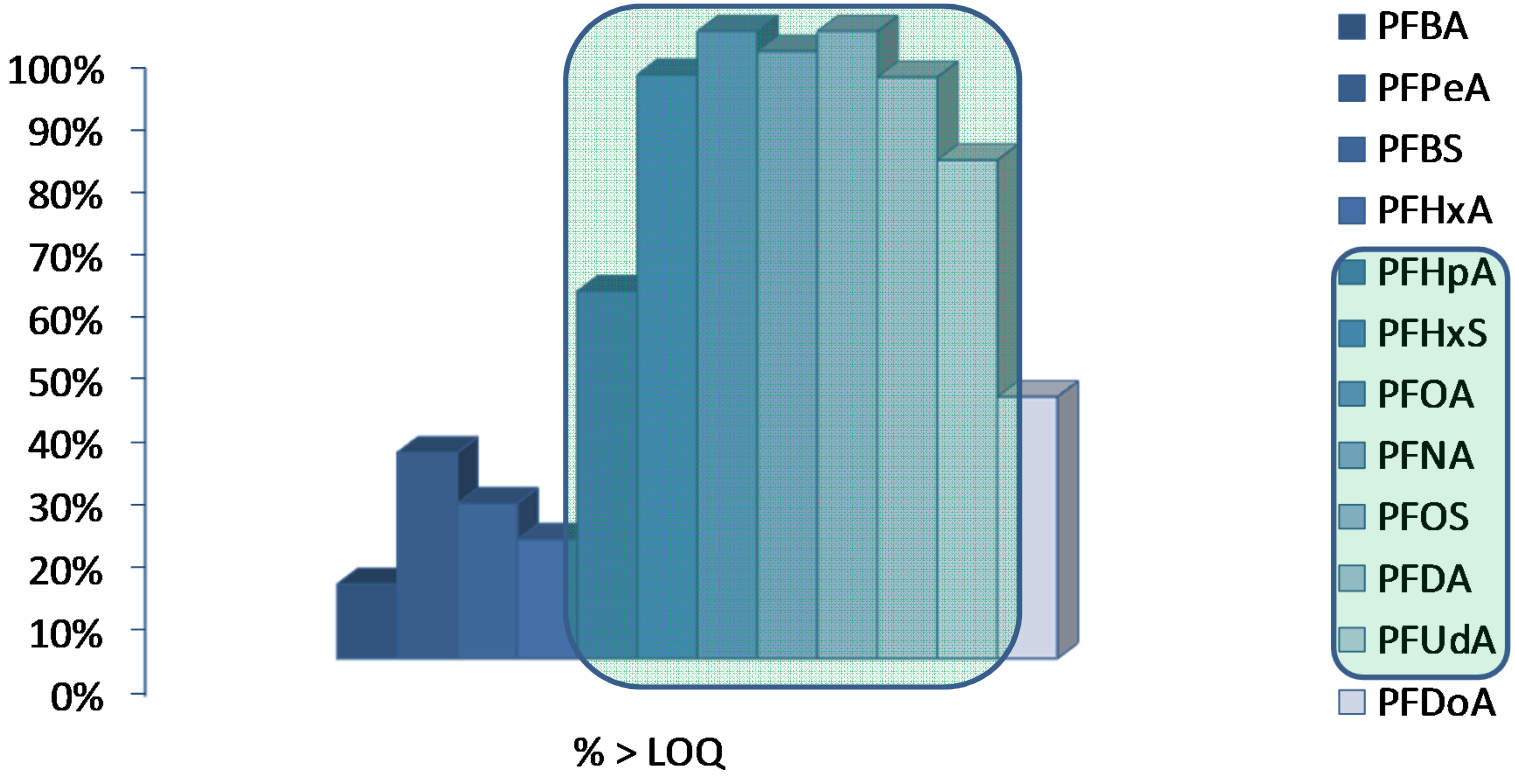
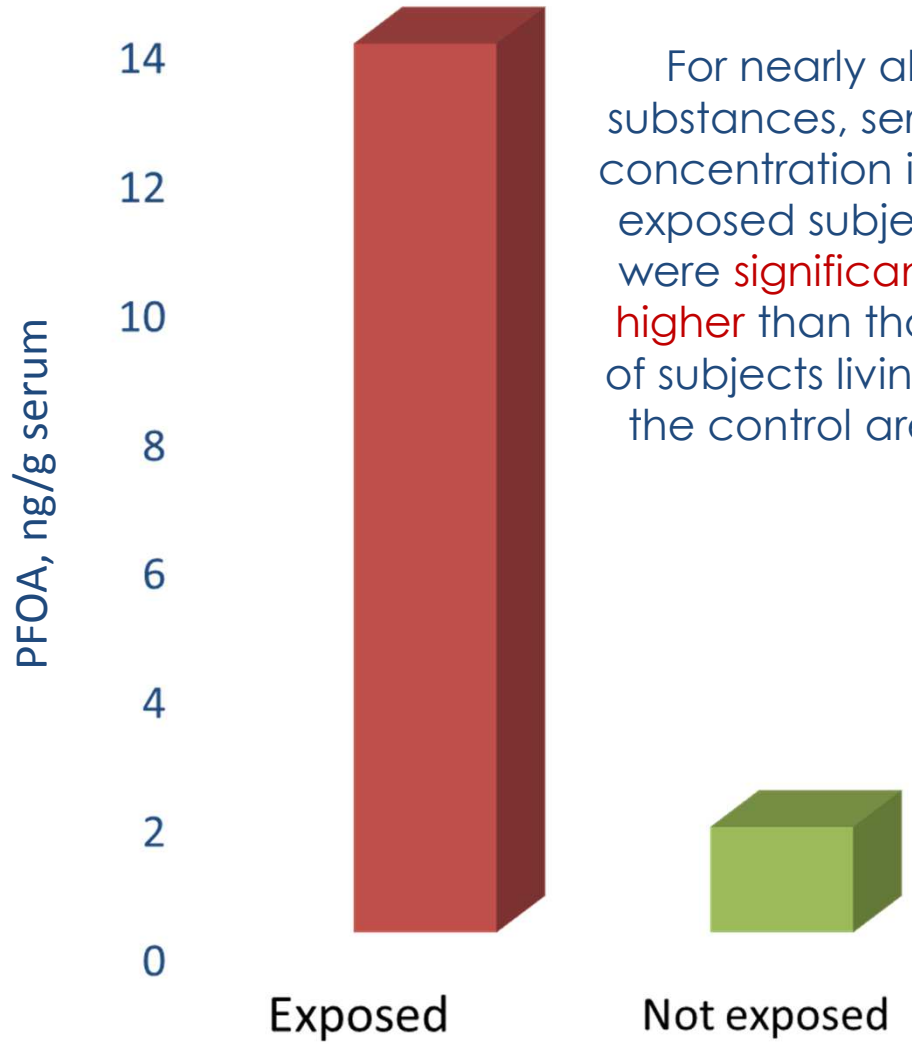


