

TAP WATER FLUORIDE LEVELS IN ESTONIA

Ene Indermitte,^a Enn Karro,^b Astrid Saava^a

Tartu, Estonia

SUMMARY: The fluoride content of local tap water was assessed throughout Estonia, including all water supplies serving at least 100 inhabitants. The distribution of water fluoride levels was found to vary significantly both between counties and within them. High and low fluoride waters from different aquifers are sometimes present in the same location. Fluoride ion levels ranging from 0.01 to 6.95 mg/L (mean 0.88±0.90 mg/L) are divided into 8 concentration ranges and presented at the county level in order to allow linkage to epidemiological studies, health risk assessment, and remediation actions.

Keywords: Estonia; Fluoride in tap water; Local fluoride levels; Regional fluoride levels.

INTRODUCTION

Fluoride in well and spring water is mostly of geological origin. For this reason its concentration may vary widely over geographical boundaries and in groundwater aquifers.^{1,2} In Estonia, groundwater is the main drinking water source in most of the towns and rural settlements. Our previous study on the occurrence and origin of fluoride in groundwater in Estonia revealed a wide variation of levels.³ In this paper we show that waters from different aquifers are often supplied to a single location because they are mixed in the water supply system. Therefore, the relationships between natural groundwater and tap waters are difficult to quantify. Here we report the fluoride levels in tap water on a local scale throughout all Estonia so that the results can serve as a basis for future epidemiological studies and remediation actions.

MATERIAL AND METHODS

Study area: Estonia, population 1.351 million people, is the smallest Baltic nation with an area of 45,227 km², situated in the north-western part of the East-European Platform. Administratively, Estonia is divided into 15 counties (Figure). The people are well provided with drinking water—there are 1,233 public water supplies in the country, with a prevalence of small water supplies systems. In towns and rural settlements, five different aquifer systems are exploited, and the groundwater used for drinking purposes is utilized directly without treatment. Only in two towns (Tallinn, the capital, and the city of Narva) is surface water centrally disinfected.

Materials: Information on public water suppliers, exploited water sources, and size of water supplies was acquired from the Estonian Health Protection Inspectorate. All drinking water supplies serving at least 100 consumers were included in the study.

Methods: Tap water samples were collected from the points closest to the consumer. In case of combined water supply systems (several wells in the same location), additional samples were taken according to the influence area of the

^aDepartment of Public Health, University of Tartu, Estonia. ^bFor Correspondence: Dr Enn Karro, Institute of Geology, University of Tartu, Vanemuise 46, 51014 Tartu, Estonia; E-mail: enn.karro@ut.ee

wells. Altogether, 735 water samples were analysed in 47 towns and 471 rural settlements. The analyses were performed within 48 hr after collection by the SPADNS colorimetric method.⁴ In order to facilitate the presentation of analytical results and to support future correlation with dental and other health surveys, the data were grouped into eight fluoride concentration categories.

