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ORIGINAL ARTICLE

The awareness of water intake and its correlation with BMI among students attending national and international secondary schools in Riyadh, Saudi Arabia

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ABSTRACT

Dehydration is linked to worse cognitive functions and preference for beverages that are linked to obesity and other health conditions. Saudi Arabia's hot climate can exacerbate these effects and it is important to ensure that children in the region understand the benefits of adequate water intake. To evaluate secondary school student perceptions and practices regarding water intake, investigate how water intake is related to BMI and school performance, and compare international schools to national schools. This cross-sectional study surveyed understanding and practices relating to water intake of national and international secondary school students using a questionnaire based on a random selection of schools and students. One-hundred and sixty-two students from international schools (I) and 157 from national schools (N) responded. Most were aged 16 and 17 years old (I:61.1%, N:76.5%, $p = .005$). The average BMI of all students was 24.9 ± 6.013 (I:23.6 ± 4.658, N:26.1 ± 6.931, $p < 0.001$). Students understood beverages do not replace water intake (I:80.2%, N:75.8%, $p = .337$) and preferred water when thirsty (I:77.8%, N:75.2%, $p = .549$). However, water consumption was low with more than 50% of students drinking less than 1500 ml a day (I:54.3%, N:70.7%, $p = .002$). A positive correlation between BMI and water intake was observed only among international school students. Students have inadequate water intake despite understanding the importance of hydration. There are some differences between international school students and national school students that can be attributed to the availability and sources of water, though other factors cannot be excluded.

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Water intake; BMI; secondary school students; academic performance

1. Introduction

Water is considered to comprise two-thirds of our body fluids and is essential to sustain life and to maintain all functions of the human body. Sufficient water intake is important to aid food ingestion and digestion, regulate body temperature, and maintain adequate blood circulation which carries nutrients and oxygen to cells. Chronic dehydration has adverse effects on cognitive and physical performance, as well as on general health [1]. Without any water intake, we cannot survive for more than a few days [2].

The amount of water intake required depends on a variety of factors, including age, body size, metabolism, physical activity and environmental conditions such as humidity and temperature [3]. As such, it is challenging to define an adequate intake of total water (from all sources), but it is estimated to range between 2700 to 3700 in adults [3]. Despite this scientific uncertainty, the benefits of good hydration are well established and numerous studies have concentrated in evaluating public awareness on the subject. In some cases, lack of awareness is evident, as shown in a study of 1,483 adults in China where two-thirds of the participants were unaware of water-intake recommendations by the Chinese Nutrition Society (1,200 mL/day) and one third did not meet these recommendations [4].

Although there are multiple sources of water, including food and fluids such as milk, drinking water, tea, coffee, and beverages [3], not all healthy. Of particular interest are sugar-sweetened beverages (SSBs) because these are linked to obesity [5,6]. Replacing SSBs with calorie-free beverages leads to reduced weight gain in children [7] and there is a strong relationship between water consumption and weight loss [8,9]. Individuals who drink water are likely to experience weight loss compared to those who drink sweetened beverages (with the exception of coffee), who are likely to experience weight gain [10,11]. However, even when awareness of the benefits of water is high, practice can still remain poor, as shown by a study of schoolchildren in China, where the majority of

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participants understood the benefits of drinking water and yet preferred sugary drinks [12]. There is, therefore, a need to educate the population on the benefits of healthy water intake and schools are the best place to start such programs. Also, an attempts should be made to improve access to water sources, especially at schools and working areas in hot, dry environments [1].

The issue of dehydration is more pronounced in hot climates [3], like Saudi Arabia. The General Directorate of Nutrition in Saudi Arabia recommends a water intake of 1.5 L (6 cups), though it acknowledges that specifying a minimal intake can lead to dehydration due to the numerous factors that affect fluid intake needs, such as physical activity, diet and health [13]. For adults, a total water intake of at least 3 L can be considered satisfactory [14]. In Riyadh, a considerably hot zone, children are at risk of dehydration because they spend long hours away from their parents' supervision. However, there is limited literature on the level of awareness of the benefits of hydration or current practices among this group. A report involving 725 children (7–12 years old) from Al-Baha city, Saudi Arabia, revealed a high intake of sweets products and sweetened-carbonated soft drinks among children [15]. Another study from 2006 of 344 children (12–13 years old) in Riyadh City also reported that most fluid intake came from both carbonated soft drink and fruit juice/drink, with water only accounting for 37% of the fluid intake [16]. High intake of sugar-sweetened beverages is correlated with low water intake and obesity [17], and further studies are needed to examine water consumption and its determinates among Saudi children.