Study on the general population
Results



Mann-Whitney Test, Exposed vs/ Not exposed

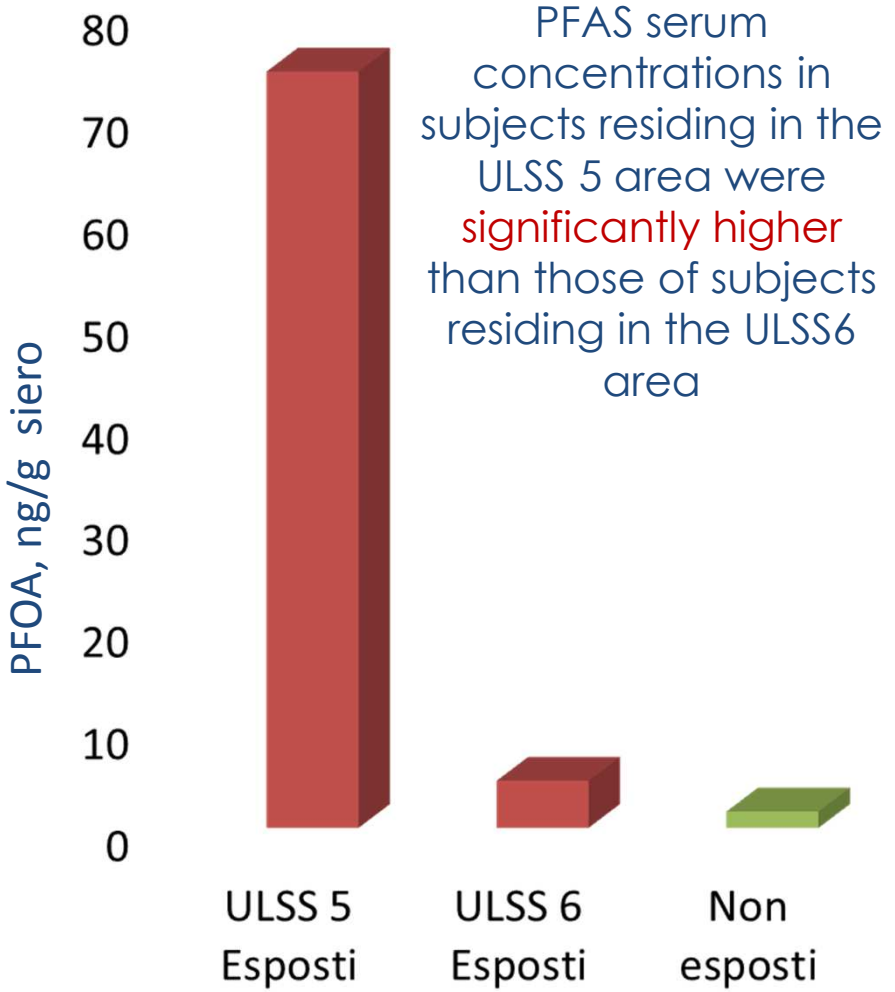
Substance	p
PFBA	<<0.0001
PFPeA	<<0.0001
PFBS	<<0.0001
PFHxA	<<0.0001
PFHpA	<<0.0001
PFHxS	0.002
PFOA	<<0.0001
PFNA	0.331
PFOS	<<0.0001
PFDA	0.871
PFUnA	0.383
PFDoA	<<0.0001



