Statistical analysis and comments on the USI-IDD survey Azerbaijan 2007

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BACKGROUND

The national USI-IDD survey in Azerbaijan in 2007 used a population-proportionate-to-size design to enroll 30 school-age children in 30 clusters (schools). The survey teams also sampled 10 pregnant women in each cluster from prenatal clinics in a location near to the schools where the children were investigated. Household salt samples were collected from half the children and pregnant women each. The results of the laboratory assays of the iodine contents in urine and salt samples were shared by UNICEF Baku through the survey consultant Dr. Gregory Gerasimov (ICCIDD, Moscow). The accompanying Excel file shows the results of the statistical analysis of these survey data. Non-parametric tests were used because the distributions of salt iodine and urinary iodine were skewed. The Excel worksheets are in an accompanying pdf document.

ANALYSIS

1. Salt iodine content (pages 1 and 2 of the pdf document)

The median iodine content in the household salt samples was 22.2mg/kg [95% CI: 21.2-24.3]. The histogram of salt iodine contents shows a significantly skewed distribution ($p<0.0001$) to higher iodine values. The majority of the salt samples (90%) had an iodine content varying between 6.6 and 42.3mg/kg, and the inter-quartile range was 15.9-31.7mg/kg. Of all the salt samples, 128 (22.9%) had iodine content below 15mg/kg and in 173 samples (31.0%), the iodine content was 30mg/kg and above.

2. Urinary iodine concentrations in school-age children (pages 3 and 4)

The histogram of child urinary iodine concentrations was severely skewed with outliers to higher values. The median child urinary iodine was 204µg/L [95% CI: 195-216] and the IQR 132-307µg/L. The iodine concentration in the majority of urine samples (90%) varied between 62 and 526µg/L. The urinary iodine was below 100µg/L in 124 children (13.3%) and in 240 children (25.8%), the urinary iodine was ≥300µg/L. Removal of outliers did not change these parameters in any significant way.

3. Urinary iodine concentrations in pregnant women (pages 5 and 6)

Similar to the urinary iodine concentrations in children, also the histogram of urinary iodine concentrations in pregnant women was severely skewed ($p<0.0001$) to higher values. Pregnant women had a median urinary iodine of 195µg/L [95% CI: 180-217] and the IQR was 121-320µg/L. The majority of urine samples from pregnant women (905) varied between 46 and 544µg/L. Low urinary iodine, i.e., <150µg/L, was observed in 107 women (35.2%) and a urinary iodine concentration of 250µg/L and above was found in 108 women (35.5%). Removal of outliers did not sizably affect these estimates. The overlap of the 95% confidence intervals demonstrates that the distributions of urinary iodine concentration did not differ between the school-age children and pregnant women.

4. Findings by cluster (pages 7-15)

Analysis of the salt iodine and urinary iodine values showed significant variations between the clusters ($p<0.0001$ in each case), indicating that the iodine nutrition situation was likely different between geographical areas in Azerbaijan. The median salt iodine content varied from 10.6mg/kg in cluster #11 to 36.0mg/kg in cluster #5. The range in median child urinary iodine concentration was from 111µg/L in cluster #2 to 429µg/L in cluster #7 and in pregnant women, the median urinary iodine concentration varied from 98µg/L in cluster #25 to 395µg/L in cluster #30. These median values do not define the situation in any single cluster, but the strong variation illustrates the contrasts in the iodine supply and nutrition situations between different areas of the country included in the survey.

5. Urinary iodine concentrations by level of iodine in household salt (pages 16-19)

The strength of this survey was that the salt samples for iodine analysis in the laboratory were obtained from the households of each of the target groups of school-age children and pregnant women from whom also the urine samples were analyzed for the iodine content. This design permits an analysis of the associations in each of these groups between the iodine consumption (approximated by the salt iodine content in their households) and the iodine status (indicated by the iodine concentration in their urine samples).

In accordance to the Minsk agreement among the CIS Heads of State, the salt iodization policy in Azerbaijan stipulates that producers should iodize at 40±15mg/kg all the salt intended for human consumption, including the salt used in the food manufacturing industry. This mandated level aims to ensure that the salt iodine content at consumption varies at ±30mg/kg. For analysis of associations, the groups of children and women were sub-divided into three groups according to the iodine content in their household salt: (a) those living in households with salt iodized below 15mg/kg; (b) those of households using salt with iodine content 15–29.9mg/kg, and (c) those living in households where the salt iodine content was 30mg/kg and above. This particular division into subgroups was also the most efficient choice in view of the variation of iodine content in the present survey (section 1 above).