The aim of the study was therefore to evaluate children's fluid intake practices and awareness of the importance of keeping themselves well hydrated. The objectives were to ascertain their knowledge on adequate hydration and healthy drinking, evaluate fluid intake practices, investigate the relation between body mass index (BMI) and water intake, explore correlations between water intake and students' school performance, and compare the findings between national and international secondary schools. Compared to international schools, public national schools are not as well funded, do not have admission fees, and students are from low to middle socioeconomic class with lower level of education. As such, a comparison will allow to identify if these factors also affect water intake behavior. The null hypothesis was that there are no differences in knowledge and practices of healthy fluid intake between children at international schools and national schools.

2. Methods

2.1. Study design, setting, and participants

This was a questionnaire-based cross-sectional study of children attending national and international secondary schools in Riyadh city. The population of interest was secondary school children in Riyadh city, so all students from 1st, 2nd, and 3rd year of secondary schools were eligible to participate. There were no exclusion criteria (apart from unwillingness to participate).

Based on the proportional allocation technique, students were selected using the multistage stratified random sampling method. Firstly, two national and two international secondary schools were selected randomly from a list of all schools in Riyadh, Saudi Arabia. Then, from each selected school, all students from each educational grade (1st, 2nd, and 3rd year) in attendance the day of the data collection were asked to participate.

2.2. Measures

A self-administrated questionnaire with 25 questions was designed by a panel of doctors (including from the Public Health Department) for the assessment of students' awareness and knowledge about the importance of water intake, as well as their drinking practices. The schools' principal and teachers were also involved in the design to ensure that the questions were in alignment to the school's policy and did not affect the privacy of the students. The questionnaire included basic demographic questions (age, self-reported grades).

The BMI was calculated from the height and weight. Weight and height were measured based on the World Health Organization guidelines [18]; students were asked to remove all objects from their pockets, be barefoot, and wear light clothing. We categorized BMI as <18.5 (Underweight), 18.5–24.9 (Normal), 25–29.5 (Overweight), and ≥30 (Obese).

2.3. Sample size

A pilot study of was performed to confirm that students understood the questionnaire and estimate sample size for the purpose of comparing children from national and international schools. Twenty students were randomly selected from two different secondary schools (national and international). We found out that 13 out of 20 (65%) in international schools and 9 out of 20 (45%) in public schools were aware of the importance of water intake. For a power of 90%, 95% confidence intervals, a proportion of 65% in one group and 45% in the other, a minimum sample size of 128 per school type was calculated based on the two-proportion formula [19]. To ensure the minimum sample size was reached, we chose two schools from each school-type cluster.

2.4. Statistical analysis

Data were entered and analyzed using the Statistical Package for Social Sciences version 21 (SPSS Inc., Chicago, IL, USA). Descriptive statistics (mean, standard deviation, and percentages) were used to describe the quantitative and categorical variables. Unpaired T-test for continuous variables and Pearson chi-square test was used to observe and quantify an association between categorical study and outcome variables. A p-value of <0.05 was set as significant, and 95% confidence intervals (CI) were used to report the statistical significance and precision of the results.

2.5. Ethics

The study was accepted and reviewed by The Institutional Review Board of the College of Medicine Research Center, Vice Deanship for Scientific Affairs, and College of Medicine, King Saud University. Written consent was obtained from all participants after they had been given a complete explanation of the aims of the research and the nature of the questionnaire.

3. Results

The study took place from February to April of 2018. Table 1 shows the demographics and characteristics of the participants. The schools that were randomly selected were the British International school, the Alrowad International school, the King Saud Secondary school, and the Prince Abdul Majeed Bin Abdulaziz secondary school in Riyadh. Three hundred and nineteen students completed the questionnaires, 162 from international schools and 157 from national. Average student age was similar between international schools (16.5 years ± 10.02 SD) and national schools (16.7 years ± 0.84, p = 0.094). However, the distribution of ages was different between schools with 16 and 17-year-old students comprising 61.1% of students in international schools compared to 76.5% in national schools (p = 0.005). Only 4 students had any chronic illnesses. The average BMI of all students was 24.9 ± 6.013, with the BMI of students at international schools (23.6 ± 4.658) being lower than that of students at national schools (26.1 ± 6.931), p < 0.001. International schools had a much higher percentage of students with BMI of 18.5 to 24.9 (58.6%) than national schools (38.2%). Lastly, the majority of students had very good or excellent grades, and that was true for both types of schools. Students in national schools counted their grades higher (8.759 ± 1.24) than students in international schools (8.1107 ± 1.51), p = 0.015.

