Boiled and unboiled tap water intake of Cape Town residents

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Abstract

Two dietary surveys, utilising a 24-h recall method, of all food and drink items consumed, were carried out in the summer and winter of 1983 and 1984 in Cape Town. Water consumed was classified as from domestic tap water, commercial beverages, or naturally bound in food. The water was also classified as to whether it had been boiled or not, as well as whether it was consumed at home, or away from home. Tea and coffee consumption was explicitly recorded. Boiled tap water consumption in foods and drinks constituted 64,2%. Boiled tap water intake derived from tea or coffee amounted to 83,7%. Mean total intake of all forms of water consumed was 1,77 ℓ per head per day.

Introduction

Adverse health effects of poor quality drinking water have been clearly established. An early demonstration by Snow (1855) showed through a careful epidemiological study that there was a relationship between cholera and the quality of water from the Broad Street pump in London. Since this time, numerous examples have occurred where it could be shown that not only the microbiological contaminants in water, but also chemical compounds, affected the consumer. Well-known examples are nitrates, fluorides, arsenic, mercury, cadmium, lead and there is a scare at present about some organic chemical compounds such as the chlorinated hydrocarbons (Conway, 1982).

Therefore, it is custom to reduce the intake of those contaminants via water by setting criteria or standards that prescribe the maximum concentration in the water. It has become customary also to assume that the average man of 70 kg would consume 2 ℓ of water per day (World Health Organisation, 1984; National Academy of Sciences, 1977). These values are then used to calculate the safe levels of intake.

The setting of a standard has financial implications, because water has to be treated to reduce the value of the constituents below the value set. Therefore it is of importance to know if the assumed value of 2 ℓ/d is valid and if not, what the actual intake of water is. However, the matter is not that simple since water occurs in many forms in the diet of man and in addition water may be boiled in the preparation of food and beverages. Boiling may have two distinct implications viz. :

- Water is evaporated and continuous replenishment of the water concentrates the non-volatile compounds in the water. Therefore the concentration of chemicals such as Ca, Na, K, Cl, Pb, and Cd is increased and total exposure is different to that acquired from unboiled water.
- Alternatively, boiling may remove volatile compounds and therefore exposure is reduced if the cold water concentration is taken as the exposure.

Relatively few studies have been carried out to determine actual amounts and patterns of water intake (Gardner, 1976; Abu-Zeid, 1979; Comstock *et al.*, 1980) and only one (Hopkin and Ellis, 1980) has clearly differentiated between boiled and unboiled liquid intake. In most countries an arbitrary figure for average liquid intake per head per day is normally used as a basis in calculating exposure to elements in drinking water. Mean values ranging from one to two litres per day are used and there are no apparent attempts to account for the intake of boiled water. In addition, health effects of water consumption are often related to the residential address of the subjects. It is thus important to know how much water is drunk at home and away from home.

To obtain a better understanding of how much water the average man consumes and in what form, the following study was carried out.

Subjects and methods

Two surveys on total dietary intake (i.e. all food and drink items consumed) were carried out, one in the winter of 1983 and the other in the summer of 1984 (n = 1 393 and 1 445 persons respectively) (Bourne and Bourne, 1987). The survey incorporated the two main ethnic groups found in greater Cape Town and the design of the survey involved a systematic random sample of households which were representative of the socio-economic and demographic structure of the area. In this way males and females of all ages were included in the sample.

Food items as well as drinks were recorded (utilising a 24 h recall), since water is the principal constituent of almost all foods except for pure sugars and fats (Table 1) (Newburgh and MacKinnon, 1934). Furthermore, in items such as home-prepared stews and cooked cereals, the high water content would be made up almost entirely of domestic tap water which should not be ignored in a comprehensive liquid consumption study.

Trained interviewers supplied pretested 24 h recall questionnaires to all members of the household, interviewing the person responsible for preparing the food in cases where the respondent was too young or too old to supply valid information. Household measures were used to record quantities, the volumes of certain food containers e.g. drinking vessels, being determined by the field workers. A system similar to that described by Moore *et al.* (1967) of "graduated food models" was adopted for home prepared foods, and for commercial food items empty containers of commonly used products were used to permit easy identification. All items recorded on the questionnaire were checked and converted to gram weights by an independent coder. The survey was conducted on all weekdays from Monday to Friday, thus covering a recall of four previous weekdays (Monday to Thursday) and one previous weekend day (Sunday).

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TABLE 1
WATER CONTENT OF CERTAIN FOODS

Foods	Per cent water
Milk	87
Eggs	75
Meat (well done)	40
Meat (rare)	75
Stew (with vegetables)	82
Fruit, vegetables	70 - 95
Cereals (ready to eat)	1 - 5
Cereals (cooked)	80 - 88
Bread	35

(After Newburgh and MacKinnon, 1934).

