

# Health significance of essential nutrients in drinking water

***František Kožíšek, MD, PhD***

*National Institute of Public Health, Prague*

*XXII. Conference WATER AND PUBLIC WATER SUPPLY*

*Sisak, Croatia, 2-5 October 2018*

# EU Drinking Water Directive

## Article 4

- Member States shall take the measures necessary to ensure that **water** intended for human consumption **is wholesome and clean.**

# EU Drinking Water Directive

## Article 4

- ...For the purposes of the minimum requirements of this Directive, water intended for human consumption shall be wholesome and clean if it:
- is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health, and
- meets the minimum requirements set out in Annex I, Parts A and B;

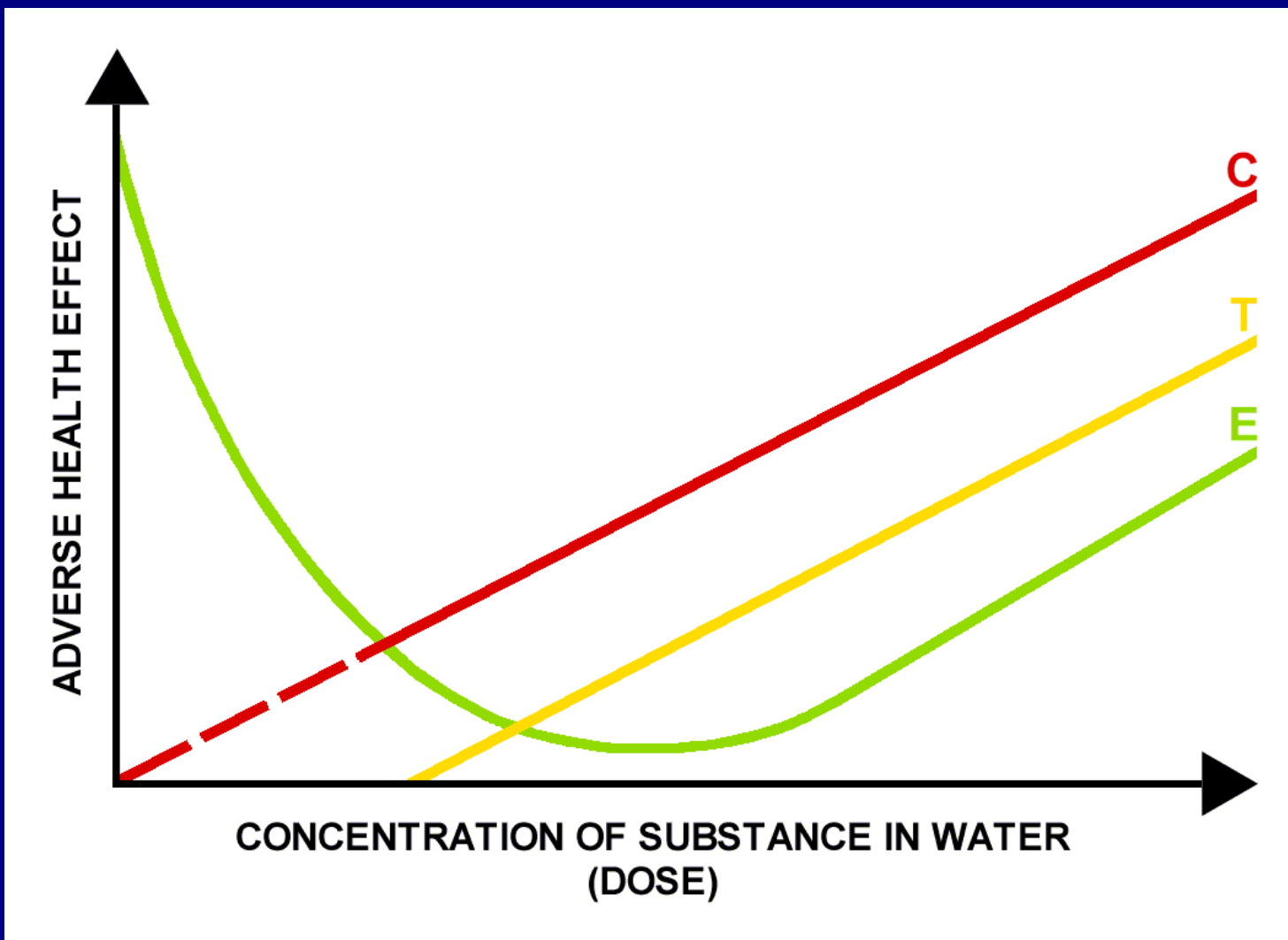
## However...

