Water status of breastfed infants during weaning in Yazd, Iran

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ABSTRACT

الأهداف: البحث عن حالة التروية لدى الرضع خلال فترة الفطام في الطقس الجاف والحار في وسط إيران.

الطريقة: باستعمال مقياس الانكسار، تم قياس 162 الثقل النوعي للبول (USG) من 400 رضيع، تراوحت أعمارهم ما بين 4 إلى 6 أشهر، تم اختيارهم من بين الرضع الذين راجعوا العيادات الأولية – مدينة يازد – إيران، من أجل تلقي التطعيم الروتيني خلال فصلي الصيف والشتاء لعام 2005م. تمت تعبئة استبيانات من قبل الأمهات عن جهاز التكييف والنظام الغذائي. تم قبول نتيجة ($USG_{>}1.020$) كحالة جفاف، و ($USG_{<}1.010$) تروية جيدة.

النتائج: كان 31% من الرضع يعانون من الجفاف و34% كانت ترويتهم جيدة، كان الرضع أكثر جفافاً في فصل الصيف ($p_{<}0.05$). بدأ 27% منهم في تلقي الطعام غير السائل وبدون التزود بالماء، كانت نسبة الجفاف لديهم أكثر بشكل ملحوظ ($p_{<}0.05$). لم يكن بإمكاننا إظهار نوع أجهزة تكييف الهواء المستخدمة في المنازل والتي تؤثر على حالة الماء ولكن كان هنالك ميل نحو الجفاف للذين يستعملون المروحة والبراد ($p=0.096$).

خاتمة: يتعرض حوالي الثلث من الأطفال الرضع لخطر الإصابة بالجفاف في المناطق الصحراوية في منتصف إيران خلال فترة الفطام، يجب على مقدمي الرعاية الصحية الأولية لدينا الأخذ بعين الاعتبار أهمية الماء خلال فترة الفطام عندما يكون التزويد بالماء آمناً.

Objective: To investigate the state of hydration in infants during the weaning period in dry and hot climates in the center of Iran.

Method: Using a refractometer, 162 urine specific gravity (USG) was measured from 400 infants, between 4 to 6 months old. They were chosen among infants who visited the primary clinics in the city of Yazd, Iran for routine vaccination during the summer and winter of 2005. A questionnaire was filled out on air conditioning system and diet from mothers. A USG >1.020 was accepted as dehydrated, and a USG <1.010 as well hydrated.

Result: Thirty-one percent of the infants were dehydrated, and 34% were well hydrated, infants were more dehydrated in summer ($p<0.05$). Twenty-seven percent of them started solid food without water supplementation, and dehydration was significant in most of them ($p<0.05$). We could not determine which type of air conditioning devices now used at home affect water status, but there was a trend toward dehydration in those using both fan and cooler ($p=0.096$).

Conclusion: In the desert area in the center of Iran, during weaning, approximately one third of the infants are exposed to the danger of dehydration. Our primary health care provider should consider the priority of water during weaning when water supplementation is safe.

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Dehydration is a potentially life threatening condition, especially in infants. The failure to diagnose dehydration can have serious consequences, from sleep problems to malignancies beyond infancy.[1-6] Even short-term dehydration in infancy may increase risk of hypertension in adulthood.[7] If dehydration occurs slowly and becomes chronic, its signs and symptoms might not be obvious, hence, it is more difficult to recognize it clinically. It is well established that breast feeding is the best way to feed infants. Several studies have shown that breast milk can provide the optimal level of hydration in exclusively breastfed infants.[8-10] However, in hot and dry climates, infants are more susceptible to dehydration and its consequences, and might occasionally require extra water intake specially when introducing solid food