TABLE 2
MEAN CONSUMPTION FIGURES FOR GREATER CAPE TOWN (mℓ/head.day)

Domestic tap water consumed at home	924,7
Domestic tap water consumed away from home	179,0
Commercial products consumed at home	128,3
Commercial products consumed away from home	53,9
Water bound in food consumed at home	408,4
Water bound in food consumed away from home	75,0
Total domestic tap water consumed	1 103,8
Total commercial products consumed	182,2
Total water bound in food consumed	483,5
Total liquid consumed at home	1 461,5
Total liquid consumed away from home	308,1
Total liquid consumed	1 769,6

The water component was calculated using local food composition tables (Gouws and Langenhoven, 1981). Water intake was divided into 3 classes :

domestic tap water - water drunk as such, or incorporated in domestic food preparation, e.g. tea, coffee, soup, stew, porridge, etc.;
commercial products - water added in commercial processing, e.g. commercial beer, soft drinks, carbonated beverages, jam, canned fruits;
water bound in food - naturally occurring water, e.g. milk, wine, pure fruit juices, meat, vegetables, eggs, etc.

Each item was then further classified as either boiled or unboiled, according to the following operational definition:

A food or drink item is defined as "boiled" if its major components have been subjected to the boiling process during domestic-type preparation or commercial processing.

In this way it was possible to determine quantities or tap water incorporated into drinks as well as that absorbed by certain foods during cooking (e.g. rice, porridge, soup).

Results and discussion

The main results of the survey are listed in Table 2. The data on boiled and unboiled domestic tap water are presented in Tables 3 and 4, and the data for water naturally bound in food appear in Table 5.

The mean total liquid intake was found to be 1 769 litres per head per day (Table 2), which does approximate the generally accepted value of 2 litres of water per day. However, in this study domestic tap water constituted 62,4% of total intake, with water bound in food and water incorporated into commercial products contributing 27,3% and 10,3% to total water intake respectively. Water incorporated into commercial products was not included in the boiled and unboiled water analysis because of uncertainty in the manufacturing process.

Of the tap water (domestic) consumed in foods and drinks 64,2% is boiled. Of the total boiled domestic tap water intake, 82,3% is consumed at home and 17,7% away from home.

Most of the unboiled domestic tap water is also consumed in the home (86,4%) with only 13,6% being consumed away from home. Boiled tap water intake derived from tea and coffee amounted to 83,7%. The figures for mean intake of boiled domestic tap water (0,708 ℓ/head.day) and total liquid intake (1,770 ℓ/head.day) compare well with those determined by Hopkin and Ellis (1980) which are 0,950 ℓ/head.day and 1,790 ℓ/head.day respectively. It is not surprising that a larger amount of water is consumed boiled in Britain as it is a colder country and tea drinking is part of the British tradition. Similarly Capetonians consume a higher proportion of cold or unboiled drinks (0,396 ℓ/head.day) as opposed to the English (0,120 ℓ/head.day).

It must be noted that the Cape Town study included water in foods which the British study did not, so that the Cape Town figures would be even lower if the same methodology had been applied.

The comparison, however, corroborates the point that a considerable proportion of liquid intake is boiled in warm as well as in cool climates.

The traditional 2 ℓ/head.day water intake which tends to be reported in the literature and which has been used by the World Health Organisation (1971) and the Environmental Protection Agency (1976) remains a useful approximation for local use in the light of the Cape Town study. It is 25% higher than the mean intake quantified in this study (in spite of the liquid in food being included) and between 30% to 50% higher than that reported by other authors (Environmental Protection Agency, 1976) and is therefore defensible as a reference standard.

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TABLE 3
MEAN INTAKE OF PREVIOUSLY BOILED DOMESTIC TAP WATER (mℓ/head.day)

	Mean	SEM
Domestic tap water consumed at home	582,7	9,0
Domestic tap water consumed away from home	125,4	5,0
Total tap water consumed	708,1	10,5
Includes:		
Total tea consumed	311,8	7,8
Total coffee consumed	281,2	7,6

TABLE 4
MEAN INTAKE OF UNBOILED DOMESTIC TAP WATER (mℓ/head.day)

	Mean	SEM
Domestic tap water consumed at home	342,0	8,5
Domestic tap water consumed away from home	53,6	3,4
Total domestic tap water consumed	395,6	9,7

TABLE 5
MEAN INTAKES OF BOILED AND UNBOILED WATER NATURALLY BOUND IN FOOD (mℓ/head.day)

	Mean	SEM
Previously boiled water naturally bound in food consumed	179,2	3,2
Unboiled water naturally bound in food consumed	304,3	6,4
Total water naturally bound in food consumed	483,5	7,2

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