- If we would start to treat water for some community, e.g. by RO, to get absolutely clean water (free of any substance – pure H<sub>2</sub>O) →  
  
many consumers would have various health problems within weeks or months even they have perfectly balanced diet...

# Drinking water is not just H<sub>2</sub>O !

- Natural water (incl. DW) is not pure H<sub>2</sub>O, but complex system of natural (essential) minerals and gases dissolved in water
- Although most people are not aware, too low or too high content of these natural minerals can influence health of consumers
- The minerals are important also for good taste of water

# Dose-response relationships



**C ... Carcinogenic substances (non-threshold effect)**

**T ... Toxic substances (threshold effect)**

**E ... Essential substances**

# EU Drinking Water Directive

- 35 chemical substances are regulated
- We have evidence on real negative health impact only for several regulated parameters in drinking water:  
**DBP, arsenic, lead, copper, nitrate, fluoride, nickel, sodium, manganese (?), iron (?)**
- All other parameters: only hypothetical risk, regulated on precautionary principle

## Scientific evidence ?

- **Scientific evidence for negative health effects of low mineral water is comparable with evidence for DBPs, arsenic and lead and much higher than for other regulated parameters: NO<sub>3</sub>, F, Ni, Cu, Mn, Na, Fe...**



# > 100 years of research on water hardness (Ca+Mg) and health

The first (?) papers already in 1870s in *Journal für Gasbeleuchtung und Wasserversorgung*

*The Lancet*, 1913

Studies of 1960s, conclusions: „soft water, hard arteries“

In 1970s/1980s health benefits of water hardness widely accepted among public health authorities, by the WHO and the EC

## HARD v. SOFT WATER.

BY JOHN C. THRESH, M.D. VICT., D.SC. LOND.,  
MEDICAL OFFICER OF HEALTH OF THE COUNTY OF ESSEX.

IN the annual report for the county of Essex for the year 1910 I gave a series of statistics showing that (1) in the areas supplied with hard water the death-rate is quite as

THE LANCET,]

DR. JOHN C. THRESH: HARD V. SOFT WATER.

[Oct. 11, 1913 1057

river water, even when the river water impounded is known

# Review ordered by the Drinking Water Inspectorate (DWI), UK

University of East Anglia (UoEA):

## **Review of evidence for relationship between incidence of cardiovascular disease and water hardness**

Final report for contract DWI/70/2/176

Date: 21st October 2005

Available at: [www.dwi.gov.uk](http://www.dwi.gov.uk)

# UoEA review

Of 2,906 papers on water hardness and human health (CVD) have been found (in English). 115 analytical studies reviewed in detail.

Experimental animal studies and human dietary studies were excluded from this review – just epidemiological evidence.

General conclusion found by most of the studies:  
**Inverse association exists = lower Mg (Ca, hardness) → higher risk of death from cardiovascular disease (CVD)**