For nearly all substances, serum concentration in of exposed subjects were significantly higher than those of subjects living in the control area

Mann-Whitney Test, Exposed subjects stratified by ULSS

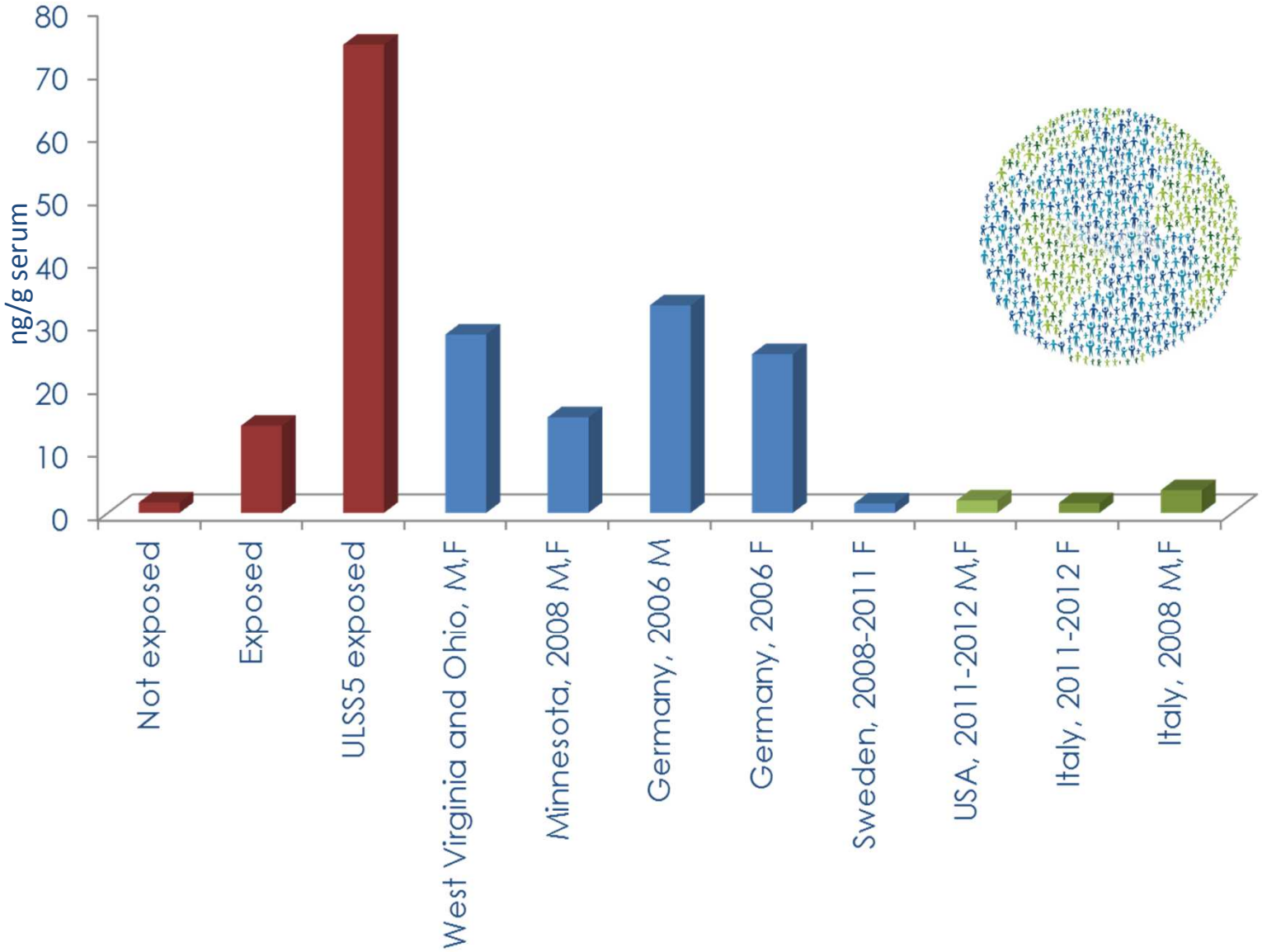
Analyte	U5vsNE p	U5vsU6 p	U6vsNE p
PFBA	<<0.0001	<<0.0001	<<0.0001
PFPeA	<<0.0001	<<0.0001	0.00015
PFBS	<<0.0001	0.00034	<<0.0001
PFHxA	<<0.0001	<<0.0001	<<0.0001
PFHpA	<<0.0001	<<0.0001	0.050
PFHxS	<<0.0001	<<0.0001	<<0.0001*
PFOA	<<0.0001	<<0.0001	<<0.0001
PFNA	0.041	0.039	0.55
PFOS	<<0.0001	<<0.0001	0.26
PFDA	0.85	0.69	0.62
PFUdA	0.76	0.26	0.24
PFDoA	<<0.0001	0.00039	<<0.0001



