

Pattern of fluid consumption in a sample of Saudi Arabian adolescents aged 12–13 years

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Summary. *Objective.* To study the pattern of fluid consumption in a group of Saudi adolescent boys and girls aged 12–13 years.

Design. Prospective study.

Methods. Three hundred forty-four boys and girls attending school in Riyadh recorded their fluid intake for three consecutive days, including one weekend day, in April and May 2002. Types of drink/beverage and total amount consumed were analysed and ranked in order of amount/quantity of consumption. Independent samples *t*-test was used to compare between genders.

Results. Mean daily fluid intake was 1917 mL (SD 287). Drinking water provided 37%, whereas carbonated soft drinks and fruit juice/drink accounted for 26% and 25%, respectively. Seven percent of total fluid intake amounting to 134 mL came from milk and 5% (103 mL) was from tea/coffee. Fluid intake was higher in boys (2006 mL) than in girls (1821 mL) ($P = 0.049$). This was also true for carbonated soft drinks ($P = 0.050$) and tea/coffee ($P = 0.000$). Girls consumed more milk ($P = 0.001$) and fruit juice/drink ($P = 0.001$) than boys.

Conclusion. Both carbonated soft drink and fruit juice/drink accounted for the largest proportion of total fluid intake by the sampled Saudi adolescents to the detriment of nutritious milk.

Introduction

Fluid intake is essential for life. It can also be an important source of nutrients and fluoride, which in turn may be related to a number of diseases [1–3]. Few studies have focused on water intake and beverage consumption especially in healthy children and adolescents. Maintenance of a relatively constant volume and stable composition of the body fluids is essential for normal functioning of the body tissues. Dehydration may result if appropriate measures are not instituted to maintain water balance.

Epidemiological studies of water or fluid intake have been reported for various age groups in some communities. Galagan *et al.* [4] reported that the daily fluid intake of 9–10-year-old children living in two Californian communities was 1500 mL, of which 760 mL came from tap water. Similar study was carried out in Canada by McPhail and Zacherl

[5] for the same age group. They reported a fluid intake of 1310 mL, with tap water accounting for 676 mL. In both studies, milk provided for most of the nontap-water fluids. Among 12-year-old Canadians, Clovis and Hargreaves [6] reported mean daily fluid intake of 1211 mL. In Great Britain, Hopkin and Ellis [7] reported that the total liquid intake among 12–17-year-olds was 1401 mL for boys and 1178 mL for girls. From Perth, Australia, Crosby and Shepherd [8] reported a mean daily intake of 1195 mL over both summer and winter among 12–15-year-olds. In a comprehensive study of total water intake in Northumbrian adolescents aged 12–14 years in UK, Rugg-Gunn *et al.* [9] reported mean intake from all sources was 1259 g/day with 66% coming from drinks and 34% from foods.

Recent dietary studies indicate water intake among children has declined and consumption of soft drinks and juices has increased [10–12]. Potential health problems associated with high intake of sweetened drinks such as being overweight or obesity [3], dental caries [12], and potential enamel erosion [13,14] have been reported and thus became major concern to health-care professionals [15,16]. Con-

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sumption of fluids is highly variable among different people and even within the same person on different days, depending on climate, habits, and level of physical activity. As far as we know, there are no reported studies on fluid consumption among adolescents in an Arab community.

The aim of this study, therefore, was to investigate the sources of fluid intake in a sample of adolescents aged 12–13 years in Riyadh, Saudi Arabia.

Material and Methods

Between March and April 2002, two groups of intermediate school children aged 12–13 years were requested to record all fluids consumed for three consecutive days (including two weekdays and one weekend day). These children were volunteers from primary school no. 20 (for girls) and Prince Sultan Building Primary School (for boys), both in Riyadh, the capital city in the central region of Saudi Arabia. The schools are government-funded with children from a wide variety of socioeconomic backgrounds. The schools were chosen because they provided a convenience sample of the target population. The sample size was calculated with 80% power of the test with 95% confidence interval and a maximum error of ± 25 mL of estimated mean fluid intake [17]. The study protocol was approved by the ethics committee of the College of Dentistry Research Center. Permission was sought for and granted by the directors of the schools during school visit for dental health education project. After full explanation to the pupils, only those who agreed to participate in the study and had parental consent were recruited. A specially designed diary was given to each pupil to record the type of drink such as water and source (tap or bottled), tea/coffee, milk, fruit juice/drink, and carbonated soft drinks. The approximate amount consumed in household measures or as packaged drinks and the times of consumption were also recorded. The study was carefully explained to the pupils such that they understood how to complete the diary. Thereafter, the diary was pre-tested on a sample of 20 pupils. Children known to have any adverse medical conditions, such as diabetes, cardiac, or renal disorder, were excluded from the study.

