Effect of Seasonal Temperature and Humidity on Urine Density in Children

Mevsimsel Sıcaklık ve Nem Değişikliklerinin Çocuklarda İdrar Dansitesine Etkileri

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ABSTRACT Objective: Temperature and humidity of environment are important factors affecting hydration. Urine density is a valuable parameter that can be evaluated for checking hydration status of healthy children. We aimed to investigate effects of seasonal climate changes on urine density of children in Cyprus. **Material and Methods:** 1700 healthy 0-18 year children's age, sex and urine density results were collected retrospectively for three years. The correlation of urine density with each seasonal and 12 months' average temperature and humidity has been analysed respectively. **Results:** Mean urine density of the total 1700 cases was 1019.77 ± 8.39, minimum 1000, maximum 1030. The urine density results had a positive correlation with temperature (r= 0.083, p= 0.001) and a negative correlation with humidity (r= -0.072, p= 0.003). Mean urine density in spring was higher than that of autumn (p= 0.02) and winter (p= 0.00). Mean urine density value of summer was higher than autumn (p= 0.03) and winter (p= 0.00). 0-24 months age group had lower urine density results. There were no significant differences between urine density of girls and boys, as well as pubertal vs. postpubertal age. **Conclusion:** As a result, climate changes have an impact on urine density in children and consuming water is essential especially in infants during high temperature seasons in order to avoid dehydration and help to protect children from chronic health problems.

Key Words: Climate; dehydration

ÖZET Amaç: Çevresel sıcaklık ve nem değerleri hidrasyonu etkileyen önemli faktörlerdir. İdrar dansitesi sağlıklı çocukların hidrasyon durumunun saptanmasında değerlendirilebilecek kıymetli bir parametredir. Bu çalışmada Kıbrıs'ta yaşayan çocuklarda mevsimsel iklim değişikliklerinin idrar dansitesine etkilerini araştırmak amaçlanmıştır. **Gereç ve Yöntemler:** Retrospektif olarak 3 yıl boyunca 1700 sağlıklı 0-18 yaş arası çocuğun yaş, cinsiyet ve idrar dansitesi sonuçları incelendi. İdrar dansitesi ile her mevsimin ve 12 ayın ortalama sıcaklık ve nem değerlerinin korelasyonu ayrı ayrı analiz edildi. **Bulgular:** Toplam 1700 olgunun ortalama idrar dansitesi 1019,77 ± 8,39, en düşük 1000, en yüksek 1030 olarak bulundu. İdrar dansitesi sonuçlarının sıcaklık ile pozitif korelasyonu (r= 0,083, p= 0,001), nem ile negatif korelasyonu (r= - 0,072, p= 0,003) olduğu saptandı. İlkbahardaki ortalama idrar dansitesi, sonbahar (p= 0,02) ve kış (p= 0,00) sonuçlarından daha yüksekti. Yaz aylarındaki ortalama idrar dansitesi, sonbahar (p= 0,03) ve kış (p= 0,00) aylarından daha yüksek bulundu. Kızlar ile erkekler ve prepubertal ve postpubertal yaş gruplarının idrar dansitesi sonuçları arasında anlamlı fark bulunmadı. 0-24 ay yaş grubunda idrar dansitesinin daha düşük olduğu görüldü. **Sonuç:** Sonuç olarak, iklim değişiklikleri çocuklarda idrar dansitesini etkilemektedir ve özellikle infantlarda sıcak mevsimlerde yeterli miktarda sıvı tüketilmesi dehidratasyonun önlenmesinde ve çocukları kronik sağlık sorunlarından korumada çok önemlidir.

Anahtar Kelimeler: İklim; dehidrasyon

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Temperature and humidity of the environment are important factors that affect hydration of children.[1] The climate may change hydration levels of children in a specific area either favorably or unfavorably.

Urine density is a valuable parameter that can be evaluated for checking hydration status of healthy children.[2] The island of Cyprus is in a geographical region having Mediterranean climate. In this study we aimed to investigate the effect of seasonal temperature and humidity changes on urine density of children living in Cyprus that do not have any kidney diseases.

MATERIAL AND METHODS

In this study we retrospectively collected the urine density results of 1700 healthy children aged 0 - 18 years. All children were evaluated for routine pediatric follow up in our Healthy Childcare Department of the Near East University (NEU) Hospital between December 2012 - May 2015. Cyprus has Mediterranean climate in the North hemisphere, therefore June, July and August are summer months, while December, January and February are winter months. The average values of temperature in centigrade and humidity as percentage of each month was obtained from the Central Meteorology Office. Urine density was measured using automated dipstick analysis in the Clinical Biochemistry Laboratory of the NEU Hospital. Ethical approval was given by institutional review board and the study was in accordance with 1964 Helsinki declaration and its later amendments. The correlation of urine density with each seasonal and 12 months' average temperature and humidity has been analysed respectively. We used One Way Anova test, Pearson correlation analysis, multiple comparisons test and student *t* test for statistical analysis and p values less than 0.05 were accepted as significant.