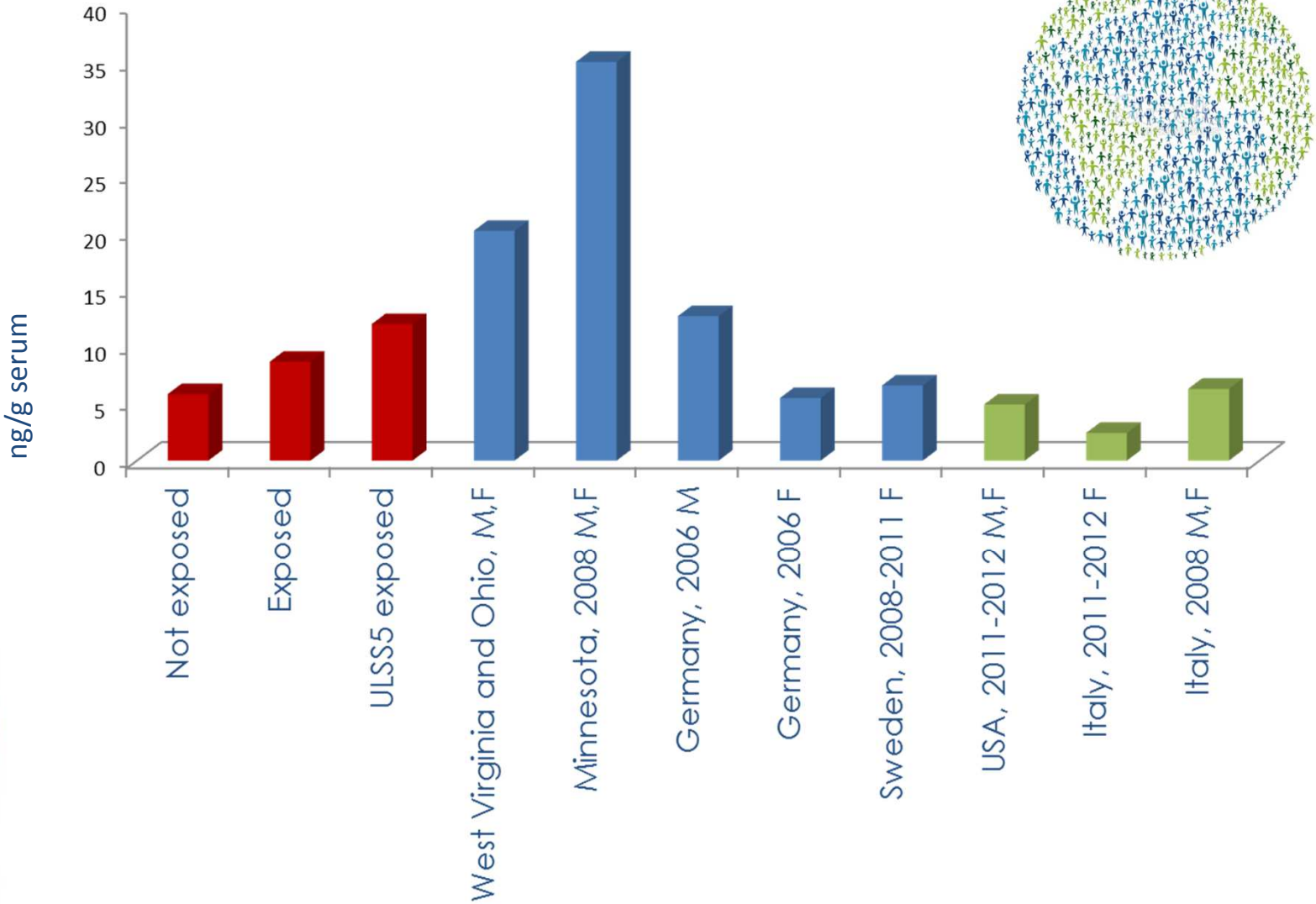
PFAS serum concentrations in subjects residing in the ULSS 5 area were significantly higher than those of subjects residing in the ULSS6 area

*Higher in the NE group

PFOA serum concentrations (median values) in subjects in this study, in subjects exposed to contaminated water in other studies, and in subjects not exposed to contaminated water



PFOS serum concentrations (median values) in subjects in this study, in subjects exposed to contaminated water in other studies, and in subjects not exposed to contaminated water