The definitions used were:

(i) Fluid: any nonalcoholic liquid substance, including carbonated soft drinks, milk and milk based drinks, fruit juice/drink, tea/coffee, and plain water.

(ii) Carbonated soft drink: any effervescent soft drink aerated with carbon dioxide.

(iii) Milk: any drink in which milk is the basic constituent and to which a flavoured powder or syrup may be added.

(iv) Fruit juice: 100% pure juice at the same strength and consistency as when the fruit was originally squeezed.

(v) Fruit drink: concentrated fruit and other flavoured drinks that are sold already diluted or to which water is added before consumption.

(vi) Tea/coffee: drink made by adding water to tea or coffee.

(vii) Plain water: bottled or tap water consumed on its own as a drink.

The data were analysed using the Statistical Package for Social Sciences (SPSS) program version 10. Fluid consumption was calculated as individual means of the three record days. Descriptive statistics and tables were generated for each variable. The mean daily fluid consumed, percentage of the total fluid contributed by water, milk, fruit juice/drink, and carbonated soft drinks were calculated. Independent samples *t*-test was used for comparison between genders.

Results

Three hundred forty-four children participated in the study yielding a total of 1032 (344×3) diaries. Of these, 11 children were excluded because they provided incomplete information or had medical disability, thus 999 (333×3) diaries were available for analysis. There were 170 boys and 163 girls.

The mean daily fluid consumption for all children was 1917 mL (Table 1). Drinking water provided 37% of total fluid intake, whereas carbonated soft drinks and fruit juice/drink accounted for 26% and 25%, respectively. Seven percent of the total fluid intake amounting to 134 mL came from milk and only 5% (103 mL) was contributed by tea or coffee.

Table 1. Mean daily fluid consumption (mL \pm SD) of 333 Saudi adolescents aged 12–13 years.

Dietary sources	Mean	SD	Percentage of total fluid
Water	707	167	37
Carbonated soft drink	492	199	26
Fruit juice/drink	481	105	25
Milk	134	55	7
Tea/coffee	103	80	5
Total fluid	1917	287	100

Table 2. Comparison of mean daily fluid consumption (mL \pm SD) between boys and girls.

Dietary sources	Males (N = 170)			Females (N = 163)			t-test P values
	Mean	SD	Percentage of total fluid	Mean	SD	Percentage of total fluid	
Water	795	140	40	614	140	34	0.713
Carbonated soft drink	540	187	27	442	200	24	0.050
Fruit juice/drink	443	88	22	520	107	28	0.001
Milk	111	40	5	157	58	9	0.001
Tea/coffee	117	70	6	88	88	5	0.000
Total fluid	2006	256	100	1821	288	100	0.049

Boys drank significantly more fluid than girls ($P = 0.049$) as shown in Table 2. The intake was also significant for carbonated soft drinks ($P = 0.050$) and tea/coffee ($P = 0.000$). On the other hand, girls consumed significantly more milk ($P = 0.001$) and fruit juice/drink ($P = 0.001$) than boys. There were no significant differences, however, in the drinking water intake ($P = 0.713$) between both genders.