during the weaning period.[8] According to the official survey, the rate of exclusive breastfed infants in Yazd province is close to 45% up to 4 months, and 15% up to 6 months of age. Weaning usually starts with some herbal remedy, juice, baby foods, and cereal. Iran is a country with many cities, such as Yazd, located near the deserts. The humidity usually changes from 15-33%, and the temperature exceeds 35°C in the summer, and using insufficient air conditioning systems, usually accompanied by poor house design creates a situation that increases the risk of dehydration in infants. This highlights the need for a more detailed evaluation of the dehydration status, and recommendation for extra water intake, especially during the important period of weaning. There is no ideal marker to determine the state of hydration in all situations.[11-13] However, urine osmolarity and urine specific gravity (USG) are the most widely markers used. Urine specific gravity was shown to be an accurate indicator of hydration level, except in the rapid rehydration phase, and during the acute phase of dehydration, being less than 1.01 in well or over hydration, and more than 1.02 in dehydration states.[12,14-16] Infants are rarely able to concentrate urine more than 1.02,[17,18] therefore in another study USG>1.018 has been set as an acceptable cut of point for dehydration.[19]

The purpose of this study was, therefore, to assess the hydration levels, and the requirements for water supplementation in infants living in the hot and dry city of Yazd during the weaning period.

Method. This cross sectional descriptive study was conducted in 162 infants, aged between 4-6 months, who were brought for routine vaccination in 5 primary clinics in Yazd, Iran during the summer and winter of 2005. These clinics were randomly selected from 26 primary clinics, which actively provide primary care for mothers and infants in the city of Yazd. On a specific day of the week (except holidays) for each clinic, all healthy infants visiting the clinic, without any apparent illness such as kidney, respiratory, and gastrointestinal diseases were included in this study, with permission from their guardian. Infants who received any medication were excluded from the study. As an optimum sample size, based on P:0.20 with a=95%, and d:0.07, we aimed to include 170 infants in this study.

Data were collected using a questionnaire, which was completed by the mothers in the presence of a physician. Included data were: age, feeding pattern, air conditioner systems, water supplementation, and infant problems. The participating families were from urban areas, with 70% high school and 30% secondary school education. Two types of air conditioning devices were used: fan that circulates air movement without humidity, and cooler that produces cool and humid air by evaporating water. To collect urine samples, an adhesive bag was attached in 400 infants. Mothers were encouraged to feed their infants while they were waiting. One hundred and sixty-two samples were obtained from 85 males and 77 females, before vaccination. Infants were excluded from the study if it took more than 2 hours to collect their samples (238 infants). Urine collection took place between 8-12 am of each morning. Urine specific gravity was measured using a refractometer. To examine the reproducibility of USG measurements, one third of the samples were measured twice, and another technician rechecked 30 samples. Urine specific gravity of more than 1.02 was considered as significant dehydration, and USG of 1.01-1.02 was labeled as hypo-hydration.[12,14-16] The procedure of the study was fully explained to all parents, and only if they consented to the study, the urine bag for obtaining urine sample was applied. The study was approved by the Shahid Sadoughee ethical committee.

Data were analyzed using SPSS software version 12 and reported as mean ± SD and median. Chi-square test, Mann-Whitney, and Kruskal-Wallis were used to determine the level of significance, and Dunn's multiplicity comparison for post hoc analysis. *P* values of less than 0.05 were considered significant.

Results. Participating infants were divided into 3 groups: 137 breastfed in whom 32 of them were exclusively breastfed, 6 were formula-fed, and 19 with both formula and breast feeding. Mean USG for group I was 1.014±0.008 (median 1.01), group II was 1.017±0.007 (median 1.02), and group III was 1.010±0.007 (median 1.01), (p=0.133). Two exclusive breastfed infants had individual USG=1.026 and USG=1.028, but the mean USG of exclusive breast fed infants was similar to others (USG 1.012±0.008). According to National Center for Health Statistics growth scale, 4 infants (3 breastfed, one on powdered milk) were under 3% of normal weight distribution, and 158 were over 3% in whom 8 were over 97% (3 exclusively breastfed, 2 on power milk, and 3 used both types of milk). Mean weight of infants were 6.9±0.8 kilogram. Mean USG of infants under 3% were 1.011±0.05 (1.008-1.020) and infants over 3% were 1.013±0.08 (1.001-1.032), which was not statically different (p=0.635).