Table 1:
Urinary iodine excretion in school-age children by the salt iodine content in their households, Azerbaijan 2007

Level of iodine content in household salt	Urinary iodine concentration in school-age children (µg/L)						
				Relative risks of urinary iodine levels			
	n	Median	95% Conf. Interval	<100µg/L	95% Conf. Interval	>300µg/L	95% Conf. Interval
0-14.9mg/kg	85	175[a]	149 – 199	1.84	0.83 – 4.06	0.69	0.42 – 1.12
15-29.9mg/kg	175	202[b]	180 – 230	1.71	0.84 – 3.46	0.69	0.47 – 1.01
≥30mg/kg	130	242	206 - 271	1.0		1.0	

[a] $p<0.01$ compared to the group ≥30mg/kg; [b] $p<0.05$ compared to the group ≥30mg/kg

In school-age children, a consistent and significant relationship was observed between the salt iodine level in their households and the median urinary iodine concentration (Table 1). With each 15mg/kg increment in household salt iodine content, an average increase of 30-35µg/L occurred in median urinary iodine concentration in school-age children. Nevertheless, in comparison to the children in households where the salt iodine content was ≥30mg/kg, children in households using salt with lower iodine content were not found to exhibit significantly different risks of urinary iodine concentrations of either <100µg/L or >300µg/L.

The results of this analysis for pregnant women are shown in Table 2. Contrary to the findings in school-age children, no direct associations were found between the iodine content in household salt on the one hand and the median or proportions of urinary iodine concentration in pregnant women living in these households on the other. It must be noted, that the number of pregnant women in the survey was small, however. In this survey, the urinary iodine concentrations of pregnant women of households with salt iodized at ≥30mg/kg were generally lower than those of pregnant women from households using salt with lower iodine contents.

Table 2:
Urinary iodine excretion in pregnant women by the salt iodine content in their households, Azerbaijan 2007

Level of iodine content in household salt	Urinary iodine concentration in pregnant women (µg/L)						
				Relative risks of urinary iodine levels			
	n	Median	95% Conf. Interval	<150µg/L	95% Conf. Interval	>250µg/L	95% Conf. Interval
0-14.9mg/kg	38	212	149 – 237	0.97	0.51 – 1.83	1.23	0.56 – 2.70
15-29.9mg/kg	60	213	151 – 256	0.99	0.56 – 1.76	1.56	0.78 – 3.11
≥30mg/kg	34	173	127 – 208	1.0		1.0	

6. Relationship between urinary iodine concentrations in school-age children and pregnant women (pages 20-25)

The children and women sampled in this survey were not living together in the same households and, therefore, it is not possible to directly compare their iodine status indices. By sampling the women and children from adjacent institutions, however, it is reasonable to assume that if analyzed across clusters, the two groups were sharing similar environments, including the supply of edible salt in the markets. The association between the urinary iodine concentrations in school-age children and pregnant women of Azerbaijan was therefore approached on basis of the cluster medians. The analysis proceeded in two stages: First, a test was performed whether the cluster median values of urinary iodine concentration between the two groups are different, and second, an analysis of the nature of the association between the cluster medians of the two groups was performed.

For the first step, pages 20-22 show the preferred test for differences between the cluster medians of iodine status indices in women and children, without assuming that the medians are distributed normally. The identity line in the scatter-plot indicates the situation when the medians would be in perfect agreement. Despite the sizable variation in the values of both the children and women, the individual medians are well and evenly scattered around the identity line. The median urinary iodine concentrations in pregnant women were 0.6% higher on average [95% CI: -11.2-12.5] than in school-age children. Thus, if analyzed by cluster, the urinary iodine concentrations in pregnant women and school-age children did not differ significantly. This is similar as for the iodine status indices for the overall groups of women and children.

Pages 23-25 analyze the association between the median urinary iodine concentrations in women and children in Azerbaijan. Page 23 shows a significant relationship between the cluster medians of urinary iodine concentrations in pregnant women and school-age children ($p<0.01$). The nature and direction of this relationship is shown in pages 24-25. The linear regression analysis indicated that the 95% confidence intervals of both the intercept (66µg/L) as well as the slope (0.72) of the regression equation are overlapping with their unity values. Therefore, the medians of urinary iodine concentrations in pregnant women across clusters increased evenly and on par with the median urinary iodine concentrations in school-age children ($p<0.01$).

COMMENTS

The present analysis demonstrates the important progress that has taken place in pursuit of IDD elimination by the USI strategy in Azerbaijan. The national coverage of adequately iodized salt in households has improved from 41% just a few years ago to 77% in 2007. This is a quantum increase that took place along with a sizable improvement of the iodine nutrition status of the population, which in this survey was represented by the biological iodine indices among school-age children and pregnant women. Despite the fact that the achievement of salt iodization is falling short of the 90% target, the status indicators among children and pregnant women have already reached their respective recommended optimal ranges. From a policy perspective, these findings are very encouraging. The joint collaborating partner organizations in Azerbaijan can take support from this progress and intensify their drive toward reaching truly successful USI.