Discussion

This study offers an insight into the sources of fluid intake in a group of Saudi Arabian adolescents. The study is limited in that it was based on a convenience sample of 333 schoolchildren, consequently extrapolating the results to the rest of Saudi Arabia warrants careful consideration. Results nevertheless provide a pointer to fluid intake characteristics of urban school children, and the need for broader corroboration is acknowledged. Fluid consumed by individuals can be an important source of minerals and nutrients. Dietary guidelines for these nutrients provide authoritative advice on how much one should consume to be healthy. Comparisons between

studies are difficult and could prove complicated for various reasons. The climatic environment in this subregion is different from those of other studies. Saudi Arabia is an arid tropical country with extremely high and dry temperatures. Furthermore, there are differences in the age groups studied, and finally definitions of what constitutes 'fluid' have been sparse. Although some studies included total water intake, including that present in foods, others considered tap water only. A few considered dietary drinks. In this study, only drinks are considered. Drinking water contributes 37% of the total fluid intake. This was higher than the 33% reported by Sichert-Hellert *et al.* [18], 29% by Clovis and Hargreaves [6], and 21% by Rugg-Gunn *et al.* [9]. The findings that boys consumed more fluid than girls are in agreement with earlier studies [6,9,17]. The mean daily fluid intake (1917 mL), however, was quite high when compared with data from studies of similar age groups as shown in Table 3. This may be due to climatic differences. The average air temperatures in Riyadh during the survey ranged between 25°C and 31 °C with a mean of 28.6 °C. The average relative humidity was 19% [19]. The hot air temperature coupled with low humidity must

Table 3. Comparison of fluid consumption among five studies. References to the studies are given in parentheses.

Source	Age (y)	Period	Total daily fluid intake	Water	Milk	Soft drink*	Tea/coffee
This study	12–13	March, April (Spring)	1917 mL	707 mL	134 mL	973 mL	103 mL
Sichert-Hellert <i>et al.</i> 2001 [18]	9–13	All season	Males 969 g Females 822 g	344 g 298 g	203 g 144 g	336 g 293 g	87 g 87 g
Rugg-Gunn <i>et al.</i> 1987 [9]	11–12	All season	840 g	176 g	219 g	109 g	336 g
Clovis and Hargreaves 1986 [6]	12	February & June (Winter & Summer)	1211 mL	350 mL	376 mL	485 mL	485 mL
Pang <i>et al.</i> 1992 [26]	7–10	April, May, June (Spring)	1242 mL	486 mL†		756 mL**	

*Carbonated and non-carbonated drinks.

**Includes tea/coffee.

†Includes milk.

All intakes are for per day.

be partly responsible for the higher fluid intake. Kleiner [20] stated that the recommended fluid requirement for infants and children is 1.5 mL/KCal energy expenditure per day. Factors that add to the fluid needs include exercise, high temperature, low humidity, and increased fluid loss due to caffeine consumption [20]. For 12–13-year-old children in this environment, therefore, their requirements will be in excess of 2500 mL of fluid. Children who fall short of their daily fluid requirements may thus be at risk of dehydration, the consequences of which include diminished salivary secretion, risk of kidney stone, and some forms of cancer [20–22].

Carbonated soft drinks and fruit juice/drink constitute 51% total fluid intake. Similar observation was reported by Johansson *et al.* [13] in young Saudi men. Although the survey did not include beverage preferences between regular and diet/low sugar, it was commonly observed that diet beverages are not popular among school children in this environment. A typical 330 mL can of sugared carbonated soft drink contain 10 teaspoons (tsp) of table sugar [12]. Assuming 1 tsp of table sugar is equivalent to 4 g [11], total sugar intake from carbonated soft drink is equivalent to 60 g. The fruit drink also provides an equivalent of 58 g of sugar (250 mL pack contains 30 g of sugar). Thus, both carbonated soft drink and fruit drink constitute 51% of total fluid intake accounted for 118 gEq of sugar. Sheiham [23] reported that sugar levels of 15 kg/person/year may represent upper limit of 'safe' or 'acceptable' levels of sugar consumption. Of great concern, however, is that this soft drink consumption is alarmingly high and far exceeds the safe limit, and even those reported in some Western countries [24–26]. Dissimilar lay public awareness and craving for more fluid intake because of hot weather may be partly responsible. Targeted marketing by manufacturers of soft drinks and easy access also encourage consumption. Apart from the home environment, which could be a source of children's access to soft drinks, an increasing share was obtained from restaurants, fast-food outlets, and vending machines that abound in shopping malls. Furthermore, many soft drinks also contain significant amount of caffeine, which, if consumed regularly, may lead to habitual usage [12]. This is in agreement with a recent study on decision-making process for sugar consumption, which stated that with adolescents, immediate pleasurable taste of sugar outweighed and deferred the recognition of dangers associated

with its consumption [2]. Adolescence is a time of rapid growth, independent food choices, and food fads. It is also a period of heightened caries activity as a result of increased intake of cariogenic substances and inattention to oral hygiene procedures [12]. Although detection of caries activities was not part of this survey, previous studies [27,28] on caries prevalence among Saudi adolescents have alluded to this fact.