Table 1 shows the state of infant hydration in the winter and summer, which indicates significant difference in well hydration (p=0.001), and dehydration (p=0.017) in summer and winter, but no difference in hypohydration state (p=0.13). Mean ± SD and median of USG was 1.016±0.008 and 1.017 in summer, and 1.011±0.007 and 1.010 in winter (p=0.001, Mann-Whitney test). **Table 2** shows the type of air conditioner

used, and its relation with the state of hydration. Seventy-two percent of the houses were equipped with cooler, 7% with fan, 20% had both fan and cooler and only 2 cases (1%) had no air conditioning systems. In the cooler group, 38% were hydrated and 27% were dehydrated, and in the user of both devices these ratio became reversed, and 40% were dehydrated and 25% were hydrated (p=0.096, Chi-square linear-by-linear). Mean USG in cooler group was 1.013±0.007 (median 1.014), fan 1.014±0.010 (median 1.014), and 1.016±0.008 (median 1.016) in the user of both devices, which were similar (p=0.36, Kruskal-Wallis). Data regarding the relationship between intake of extra foods and USG values has been shown in **Table 3**. A significant difference in USG has been observed in infants who was given solid food without extra water (p=0.001, Kruskal-Wallis).

Table 1 - State of hydration in 162 infants in summer and winter of 2005.

Season-state of hydration	Summer	Winter	Total	*P*-value
		n (%)		
Well-hydrate USG ≤1.010	16 (20)	39 (48)	55 (34)	0.001
Hypo-hydrate 1.010<USG<1.020	33 (41)	24 (30)	57 (35)	0.13
Dehydrate USG ≥1.020	32 (39)	18 (22)	50 (31)	0.013
Total	**81**	**81**	**162**	

p=0.001 Chi-square, USG - urine specific gravity

Table 2 - State of hydration according to the different types of air conditioning system used by family.

Type of air conditioning - state of hydration	Cooler	Fan	Both
		n (%)	
Hydrate - SG ≤1.010	44 (38)	4 (33.3)	8 (25)
Hypo-hydrate	41 (35)	4 (33.3)	11 (34)
Dehydrate - SG ≥1.020	31 (27)	4 (33.3)	13 (40)
Total	**116**	**12**	**32**

p=0.096, Chi square linear by linear association, SG - specific gravity

Table 3 - Urine specific gravity (USG) measurements according to the pattern of infants' feedings.

USG supplement	N=124	Mean±SD	Median	Range
1-only water	38	1.010±0.006	1.010	1.005 - 1.031
2-solid cereal	33	1.016±0.008	1.017	1.005 - 1.032
3-water and solid cereal	53	1.015±0.008	1.017	1.004 - 1.033

p=0.004, Kruskal-Wallis, comparison 1 and 2 p=0.001, 1 and 3 p=0.001, 2 and 3 p=0.6 by Dunn's multiply comparison test

Discussion. Several previous studies have shown that exclusive breastfed infants do not require extra water intake in hot and humid climates before weaning.[20-22] In these studies, which were performed in a controlled situation, they used mean of USG of breastfed. In the study on USG of 31 infants, Almroth and Bidinger[8] reported the mean of USG being less than 1.01, but their range exceeds the value of 1.02 (2 cases or possibly 2 episodes from one infant). Goldberg and Adams[23] also studied a group of 15 infants in a similar situation, and found that the mean USG in their study was in the hydrated level.