Table 1. Participants' characteristics (n = 319).

	International school (N = 162)	National school (N = 157)	
	n (%)	n (%)	P value
Age			
15 years	32 (19.8%)	11 (7%)	<.005
16 years	49 (30.2%)	56 (35.7%)	
17 years	50 (30.9%)	64 (40.8%)	
18 years	31 (19.1%)	26 (16.6%)	
Chronic illness			
Yes	0 (0%)	4 (2.5%)	.041
No	162 (100%)	153 (97.5%)	
BMI			
<18.5 (Underweight)	16 (9.9%)	18 (11.5%)	<.005
18.5–24.9 (Normal)	95 (58.6%)	60 (38.2%)	
25–29.5 (Overweight)	35 (21.6%)	38 (24.2%)	
≥30 (Obese)	16 (9.9%)	41 (26.1%)	
Grade			
Excellent	73 (45.1%)	108 (68.8%)	<.005
Very good	51 (31.5%)	35 (22.3%)	
Good	30 (18.5%)	14 (8.9%)	
Acceptable	8 (4.9%)	0 (0%)	

Water consumption was low with the most frequent amount being 1000 to 1500 ml in both international (36.4%) and national (39.5%) schools (Table 2). However, more students in international schools consumed larger amounts of water than students in national schools, Table 2 (p = 0.002). These results are reflected also in the ml/kg water consumption (Table 2). Most students also reported that the body needs 5–10 cups of water a day, though students in international schools were more likely to think so than students in national schools (p < 0.005).

Most students reported that they drink water when they feel thirsty (with no difference between schools, p = 0.549), fewer students in national schools compared to international schools drunk water regularly (32.5% vs 46.3%), and most students in national schools preferred soda when having a meal (45.9%) compared to those in international schools (21.0%), who still preferred water (45.7%) (Table 2).

Students in international schools were more likely to drink barrel water compared to national schools (1.9%), which drunk bottled water (58%), p < 0.001 (Table 3), and the main areas providing water were cafeterias in both international schools (47.5%) and national (81.5%), p < 0.001.). A substantial percentage did not carry water bottles with them (42.6% in international schools, 74.5% in national schools, p < 0.001), and if they did, most only filled them once (37.4% in international schools, 52.4% in national schools, p = 0.140), despite the fact that most bottles were small (42.5% had less than 500 ml capacity in national schools).

Many students observed that they had never been reminded to bring a bottle of water with them during training (Table 4), though this was more frequent in national schools (89.5%), p < 0.001. The most frequent amount of water drunk after exercise was 100 ml to 600 ml, with

Table 2. Water drinking practices.

	International school (n = 162) N (%)	National school (n = 157) N (%)	CI 95%	P values
Daily water consumption				
10 mL/Kg	11 (6.8%)	25 (15.9%)	.08-.153	.005
20 mL/Kg	33 (20.4%)	42 (26.8%)	.19-.286	
30 mL/Kg	62 (38.3%)	60 (38.2%)	.329–438	
40 mL/Kg	27 (16.7%)	17 (10.8%)	.102-.181	
50 mL/Kg	29 (17.9%)	13 (8.3%)	.097-.174	
Daily water consumption				
500–1000 mL	29 (17.9%)	49 (31.2%)	.198–295	.002
1000–1500 mL	59 (36.4%)	62 (39.5%)	.326-.435	
1500–2000 mL	41 (25.3%)	33 (21%)	.187-.282	
2000–3000 mL	33 (20.4%)	13 (8.3%)	.108-.188	
Daily water requirements (cup = 200 ml)				
1–5 cups	10 (6.2%)	47 (29.9%)	.138-.225	<.005
5–10 cups	98 (60.5%)	78 (49.7%)	.495-.607	
10–15 cups	47 (29%)	29 (18.5%)	.193-.289	
15–20 cups	7 (4.3%)	3 (1.9%)	.015-.057	
Water at home				
Tap water	36 (22.2%)	22 (14%)	.141-.229	<.005
Barrel water	36 (22.2%)	36 (22.9%)	.181-.276	
Bottled water	72 (44.4%)	51 (32.5%)	.332-.441	
Filtered water	18 (11.1%)	48 (30.6%)	.164-.256	
Drink with meal				
Water	74 (45.7%)	31 (19.7%)	.278-.384	<.005
Juices	38 (23.5%)	39 (24.8%)	.195-.292	
Soda	34 (21%)	72 (45.9%)	.281-.387	
Other	16 (9.9%)	15 (9.6%)	.067-.135	
Drink when thirsty				
Water	126 (77.8%)	118 (75.2%)	.714-.810	.549
Juices	12 (7.4%)	17 (10.8%)	.062-.128	
Soda	22 (13.6%)	18 (11.5%)	.091-.167	
Other	2 (1.2%)	4 (2.5%)	.007-.040	
Frequency of water intake				
Regularly	75 (46.3%)	51 (32.5%)	.341-.451	.012
When thirsty	87 (53.7%)	106 (67.5%)	.549-.659	
I drink water more during:				
summer	152 (93.8%)	146 (93%)	.901-.959	.764
winter	10 (6.2%)	11 (7%)	.041-.099	