In a study on fluid consumption related to climate among children in USA, Sohn *et al.* [29], found no evidence that fluid consumption is significantly related to mean daily temperature. Clovis and Hargreaves [6] also found no significant difference in fluid consumption between winter and summer. Crosby and Shepherd [8], however, noted an increase in fluid intake when temperature exceeded 21 °C. The mean daily temperature during the survey was 28.6 °C [19]. This study thus confirms the influence of environmental temperature on fluid intake. Although repeating the survey, each season may provide a more accurate estimation of fluid intake; this is not feasible because all schools close for vacation in summer. The study was carried out in the spring of 2002 when average daily air temperature and humidity was 28.6 °C and 19%, respectively. It was thought that liquid intake in the spring would approximate the annual mean daily consumption.

The proportion of fluid intake contributed by milk as reported by Rugg-Gunn [9] and Clovis and Hargreaves [6] (26% and 31%, respectively) was substantially higher than in this study (7%). This might be due to the traditional diet with little milk [30]. With urbanization, carbonated drinks and juices emerged recently as convenient drinks with universal appeal. This might be related to the report that increased consumption of sweetened drinks negatively affects the overall health by displacing solid food or other types of beverages or both that has higher nutritional value [2]. The consequences of this include lower daily protein, calcium, magnesium, phosphorous, and vitamins A and D intake. Maximizing peak bone mass in children during their growth period is particularly important especially in adolescent females. Almost half of adult skeletal mass is formed between 10 and 20 years of life. In addition, calcium accumulation normally triples during the pubertal growth spurt [31]. Inadequate consumption of milk by teenagers may contribute to a decrease in bone density, subsequent increase in fractures, and future risk of osteoporosis [32].

It was not the intention of this study to investigate fluoride intake by these children. It is possible, however, to calculate likely intake using various assumptions of fluoride levels in water. Water supply in Riyadh is based mainly on natural ground water and/or desalination water. The fluoride (F) concentration was determined to be between 0.00 and 2.5 mg/L [33,34]. Assuming a mean value of 0.7 mg F/L [34], the mean weight of fluoride ingested from drinking water and soft and fruit drinks would have been 1.18 mg/day. Assuming also that infusion of tea adds 1.5 mg F/L [35] to water from which it is made, a mean of 0.16 mg F/day could have been ingested from this source. Thus, the mean daily fluoride consumed from fluid might have been about 1.34 mg, which is quite substantial.

As a method of data collection, the 3-day diary has been found to be reasonably reliable [36] and economical [37]. Information on fluid intake for three consecutive days does not only approximate usual intake but also helps to determine day-to-day variations [38].

What this paper adds

- This paper shows that mean daily fluid intake excluding water in food for adolescents in Riyadh is higher than previous estimates for similar age groups in western countries.
- In this very hot environment with low humidity, very high sugar intake may well come from sweetened carbonated and fruit drinks to the detriment of more nutritious milk.

Why this paper is important for paediatric dentists

- Paediatric dentists should spend more effort getting to families very early regarding sweetened carbonated and fruit drink consumption. Reinforcement of oral and general health consequences of poor nutrition must be accomplished every dental visit.

Conclusions

- 1 Fluid intake in the sampled Saudi adolescents was substantially more than those reported in Western countries.
- 2 Both carbonated soft drinks and fruit juice/drink accounted for the largest proportion of total fluid intake to the detriment of milk.
- 3 Boys consumed more fluids than girls.
- 4 Although the proportion of milk consumed by girls was more than boys, the quantity was substantially less than in Western countries.

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