In this study, the USG was measured during weaning, in an ordinary uncontrolled environment. The sample size used was larger (N=162) than the previous studies. The infants have also been categorized according to the level of their USG instead of the mean value, as mean value might not well represent the episodes of dehydration especially, when the upper range of data exceeds dehydration level of 1.020.[8,9] A subgroup of exclusive breastfed infants (N=32) was also included in whom 2 of them had USG in the dehydrated zone in summer. This finding is in accordance with the data mentioned in Almroth's study.[8] This study demonstrates that at least 30% of healthy infants are exposed to dehydration especially in summer. However, in winter dehydration has also been observed in 22% of the infants, which can be attributed to the inadequate intake of water and milk, or low humidity and high indoor temperature. Since the samples used in this study were taken from the infants admitted to the clinic for routine vaccination, and fever and mild diarrhea is common after vaccination, the state of hypo-hydration might have been exaggerated in the following day of vaccination.

Insensible water loss is a major route for water loss in infants, particularly in the presence of different types of air conditioner. This study, for the first time, evaluated the relations between the state of infants' dehydration, and the different types of air conditioner using USG. Utilizing electrical fan by increasing evaporation creating a drier environment, than the cooler that produces humid air. Due to the poor construction of houses and high temperature in the summer, usually both systems are required to keep the houses cool. Our data shows that using different devices may affect proportion of dehydrated infants (p=0.096) and there was a trend to increased mean USG from cooler (1.013) to fan (1.014), and both (1.016) devices although it was not statically significant. It is logical to think that exposure

to the fan should be a risk factor for dehydration, as it increases insensible water loss. However, we could not show frank significant differences between these groups. This might be partly due to insufficient sampling, or the lack of information on the duration of air conditioning usage in each day. There were 2 infants in our study who used no air conditioning system, and interestingly their USG were in hydrated zone. However, more data is needed to elucidate the validity of this finding. We found that infants who started solid food had significantly higher USG than infants who had only water supplementation, and even infant who started solid food with water had USG similar to infants who had not received water (p=0.6), which means they had not received enough water. This could partly be attributed to the unawareness of mothers, and highlights the need for an educational program to emphasize the importance of water supplementation in the prevention of dehydration during the weaning period.

There are some limitations in our study such as: we have also lost 230 cases during the course of study, these infants who could not produce urine within 2 hours and were excluded from our study. This might limit our study to the more hydrated infants, as inadequate urination could be an indicator of dehydration, and by including those data it seems likely that we would have more prominent results, inadequate sampling to reveal significant effect of air conditioning, and lack of data on the length of usage of air conditioning devices in each day. We suppose a need for more devices to cool homes means existence of warmer situation at home, which render infants more prone to dehydration. In our cross sectional study, we did not determine adequacy of mother milk since we had no information on the amount of mother milk was taken by infants, so our result is not adequate to show if the mother's milk is sufficient at that time, and a longitudinal study is needed to evaluate that, but grossly there was no difference in USG of infant under 3% and over 3% of weight distributions. Although some previous studies highlighted the requirement for extra water intake in infancy,[24] and reported the increased risk of hypernatremic dehydration in exclusively breastfed infants,[25] in our study, we identified the extension of dehydration by USG in infants living in hot and dry climate during weaning.

It is an acceptable approach that the majority of infant's need no extra water intake before weaning however, even in the exclusive breast feed infant, episodes of dehydration may occasionally occur in dry and hot climates. Dry and hot weather, and introduction of solid food without water and inadequate water supplementation are possible contributing factors for dehydration in our study, Fever from vaccination, and mild diarrhea of oral polio vaccine can also aggravate dehydration in infants who have already been hypohydrated. There is a prominent trend and a marginal significant effect that air conditioning devices may influence state of hydration. It is necessary that an individual study is carried out to evaluate its effect. Using USG can be a useful and convenient indicator to identify dehydration, especially in infants living in hot climates. Furthermore, educational programs should be provided to increase health care workers knowledge, and the mother's awareness of chronic mild dehydration, in order to prevent dehydration episodes during the weaning period.

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