Table 3. Water supply in schools.

	International school (n = 162) N (%)	National school (n = 157) N (%)	CI 95%	P value
Type of water				
Tap water	42 (25.9%)	49 (31.2%)	.236-.338	<.0001
Barrel water	59 (36.4%)	3 (1.9%)	.152-.242	
Bottled water	54 (33.3%)	91 (58%)	.399-.511	
Filtered water	7 (4.3%)	14 (8.9%)	.041-.099	
Source				
Cafeteria	77 (47.5%)	128 (81.5%)	.587-.695	<.0001
Cooler	72 (44.4%)	25 (15.9%)	.254-.358	
Toilets	8 (4.9%)	2 (1.3%)	.015-.057	
Others	5 (3.1%)	2 (1.3%)	.009-.045	
I carry a water bottle				
Yes	93 (57.4%)	40 (25.5%)	.362-.473	>.0001
No	69 (42.6%)	117 (74.5%)	.527-.638	
Frequency of filling bottle				
One time	34 (37.4%)	21 (52.5%)	.334-.509	.14
Two times	32 (35.2%)	15 (37.5%)	.277-.477	
Three times	15 (16.5%)	2 (5%)	.077-.200	
Four times	10 (11%)	2 (5%)	.048-.155	
Bottle capacity				
100–500 mL	23 (24.7%)	17 (42.5%)	.224-.386	.063
500–1000 mL	58 (62.4%)	16 (40%)	.468-.642	
1000–1500 mL	10 (10.8%)	7 (17.5%)	.076-.197	
1500–2000 mL	2 (2.2%)	0 (0%)	.002-.053	

a higher percentage in international schools drinking 300 ml – 600 ml. The vast majority of students preferred water after exercise and understood that water intake depends on physical activity.

Table 4. Water intake practices during exercise and physical activities.

	International school (n = 162)	National school (n = 157)	CI 95%	P value
	N (%)	N (%)		
Course trainer reminding				
Always	34 (21%)	2 (1.3%)	.080-.153	<.0001
Sometimes	31 (19.1%)	4 (2.5%)	.078-.149	
A few times	14 (8.6%)	11 (7%)	.051-.114	
Never	83 (51.2%)	140 (89.2%)	.645-.749	
Water intake after training				
Often none	14 (8.6%)	13 (8.3%)	.057-.121	<.0001
100–300 mL	45 (27.8%)	81 (51.6%)	.341-.451	
300–600 mL	86 (53.1%)	53 (33.8%)	.381-.492	
600–900 mL	17 (10.5%)	10 (6.4%)	.057-.121	
Water intake depends on physical activity				
Yes	134 (82.7%)	99 (63.1%)	.678-.778	<.0001
No	28 (17.3%)	58 (36.9%)	.222-.322	
Preferred drink after activity				
Water	142 (87.7%)	136 (86.6%)	.830-.903	<.0001
Juices	11 (6.8%)	13 (8.3%)	.049-.110	
Soda	6 (3.7%)	8 (5.1%)	.024-.073	
Other	3 (1.9%)	0 (0%)	.002-.027	

Students at both types of schools agreed that drinking beverages could not replace drinking water (Table 5). Most students also realized there is a correlation between BMI and water intake (Table 5), though a small percentage thought water can cause weight gain (17.9% in international schools, 11.0% in national schools, p = 0.067). Students also reported that their cognitive function is affected by dehydration, and that drinking water can prevent diseases.

Water consumption was different between students of different grades, but this was statistically significant only in international schools (p < 0.001), where more students with excellent grades drunk 1500–2000 ml per day (Table 6).

