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## 9 **Fluoride**

### 10 **Introduction**

11 Fluoride is found in food and drinking water either in an ionic form or bound in  
12 complexes. Fluoride has a well-documented role in the prevention and treatment of dental  
13 caries but the mechanism is attributed to local (effect on the tooth surface) rather than  
14 systemic effects. The role of fluoride as an essential trace element is debated.

15

### 16 **Dietary sources and intake**

17 Fluoride levels in foods (except water) are generally low, with a few exceptions. Fish  
18 eaten with bones, such as canned sardines, some teas and mineral waters and drinking  
19 water in some areas have the highest content. There are few data on fluoride intake from  
20 food but according to EFSA (6) intake for young and older children and adults is reported  
21 to range from 0.042, 0.114 and 0.120 mg/day, respectively. A major proportion of  
22 fluoride intake is from water sources. Estimated intake from water sources, given a water  
23 content of 1 mg/L, is 1.7 mg/day in adults and 0.3 mg/day in small children (7), but since  
24 fluoride concentration in drinking water varies between areas, intake also varies  
25 considerably due to water source. Another source of fluoride in small children is  
26 toothpaste. It is estimated that in adults <10% of the toothpaste is ingested as the spitting  
27 reflex is well developed, whereas the estimated intake in children may be up to 40%. In  
28 children the ingestion has been reported to be as high as 48 % in 2 to 3 year olds, 42% in  
29 4 year olds and in 5 and 6 year olds 34 and 25% respectively. In children aged from 8 to  
30 12 years of age the ingestion is reported to be ~10% (8).

31

### 32 **Physiology and metabolism**

33 Fluoride in drinking water is effectively adsorbed (>90 %), while complex-bound fluoride  
34 in foods is less well absorbed. Approximately 50% of absorbed fluoride is excreted via  
35 the kidneys, the rest incorporated into the bone and, in childhood, into the teeth. Thus, the  
36 main proportion of fluoride in the body is complex-bound to calcium in the skeleton and  
37 tooth tissues, where upon replacement of hydroxyl ions in hydroxyapatite crystals it leads  
38 to less soluble crystals. This was previously considered to render fluoride its caries  
39 preventive property. Today, the presence of fluoride in the mouth and subsequent  
40 deposition of CaF<sub>2</sub> in the tooth biofilm acting as a fluoride reservoir ready to interact with  
41 the balance between enamel demineralisation and remineralisation is recognized as the  
42 basis for the cariostatic effect of fluoride (1). Besides this local effect, biological functions  
43 of fluoride in man remain largely unclear.

44

**45 Requirement and recommended intake**

46 No recommendation for daily fluoride intake is given since it is not considered an  
47 essential trace element. This agrees with the EC Scientific Committee for Foods, which  
48 also did not set any recommended intake (2). The US Institute of Medicine was unable to  
49 establish an RDA but has set a reference value for fluoride, which is based on the  
50 observed estimated intake judged to reduce the incidence of dental caries in a group of  
51 healthy adults (3). For adults this level was set to 3 mg/d and 4 mg/d for women and men,  
52 respectively (3).

53

**54 Upper intake levels and toxicity**

55 An intake of 2.2 g/kg bodyweight is lethal in adults. In children 15 mg/kg bodyweight is  
56 lethal and 5 mg/kg bodyweight causes acute symptoms, such as nausea, stomach pain and  
57 vomiting. Chronic high intakes may affect skeletal mineralisation and kidney function (4).  
58 The most common side effect of high fluoride intake is enamel fluorosis also called  
59 'mottled teeth'. Fluorosed enamel is composed of hypomineralized sub-surface enamel  
60 covered by well-mineralized enamel. The exact mechanisms of dental fluorosis  
61 development have not been fully elucidated (5).

62

63 The EFSA NDA (6) panel considered that an intake of less than 0.1 mg F/kg BW/day in  
64 children up to 8 years old corresponds to no significant occurrence of "moderate" forms  
65 of fluorosis in permanent teeth.

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