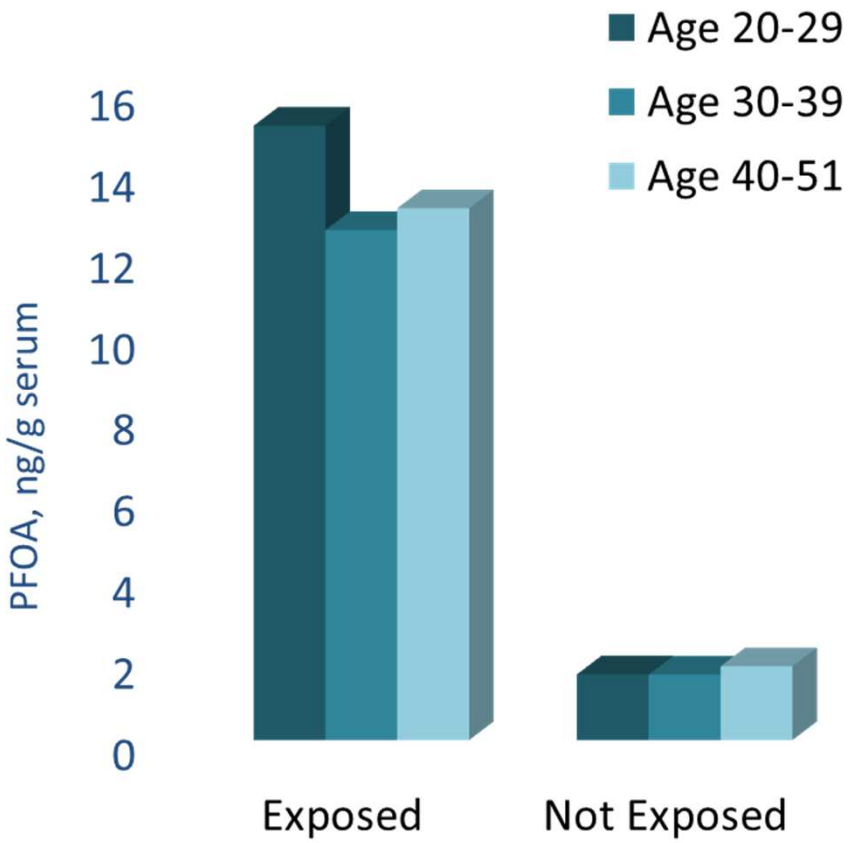
Influence of sex

Mann-Whitney Test: M>F, p<0.05		
Exposed and Not exposed (E+NE)	Exposed (E)	Not exposed (NE)
PFHxS, PFOA, PFNA, PFOS	PFHpA, PFHxS, PFOA, PFNA, PFOS	PFHxS, PFOA, PFNA, PFOS

Influence of age

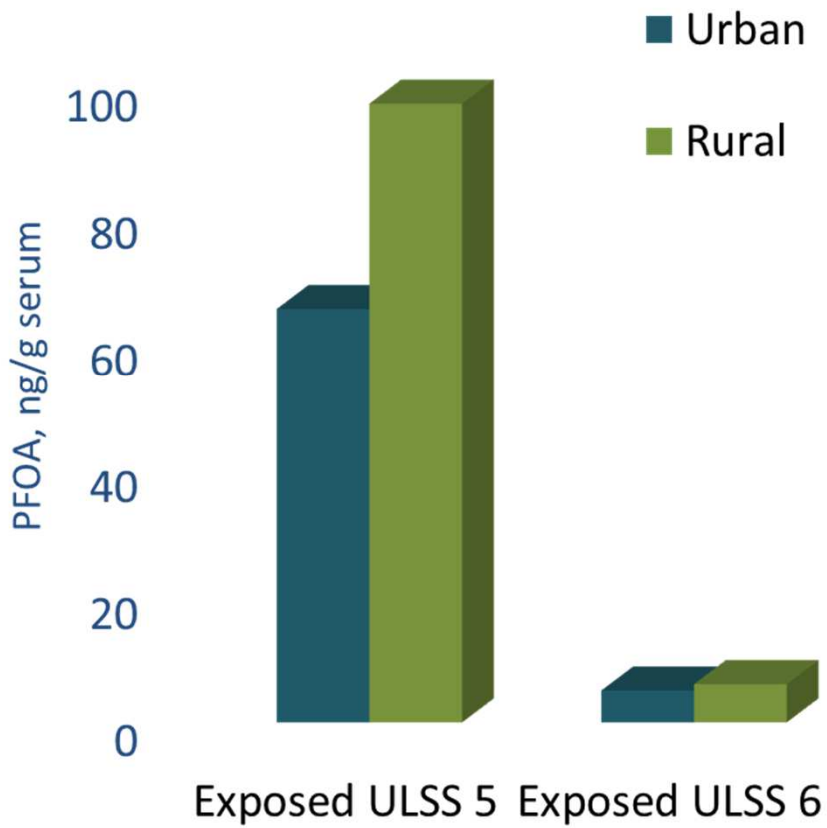
Spearman correlation, p<0.05		
Exposed and Not exposed (E+NE)	Exposed (E)	Not exposed (NE)
PFNA	PFHpA	_