Consequent meta-analysis by the team of authors (Paul Hunter at al.) →

# Systematic review (meta-analysis)

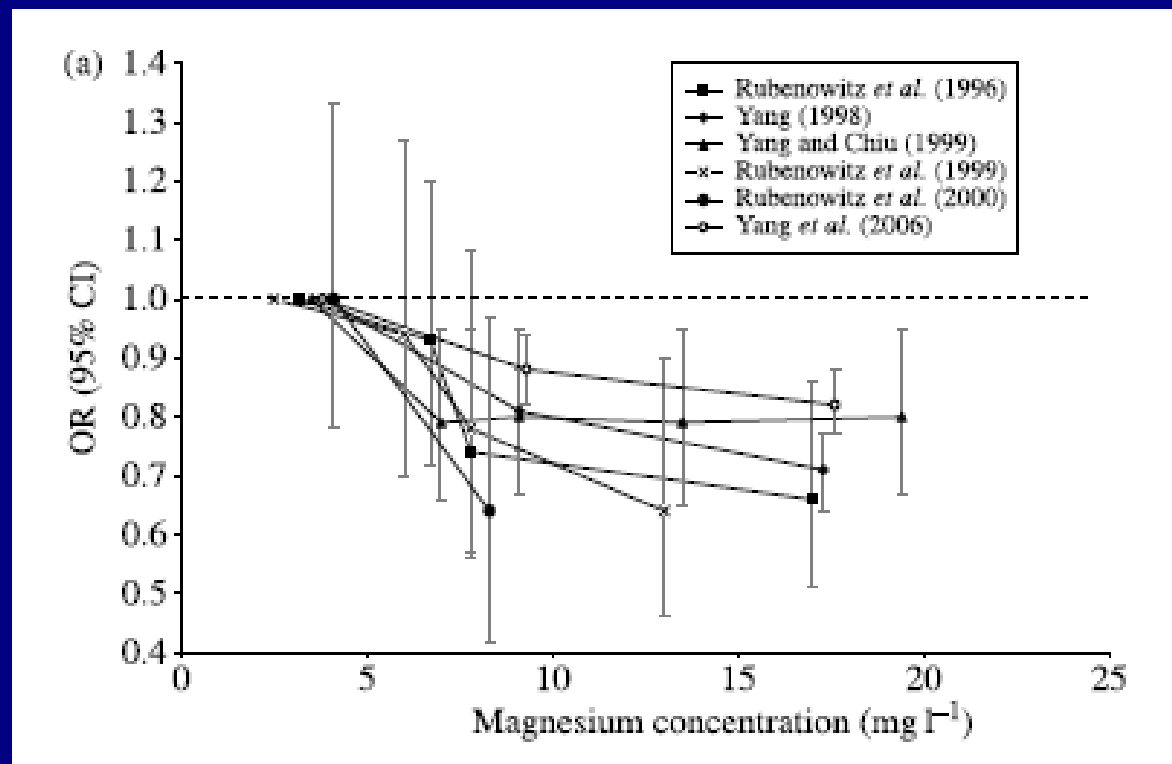
Catling et al. A systematic review of analytical observational studies investigating the association between cardiovascular disease and drinking water hardness. *J Water Health* 6(4): 433-442; 2008.

14 high quality studies (nine case control and five cohort) included:

A pooled odds ratio showed a statistically significant inverse association between **magnesium and cardiovascular mortality** (**OR 0.75** (95%CI 0.68, 0.82),  $p < 0.001$ ) →

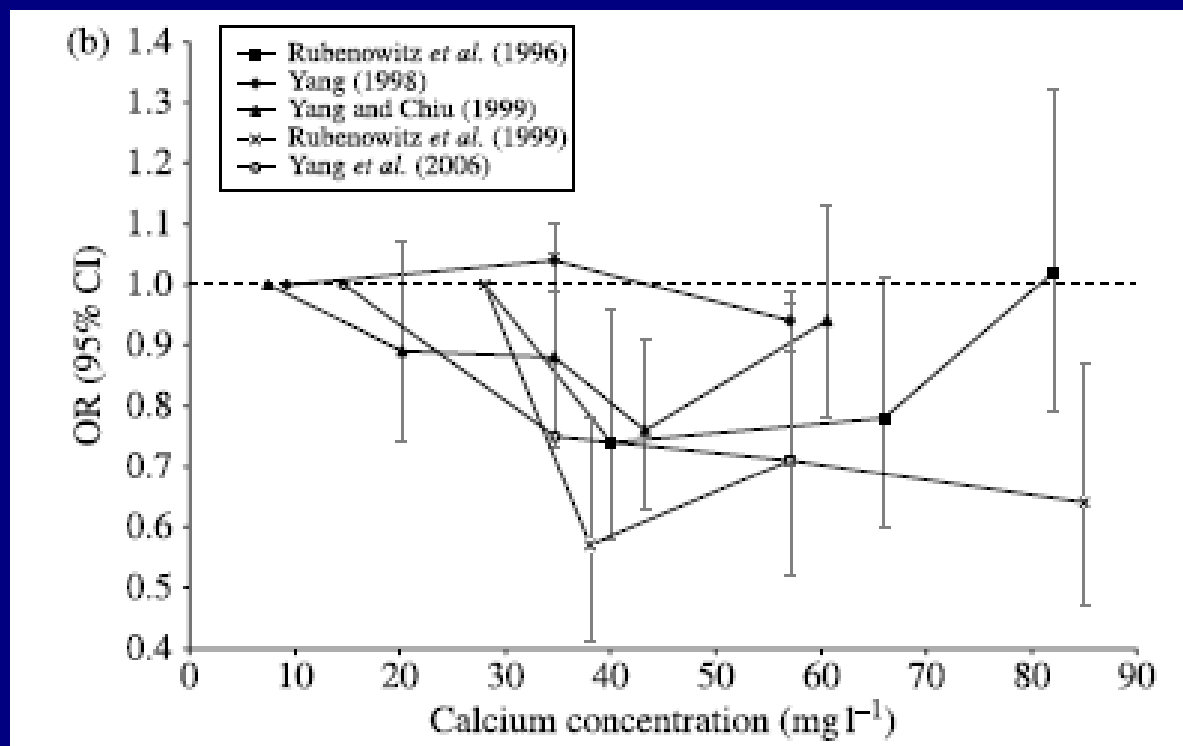
# Systematic review (meta-analysis)