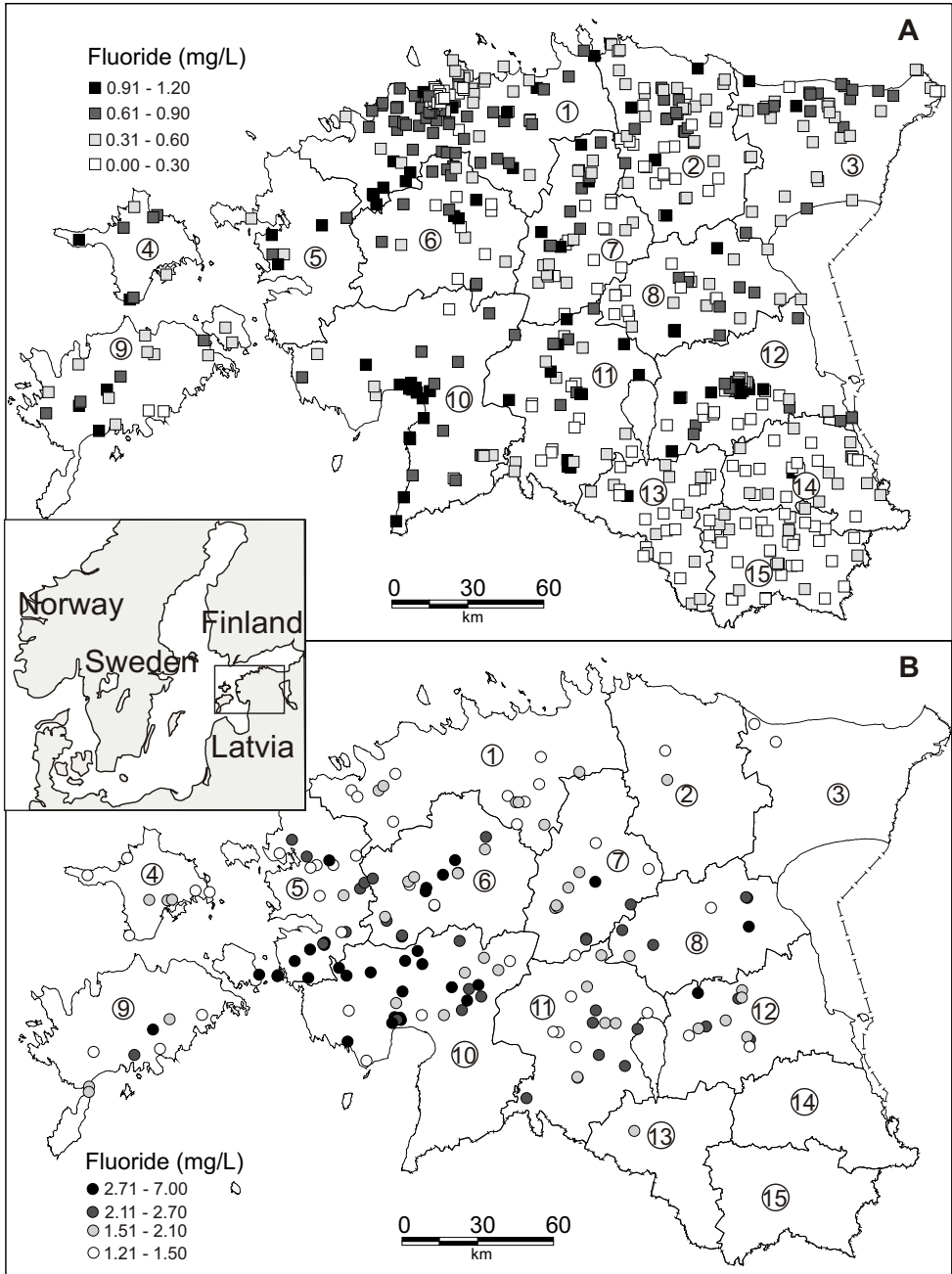


Figure. Maps showing fluoride concentrations in drinking water samples in Estonia. A: Fluoride levels 0.00–1.20 mg/L. B: Fluoride levels 1.21–7.00 mg/L.

RESULTS AND DISCUSSION

Fluoride concentrations in drinking water were found to vary from 0.01 to 6.95 mg/L, with mean value of 0.88 ± 0.90 mg/L. Low-fluoride water (up to 0.3 mg/L) was detected in 185 water samples (25%). Estonia's official limit value for fluoride in drinking water (1.5 mg/L) was exceeded in 106 water samples (14%).

The fluoride concentrations vary widely both between counties as well as within counties (Table).

Table. Distribution of water samples in Estonia according to fluoride content by counties (numbering of counties as shown in the map Figure)