Generally, serum concentrations did not increase with age



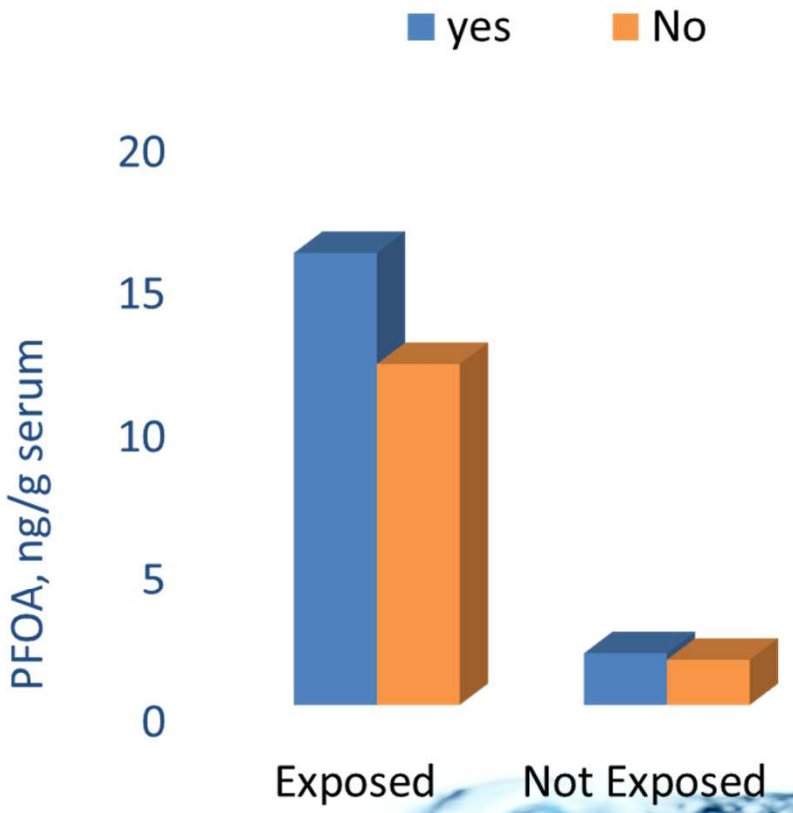
Influence of area of residence (Rural vs/ Urban), exposed subjects

Mann-Whitney Test : Rural>Urban, p<0.05		
Exposed (E)	Exposed ULSS 5	Exposed ULSS 6
PFHpA, PFHxS, PFOA, PFNA, PFOS	PFOA, PFNA	–



Growing one's own vegetables

Mann-Whitney Test: Y>N, p<0.05		
Exposed and Not Exposed (E+NE)	Exposed (E)	Not Exposed (NE)
PFNA, PFDA and PFOS	–	PFOS



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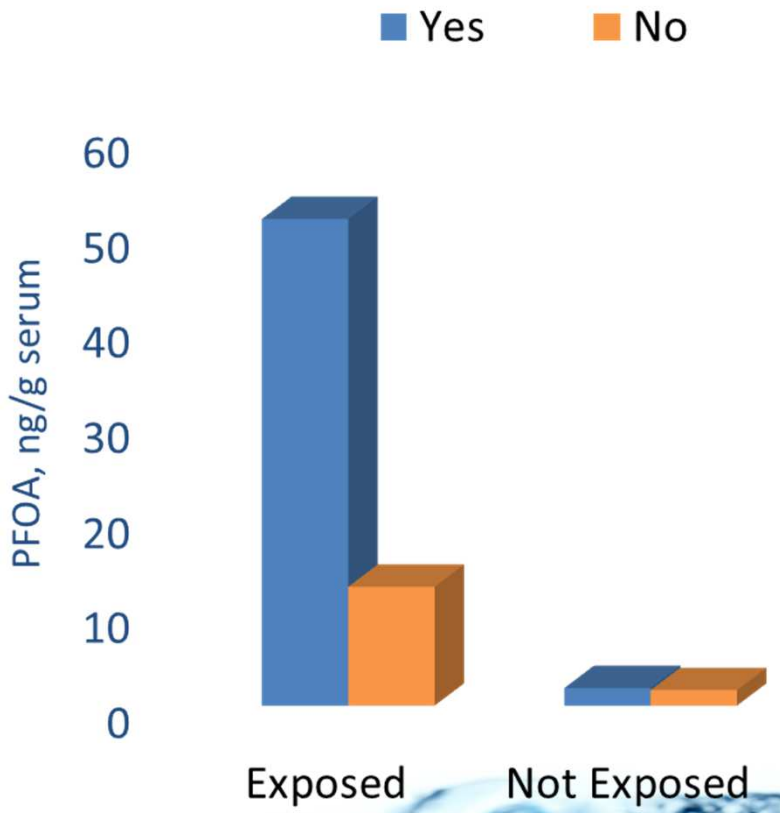
Farming one's own animals