People consuming DW with Mg 8.3 – 19.4 mg/l had by 25 % lower risk of CV mortality in comparison with people using DW with Mg content of 2.5 – 8.2 mg/l



# Systematic review (meta-analysis)

Only two studies reported a statistically significant effect for calcium. Role of water Ca in CVD (mortality) prevention is not clear, not proved by epidemiological data.



# Systematic review (meta-analysis)

Jiang L. et al.: Magnesium levels in drinking water and coronary heart disease mortality risk: a meta-analysis. *Nutrients*, 2016, 8, 1.

**Table 2.** Summary risk estimates of the levels of magnesium in drinking water and CHD mortality risk.

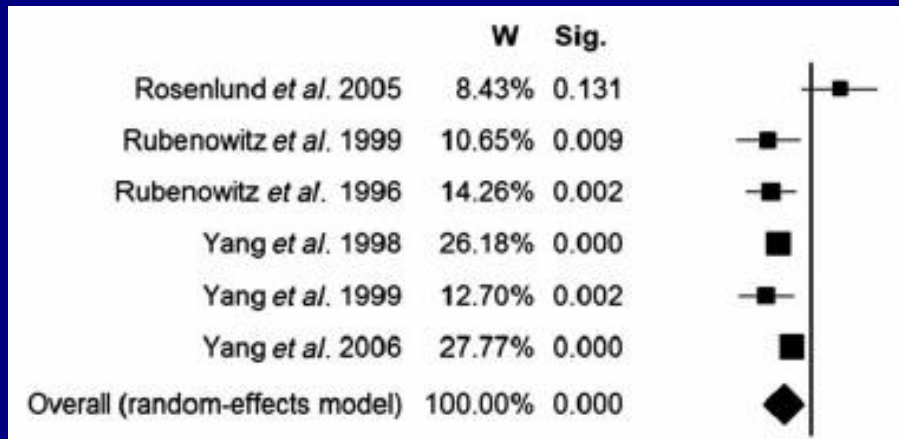
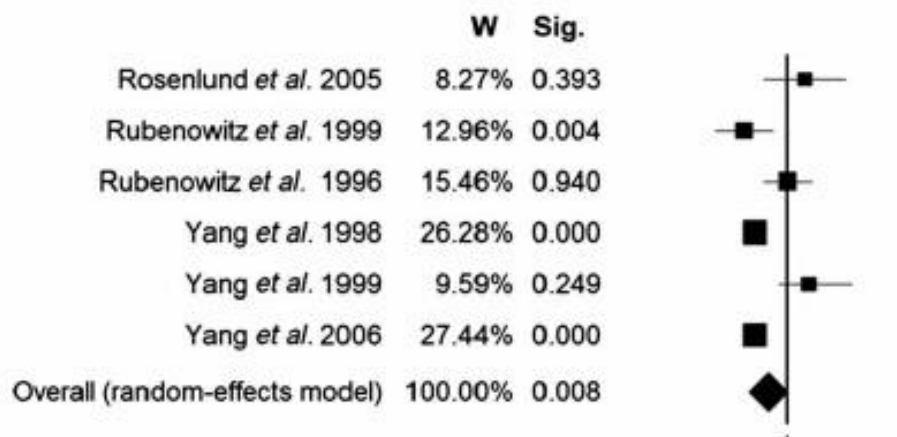
Subgroups	No.	No.	RR (95% CI)	Heterogeneity Test	
	Cases	Studies		I <sup>2</sup> (%)	p-Value
All studies	77,821	10	0.89 (0.79–0.99)	70.6	0.000
		Study design			
Cohort	1840	3	0.88 (0.57–1.34)	63.5	0.064
Case-control	75,981	7	0.87 (0.76–0.98)	74.6	0.001
		Geographic locations			
Europe	67,727	9	0.83 (0.69–0.98)	70.0	0.001
Asia	10,094	1	–	–	–
		CHD outcome			
IHD	65,868	3	1.01 (0.96–1.05)	0.0	0.586
MI	11,755	6	0.81 (0.64–0.98)	78.6	0.000
CHD	198	1	–	–	–
		Sex			
Males	2194	3	0.78 (0.54–1.15)	73.3	0.024
Females	878	2	0.75 (0.56–1.00)	0.0	0.484