Correlation analysis indicates that there is a positive relationship between BMI and water intake in international schools (r = .282, P < .001), but not so in national schools (r = .064, P = 0.424). A negative correlation between BMI and self-reported grade was

Table 5. Knowledge about water intake.

	International school (n = 162)	National school (n = 157)	CI 95%	p value
	N (%)	N (%)		
Beverages replace water				
Yes	32 (19.8%)	38 (24.2%)	.175-.296	.337
No	130 (80.2%)	119 (75.8%)	.731-.825	
Is there a relationship between BMI and water intake?				
Yes	104 (64.2%)	106 (67.5%)	.603-.710	.532
No	58 (35.8%)	51 (32.5%)	.290-.397	
Drinking more water:				
Increases BMI (Weight gain).	19 (17.9%)	12 (11%)	.10-.198	.067
Decreases BMI (Weight loss).	44 (41.5%)	62 (56.9%)	.424-.562	
Maintain my BMI	43 (40.6%)	35 (32.1%)	.298-.431	
>8 h dehydration affects mentality and understanding				
Yes	129 (79.6%)	111 (70.7%)	.701-.799	.065
No	33 (20.4%)	46 (29.3%)	.201-.299	
Drinking enough water could prevent disease				
Yes	147 (90.7%)	144 (91.7%)	.876-.941	.757
No	15 (9.3%)	13 (8.3%)	.059-.124	

Table 6. Relationship between daily consumption of water and self-reported grade.

	Amount of water per day					
International school grade	0.5–1 L	1–1.5 L	1.5–2 L	2–3 L	df	P-value
Excellent	8 (4.9%)	18 (11.1%)	31 (13%)	26 (16%)	9	<.001
Very good	13 (8%)	24 (14.8%)	10 (6.2%)	4 (2.5%)		
Good	4 (2.5%)	14 (8.6%)	10 (6.2%)	2 (1.2%)		
Acceptable	4 (2.5%)	3 (1.9%)	0 (0%)	1 (0.6%)		
National school grade						
Excellent	31 (19.7%)	42 (26.8%)	23 (14.6%)	12 (7.6%)	6	.255
Very good	11 (7%)	17 (10.8%)	6 (3.8%)	1 (0.6%)		
Good	7 (4.5%)	3 (1.9%)	4 (2.5%)	0 (0%)		

observed in both international (r = −.192, P = .015) and national schools (r = −.196, P = .014).

4. Discussion

Knowledge and awareness of the importance of water intake among international school students appeared to be higher than among national school students, as they reported carrying their own water bottle, consume the proper amount of water, and consume water while having their meals rather than soft drinks or other beverages that are a known risk to obesity [10,11]. Although previous studies show that there is a link between BMI and water intake [8–10], our findings indicate that the correlation is weak and does not apply to all settings. The effect of confounding factors that are known to affect BMI, such as sedentary life style and dietary intake [8], cannot be ruled out.

An interesting observation is that students from national schools consume water more frequent in the form of bottled water from the cafeteria, while international school students consume bottled water less frequently. We presume that there are two reasons behind that. Firstly, international schools offered coolers and barreled water for free to their students. Secondly, more international school students bring their own water bottle (57.4%) than national school students (25.5%).

Despite this cohort not meeting the required water intake of 2000–3000 ml/day [3], most students had very good or excellent grades. This possibly relates to the fact that mild transient dehydration doesn't affect cognitive function [3] and, thus, academic performance is not affected the same as in prolonged dehydration.

A limitation of this study is that there is no validated questionnaire measuring the level of awareness of water intake and its correlation with BMI in the literature, so we had to construct our own. However, we utilized a panel of experts and piloted the questionnaire on a small number of students prior to the main study. In addition, we did not explore the reasons behind non-completion of the questionnaires. Finally, we did not have any data on gender, so we could not report age and gender specific BMIs, nor evaluate if there was an unequal ratio of male to female children between the two types of schools.

5. Conclusion

Students understand the importance of water intake, generally prefer water when thirsty, and yet do not drink enough. There are some differences between international school students and national school students that can be attributed to the availability and sources of water, though other factors cannot be excluded. Finally, BMI does not always correlate with water intake.

6. Recommendations

Our results should be corroborated with studies that further explore students' awareness and perception about their daily need of water and benefits of proper hydration. We encourage the Ministry of Health to collaborate with the Ministry of Education to establish programs that educate students on the importance of drinking water, and to ensure free water is provided to all students.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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