Mann-Whitney Test: Y>N, p<0.05		
Exposed and Not Exposed (E+NE)	Exposed (E)	Not Exposed (NE)
PFNA, PFDA e PFOS	PFHpA, PFOA, PFNA, PFDA, PFHxS e PFOS	PFNA, PFDA e PFOS



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Influence of food consumption

The questionnaire was structured to allow collection of consumption data by aggregated categories/broad groups of food

As known from literature, in sites characterized by PFAS contamination of water, water consumption is the main source of exposure, and contribution to human exposure from single food categories may be difficult to characterize

Influence of food consumption

From questionnaries, it resulted that about 44% of the population biomonitored used to grow own's vegetables, and about 15% to raise own's animals. However, always from questionnaires, consumption of own-produced food resulted to be low

In the **Exposed group** there were no statistically significant and direct correlation with specific food groups with some exceptions, as for:

- Cereals and derivatives: PFHpA, PFHxS, PFOA and PFOS
- Wild fish and game: PFHpA, PFOS, PFDA and PFUdA
- Fruit: PFOA

Tap water consumption (for drinking), Exposed subjects

Spearman direct correlation, p<0.05	
Exposed ULSS 5	Exposed ULSS 6
PFOA	PFHpA and PFOA

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Correlation between PFOA serum concentrations in Exposed subjects and PFOA concentrations assessed in water (water contamination data from ARPA/Veneto Region, elaboration carried out with the «Igiene delle acque interne» Unit)

Spearman Test, DIRECT correlation p<0.05	
Tap water	Well water
p=0.0034	p<<0.001

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Spearman direct correlation, Exposed subjects p<0.05	
 PFOA concentration in subjects that use tap water to water vegetables vs PFOA concentration in tap water	 PFOA concentration in subjects that use well water to water vegetables vs PFOA concentration in well water
p=0.091	p=0.079

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Spearman direct correlation,
$p<0.05$

PFOA concentration in subjects that use tap water to water animals vs PFOA concentration in tap water

p=0.034

PFOA concentration in subjects that use well water to water animals vs PFOA concentration in well water

p=0.012

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Farmers

120 subjects

- 60 females
  - 20 age 20-29 years
  - 20 age 30-39 years
  - 20 age 40-50 years
- 60 males
  - 20 age 20-29 years
  - 20 age 30-39 years
  - 20 age 40-50 years

Enrollment has been completed in all ULSS

Analysis has been performed on all samples from ULSS 5 (59) and from ULSS 6 (22)