Abbreviations: CHD, coronary heart disease; IHD, ischemic heart disease; MI, myocardial infarction; CI, confidence interval; RR, relative risk.

# Systematic review (meta-analysis)

Gianfredi V. et al.: Cardiovascular diseases and hard drinking waters: implications from a systematic review with meta-analysis of case-control studies. *J Water Health*, 2017, 31-40.

6 high quality studies on Ca – CVD, 7 studies on Mg – CVD





## Other health effects (not CVD)?

However, water **calcium** proved to have other beneficial effects, e.g. higher content of water calcium correlated with

...higher bone density in women (prevention of osteoporosis)

...lower prevalence of dental carries in children

...lower incidence of bone fractures in children

...lower incidence of some neurological diseases

...lower blood pressure

...lower mortality of several types of cancer (Taiwan and Slovak studies)

# European Cardiovascular Disease Statistics 2017

- **Each year cardiovascular disease (CVD) causes 3.9 million deaths in Europe and over 1.8 million deaths in the European Union (EU).**
- CVD accounts for 45% of all deaths in Europe and 37% of all deaths in the EU.
- CVD is the main cause of death in men in all but 12 countries of Europe and is the main cause of death in women in all but two countries.
- <http://www.ehnheart.org/cvd-statistics/cvd-statistics-2017.html>

# Water role in CVD mortality ?

- Water – naturally or artificially – low in Mg and Ca has bigger negative population impact (just due to CVD mortality) in Europe than all other currently regulated chemical parameters together
- + other negative health effects with lower scientific evidence – still not enough to use precautionary principle ???

## Practical example: balancing two risks

- Czech town N (10,000 population)
- Local water supply polluted with TCE+PCE
- Treatment (air stripping) needed
  
- Two options: renewal of treatment x connection to neighbouring supply (unpolluted source much lower in Mg and Ca)
  
- Risk of current supply: 1 additional case of cancer per 25 years
- Risk of new supply: several additional death per year...

# Future development ?

- Situation will be worse as desalination and softening is more and more commonly used in developed countries
- Studies from Israel...



Contents lists available at ScienceDirect

## International Journal of Cardiology

journal homepage: [www.elsevier.com/locate/ijcard](http://www.elsevier.com/locate/ijcard)

---

### Desalinated seawater supply and all-cause mortality in hospitalized acute myocardial infarction patients from the Acute Coronary Syndrome Israeli Survey 2002–2013☆

Meital Shlezinger<sup>a,b</sup>, Yona Amitai<sup>a,1</sup>, Ilan Goldenberg<sup>b,c</sup>, Michael Shechter<sup>b,c,\*</sup>

<sup>a</sup> Bar Ilan University, Israel  
<sup>b</sup> Leviev Heart Center, Chaim Sheba Medical Center, Tel Hashomer, Israel  
<sup>c</sup> Sackler Faculty of Medicine, Tel Aviv University, Israel

# Approach to regulation ?

- If we want to address most serious risks with our regulation, we should not ignore the issue of essential nutrients in drinking water
- Health and aesthetic importance

# Approach to regulation ?

- It is difficult and not feasible to increase substantially naturally low content of nutrients in DW
- It is much easier to prevent unnecessary removal or too high mineral removal by softening and desalination.  
We need to look for optimum way of remineralization after desalination of seawater.
- There are already such regulations (in Czech Rep. and some other countries)
- CR proposes the same for recast of the DWD

# Acknowledgements

The project “Improvement of health status of population of the Slovak Republic through drinking water re-carbonization” (LIFE17 ENV/SK/000036)