No. and name of county	No. of water samples	Range	Fluoride concentration, mg/L and no. of samples (%)							
			< 0.31	0.31–0.60	0.61–0.90	0.91–1.20	1.21–1.50	1.51–2.10	2.11–2.70	> 2.70
1. Harju	119	0.01–2.06	23 (19)	23 (19)	45 (38)	14 (12)	9 (8)	5 (4)	0 (0)	0 (0)
2. Lääne-Viru	65	0.10–1.81	21 (32)	24 (37)	14 (22)	4 (6)	1 (2)	1 (2)	0 (0)	0 (0)
3. Ida-Viru	48	0.21–1.29	3 (6)	25 (52)	16 (33)	2 (4)	2 (4)	0 (0)	0 (0)	0 (0)
4. Hiiu	17	0.38–1.92	0 (0)	2 (12)	5 (29)	2 (12)	5 (29)	3 (18)	0 (0)	0 (0)
5. Lääne	29	0.54–5.60	0 (0)	2 (7)	2 (7)	3 (10)	7 (24)	1 (3)	6 (21)	8 (28)
6. Rapla	42	0.12–3.68	7 (17)	5 (12)	9 (21)	3 (7)	4 (10)	5 (12)	5 (12)	4 (10)
7. Järva	49	0.05–3.12	13 (27)	12 (24)	8 (16)	5 (10)	2 (4)	6 (12)	2 (4)	1 (2)
8. Jõgeva	38	0.06–3.28	10 (26)	10 (26)	8 (21)	3 (8)	1 (3)	1 (3)	4 (11)	1 (3)
9. Saare	28	0.22–5.50	2 (7)	10 (36)	4 (14)	3 (11)	3 (11)	3 (11)	1 (4)	2 (7)
10. Pärnu	63	0.08–6.95	3 (5)	7 (11)	9 (14)	15 (24)	4 (6)	5 (8)	5 (8)	15 (24)
11. Viljandi	56	0.05–2.56	11 (20)	8 (14)	6 (11)	13 (23)	6 (11)	6 (11)	6 (11)	0 (0)
12. Tartu	73	0.10–3.48	24 (33)	7 (10)	14 (19)	17 (23)	2 (3)	5 (7)	3 (4)	1 (1)
13. Valga	30	0.06–1.58	17 (57)	11 (37)	0 (0)	1 (3)	0 (0)	1 (3)	0 (0)	0 (0)
14. Põlva	31	0.08–1.10	18 (58)	10 (32)	0 (0)	3 (10)	0 (0)	0 (0)	0 (0)	0 (0)
15. Võru	47	0.08–0.45	33 (70)	14 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
1-15. Total	735	0.01–6.95	185 (25)	170 (23)	140 (19)	88 (12)	46 (7)	42 (6)	32 (4)	32 (4)

In only 3 out of 15 counties are the fluoride levels in the samples below 1.5 mg/L. In these counties (Võru, Põlva, and Ida-Viru) low-fluoride water (up to 0.6 mg/L) is prevalent (Figure). Also, in Valga county, low-fluoride water predominates, with the exception of one water supply system where 1.58 mg F/L is present (Table). In three of the counties, the variation of fluoride content is extremely large, ranging from 0.08 to 6.95 mg/L in Pärnu county and up to 5.6 and 5.5 mg/L, in Lääne and Saare countries, respectively. Although the official limit of 1.5 mg F/L is exceeded in a few cases, the highest fluoride content is found in Lääne, Pärnu, and Rapla counties (52, 40, 34%, respectively). Medium-fluoride drinking water (0.6–1.2 mg/L) is found mainly in Harju, Tartu, and Hiiu counties. Overall, 79% of water facilities with the most serious high fluoride problems occur in small systems serving less than 500 people. In order to obtain sufficient water, deep

wells have been drilled, and the water is often pumped from a depth of 150–200 m in rural areas.

Geochemically favourable conditions for high dissolved fluoride in water prevail in the deeper portions of aquifer systems due to the slow water exchange and long-term water-rock interaction.³ Since it is not possible to implement a uniform strategy for a particular region or county, such complications make the optimisation of water quality a real challenge to water engineers and water suppliers, requiring the separate development of future strategies for each case.

Numerous high-fluoride water supply systems have been renovated within recent years in Estonia. Reverse osmosis facilities have been installed, and the fluoride content lowered to an acceptable level of less than 1.5 mg/L. However, the findings of the present study reveal that defluoridation is still an important need in many small water supply systems. Until the implementation of such treatment occurs, it is important to increase the awareness of the population and local authorities about the fluoride content in the drinking water, the possible health risks involved, and strategies for remediation.

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