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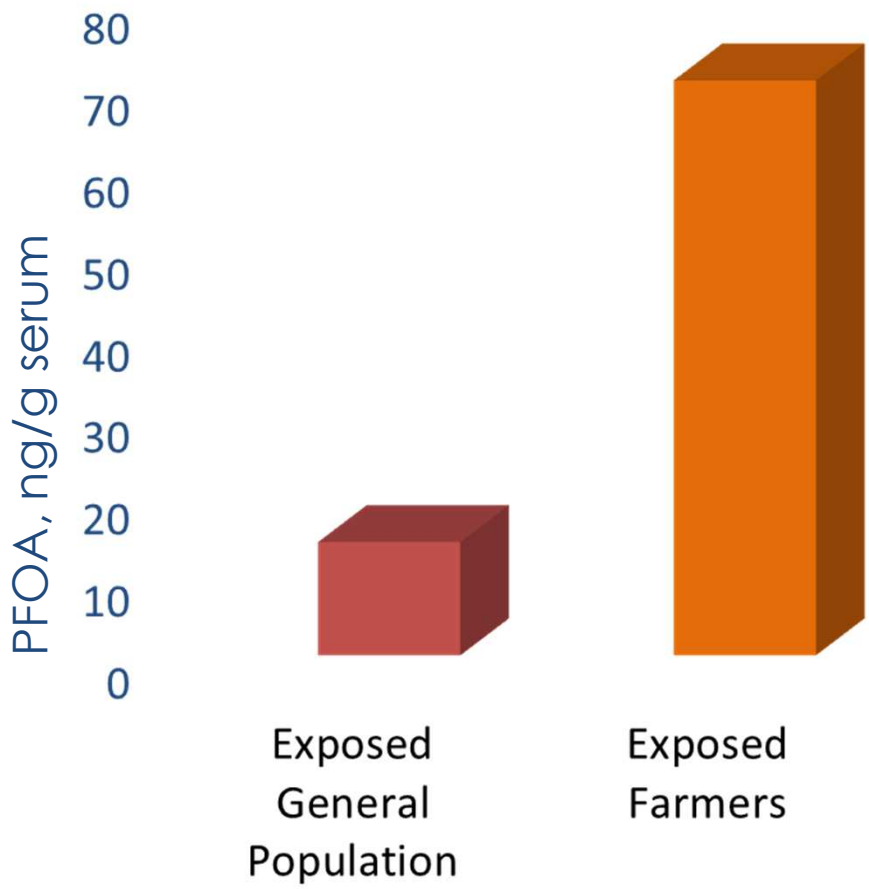
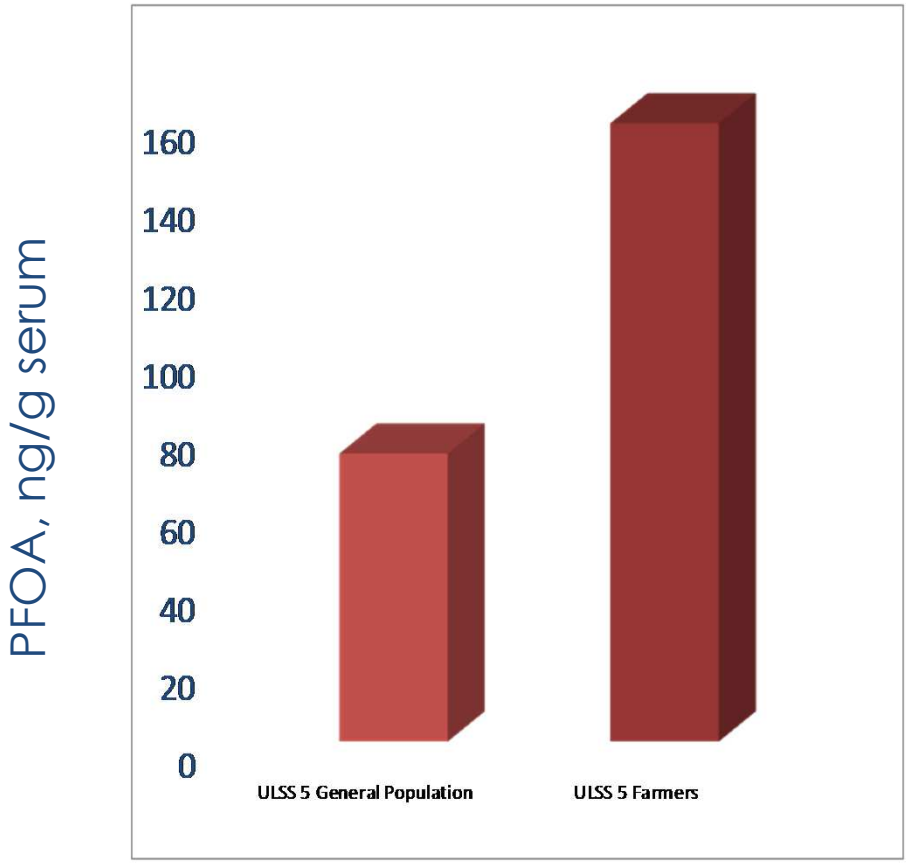
Mann-Whitney Test, Exposed general population vs/ Exposed Farmers

Substance	p
PFBA	0.41
PFPeA	0.20
PFBS	0.19
PFHxA	0.49
PFHpA	0.85
PFHxS	<<0.0001
PFOA	<<0.0001
PFNA	0.34
PFOS	<<0.0001
PFDA	0.00041
PFUnA	0.00036
PFDoA	<<0.0001

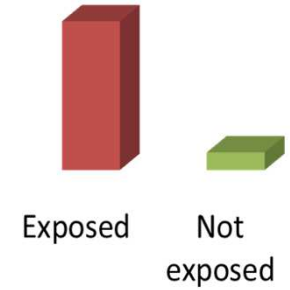


Mann-Whitney Test,
Exposed general population ULSS5 vs/ Exposed Farmers ULSS5

Substance	p
PFBA	0.0049
PFPeA	0.20
PFBS	0.18
PFHxA	0.94
PFHpA	0.88
PFHxS	<<0.0001
PFOA	0.0014
PFNA	0.90
PFOS	<<0.0001
PFDA	<<0.0001
PFUnA	0.0018
PFDoA	<<0.0001



Conclusions



- ✓ The concentrations of most PFAS in the serum of residents in areas where contamination of water had been detected were significantly higher than those detected in residents of the control areas

- ✓ Within the group of exposed subjects, residents in the ULSS 5 area showed concentrations higher than the other exposed subjects. Males from ULSS 5 showed the highest levels of concentration among subjects from the general population

- ✓ A significant association between PFOA serum levels and tap water consumption in exposed subjects was observed

Conclusions

- ✓ PFOA serum concentrations in exposed subjects correlated with PFOA water concentrations detected in the subject residence area

- ✓Serum concentrations of PFOA, PFOS, and some other PFAS observed in the group of farmers so far examined resulted to be significantly higher than concentrations observed in subjects of the general population from the same ULSS

Thank you for your attention

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