TABLE 1: Age and urine density of all cases, temperature and humidity values of all years.

	Age (months)	Temperature, °C	Humidity, %	Urine density
Mean	62.59	18.00	64.45	1019.77
Std. deviation	50.56	5.44	6.27	8.39
Minimum	0	5.7 46	.50	1000
Maximum	215	34.9	74.30	1035

Number of cases (n): 1700

RESULTS

Routine urine analysis of 1700 healthy 0-18 year children who admitted to NEU Hospital were investigated retrospectively for urine density values according to months, seasons, age groups, gender and puberty. The effect of seasonal temperature and humidity was analysed on each group.

The children consisted of 850 girls and 850 boys. The mean age, mean temperature and humidity of total months and mean urine density of total cases are given in Table 1.

The urine density values of children stratified according to age groups, months, seasons, puberty and gender are presented in Table 2.

Temperature and humidity levels of seasons did not change significantly as years passed by. The urine density results had a positive correlation with temperature (r= 0.083, p= 0.001) and a negative correlation with humidity (r= - 0.072, p= 0.003) with Pearson correlation test.

Mean urine density results between months were analysed with One Way Anova test and the difference was found statistically significant. Evaluation of density differences between months with multiple comparisons test revealed that mean urine density in January was significantly lower than April and August. Mean urine density in February was significantly lower than April, May and August. March results did not show any difference compared to any month. Mean urine density in April was higher than that of September.

When we compared the urine density results between four seasons, the difference was statistically significant. Mean urine density in spring was higher than that of autumn (p= 0.02) and winter (p=0.00). Mean value of summer was higher than autumn (p= 0.03) and winter (p= 0.00).

0-24 months age group had lower urine density than 25-48 months (p= 0.00), 49-72 months (p= 0.00), 73-96 months (p= 0.00), 97-120 months (p= 0.00) and 145-168 months (p= 0.01) age groups (Table 2).

Evaluation of the urine density results of 0 - 12 months children separately revealed that mean

TABLE 2: Urine density values of children stratified by age groups, months, seasons, puberty and gender.

Age group (months)	n	Mean urine density
0-24	482	1017.20±8.77
25-48	318	1021.36±7.95
49-72	254	1021.31±7.86
73-96	234	1020.53±8.19
97-120	162	1020.52±7.91
121-144	115	1019.47±7.87
145-168	59	1021.10±8.30
169-192	56	1018.83±8.47
193-216	20	1022.00±7.84
Age group (months)	n	Mean urine density
0-12	328	1015.53±8.51
13-24	154	1020.77±8.28
Months	n	Mean urine density
January	215	1018.16±8.37
February	159	1017.57±8.41
March	187	1020.29±7.67
April	154	1021.85±8.38
May	210	1020.64±8.51
June	80	1020.12±8.49
July	75	1021.33±7.81
August	89	1021.79±8.36
September	102	1018.13±7.86
October	130	1019.38±9.15
November	112	1020.00±8.51
December	187	1019.57±8.10
		p= 0.00
Seasons	n	Mean urine density
Spring	551	1020.86±8.20
Summer	244	1021.10±8.24
Autumn	344	1019.21±8.58
Winter	561	1018.46±8.32
Pubertal status	n	Mean urine density
0-14 years	1624	1019.77±8.40
14-18 years	76	1019.67±8.37
		p= 0.91
Gender	n	Mean urine density
Female	850	1019.66±8.23
Male	850	1019.88±8.55
		p=0.59

urine density in June was higher than that of October (p= 0.01) and November (p= 0.04). Also the results in March were higher than October. Urine density results in spring were higher than autumn (p= 0.00). Results in summer were higher than that of autumn (p= 0.00) and winter (p= 0.00).

13-24 months' urine density results difference was statistically significantly higher in summer than in winter (p= 0.03). Thus the risk of dehydration in infants has been shown to increase in hot seasons.

121-144 months, 169-192 months, 193-216 months groups' urine density results did not show statistically significant difference when compared to density of other age groups (Table 2).

Evaluation of urine density based on pubertal and postpubertal age revealed no statistically significant difference in the comparison of 0-14 yrs age group with 14-18 yrs age group (Table 2).

Moreover, there was not a statistically significant difference between female and male groups (Table 2).

The number of investigated results for each year is given in Table 3.

Finally, mean urine density results did not differ between different years considered (Table 3).

DISCUSSION

Temperatures in summer season during days are generally above 40 °C together with high humidity values in Cyprus. Water consumption and related health problems are more important in these extreme weather conditions especially in childhood. There are current studies explaining the relationship of dehydration with diseases like nephrolithiasis, hyperglycemia, cardiovascular problems and renal functional impairment.[3-5] In order to measure intracellular water content in studies with large number of groups, urine density has shown to be an easy and reliable method. Changes in urine density according to temperature and humidity, can be measured earlier than the clinical symptoms and signs of changed hydration levels.[6]

547 children that were healthy and living in Mediterranean climate were evaluated with urine specific gravity (Usg). There was not a significant change in Usg in summer and winter seasons. Assumed Usg changes were absent being different

TABLE 3: Number of cases, mean urine density, mean temperature and humidity of each consecutive year.

Year	n	Mean urine density	Mean temperature, °C	Mean humidity, %
2012	36	1020.13±8.65	19.5	64.3
2013	566	1019.75±8.37	19.8	61
2014	725	1019.70±8.34	19.8	65.1
2015	373	1019.90±8.53	-	-
Total	1700	1019.77±8.39	18	64.45
		p=0.97		

from our study and this was thought to be due to increased water intake because of fluid loss with sweating in the summer season.[1]

In another study, heat strain of 31 adult workers in a hot metal mine was considered. They demonstrated postshift Usg tests to be significantly higher (p= 0.004) than preshift results. Average postshift Usg was 1023 ± 0.008 and Usg was 1030 in 44.3% of the workers.[7]

Heat strain was related with fluid loss and absence of acclimatization in another study with 60 adult workers at an aluminium smelter. Usg, blood urea nitrogen and creatinin values were significantly increased in postshift samples. Results were compatible with dehydration as in our study, emphasizing that water intake is so valuable especially in extremely hot working conditions.[8]

23 children (3-11 years) were checked for 41 days in four seasons respectively with Usg. Samples obtained in the morning had significantly higher Usg results than those collected in evening (p< 0,001) as the children did not drink water while asleep. In this study there was not any significant correlation of Usg with seasons. As Usg is known to be higher in dehydration, dehydration was an exclusion criteria for children being evaluated in this study making it different from our study.[9]

In the current study a significantly higher urine density was found in summer and spring compared to autumn and winter. Increase in temperatures was parallel with increase in urine density in hot seasons indicating the importance of hydration similar to our study. Humidity values were high all year around in Cyprus, but seemed to be higher in winter than summer season. There was a negative correlation of humidity with urine density results in this study. Higher humidity in winter and autumn resulted in lower urine density values in those seasons. When humidity is high, sweating is decreased and fluid excretion via urine lowers the urine density. This result may be attributed to the small amount of difference in humidity between seasons. Higher humidity levels avoid benefiting from cooling effect of evaporation which results in increased dehydration.[10]

0-24 months urine density results were lower than other age groups probably due to urine concentration with inadequate ability in the infant kidney. Moreover, 0-12 months results were lower than 13-24 months urine density results. At 1.5 -2 years of age, children begin to maintain urine osmolality (Uosm) values as in adulthood. Several developmental factors have an influence on urine concentration capacity before 2 years of age resulting in insufficient concentration.[11]

There were virtually no significant differences between urine density of girls and boys, as well as pubertal vs. postpubertal age. This result suggests that sex hormones may not affect urine density in children.

On the other hand, in nine studies with adults, 6 of which were with healthy ones and 3 studies with chronic kidney disease or diabetes mellitus patients, men had 21-39% higher Uosm when compared with women. Both gender groups had similar urine volumes. Thirst sensation, level of arginine vasopressin and some other regulatory factors may cause the Uosm difference in males.[12]

Nevertheless, the difference in Uosm between genders did not seem to depend directly on the effect of sex hormones. 495 healthy German children aged 4-14.9 years were evaluated and girls urine volumes were higher therefore their Uosm were lower than boys in this prepubertal group. Girls seemed to consume food with higher water ingredient and insensible water loss was lower in girls than in boys.[13] A more traditional nutrition and different climate conditions might have contributed to the results of our study.

Postmenopausal women had also significantly different Uosm values compared to men.[12] Moreover, female and male rats that were undergone gonadectomy, had similar Uosm levels five weeks after the operation.[14] These results support the suggestion that gender differences do not directly depend on sex hormones.

CONCLUSION

Our study demonstrated that seasonal temperature and humidity changes have an impact on urine density in children including the infants as well. Water consumption in sufficient volumes is important especially in hot summer season to avoid dehydration and help to protect children from chronic health problems.

Conflict of Interest

Authors declared no conflict of interest or financial support.

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