The finding of significant differences between clusters in the salt iodine content and the urinary iodine concentrations in children and women was a major unexpected outcome of this survey. Because the clusters were selected to reflect the varying population size across different areas of the country, this finding indicates that there were sizable differences in the dietary iodine supply in the geographical areas of Azerbaijan. To identify potential sources that may explain these differences, an analysis of the national salt situation by iodized salt supply source(s) in these areas may be revealing. The existing relationship between the level of iodine in household salt and the urinary iodine concentration in pre-school children points out that varying iodization practices among salt suppliers may bring about different iodine supplies, and therefore, iodine status in the population. Because the histogram of salt iodine content did not show a high percentage of non-iodized salt, contraband supplies from outside are not likely causing the different patterns.

The iodine status in pre-school children was found to be related to the iodine level in the salt of their households. The differences in child iodine status were significant when tested at the median values, but not at the extremes of the distribution of iodine status indices. Although the relative risk estimates of low and high urinary iodine concentrations among children were not statistically significant, their extent as well as directions are nevertheless indicative that the association exists. Two key factors may have played a role in moderating the strength of this association. Most importantly, the iodization policy in Azerbaijan addresses not only the salt produced for use in the households but also the salt that is intended for domestic manufacturing of foods, particularly for bread bakeries. Likely, the iodine consumption of these manufactured foods was therefore masking an association between their consumption of iodized salt in the household and their iodine status. The second factor that did play a role is the relatively small number of salt iodine measurements performed in the present survey. With a larger number of observations, the relative risks in children would have reached statistical significance. Among the target group of pregnant women, however, as indicated by the very large 95% confidence intervals, the small number of available observations was the major reason why no association could be revealed between the household salt iodine content and their iodine status. The widths of the confidence intervals for the median urinary iodine concentrations in pregnant women were almost 100µg/L, as opposed to ±50µg/L in school-age children.

The analysis across clusters of the biological iodine status indices in pregnant women and school-age children demonstrated that the dietary iodine consumption in these population groups is very similar. Since the iodine consumption from household salt had a clear association with the iodine status in pre-school children, and also the iodine status in children was correlated with the iodine status of the pregnant women in the same clusters, the considerable variation in the iodine status of pregnant women must have also been related primarily to their iodine consumption at home. Under Azerbaijan's salt iodization policy, the added consumption of iodine in the population is determined by both the iodine content in household salt and the iodine content in commercial foods manufactured with iodized salt as part of the recipe. Due to the very small number of salt iodine and urinary iodine data of pregnant women, the partial contribution of the consumption of iodine from household salt alone could not be accurately determined from this survey.

An attempt to improve the USI policy practice in Azerbaijan can be informed from the contrasts in household salt iodine contents across different clusters. Improved iodization performance in the salt productive industry will not only bring the 90% target within reach, but it will also lead to a reduction in the variation of the iodine supplies between geographical areas, thus masking even further the influence of the iodine consumption of household salt alone. In a future survey design in Azerbaijan it would therefore be important to increase the number of salt samples, and also to consider collecting salt samples from the storage of food manufacturers such as bread bakeries. This would permit a more accurate analysis of the two principle supply channels in assuring adequate iodine status in the population.

Finally, the urinary iodine concentrations in school-age children and pregnant women in this survey do not indicate a potential risk of excessive iodine supply in either group at the time that all the salt is truly iodized according to the present policy mandate. In the school-age children of households using salt with ≥30mg iodine per kg, the upper 95% confidence limit of 271µg/L is still located comfortably below the upper limit of the optimum 100-300µg/L range for this target group. The pregnant women of households using salt that was iodized at the level of ≥30mg/kg also showed the leeway remaining for a response to an improvement of the iodized salt supplies.

RECOMMENDATIONS

The present analysis showed that in Azerbaijan 20-25% of the household salt iodine supply fell below the internationally agreed-upon minimum cut-off of 15mg iodine/kg. To improve program operations, information of the supply sources covering the different clusters used in this survey may be helpful in identifying suppliers whose salt iodization performance is poor. If this situation still exists, an effort to assist these producers in improving their performance would be indicated.

The design in this survey of enrolling school-age children as well as pregnant women in adjacent institutions of the selected clusters was an efficient method for an analysis of associations among the iodine consumption from household salt *vis-a-vis* the iodine status in these population groups. Notwithstanding that household salt represents only part of the national salt iodization policy, the limited number of observations in school-age children was still sufficient to demonstrate that this relationship existed in the population. For pregnant women, however, the salt sampling of only 50% of participants ended up being too restricted to bring out an association by a direct analysis. In future surveys, it would be prudent to increase the number of salt sample collections of pregnant women for securing the ability for analysis of relationships in this group.

Since the iodine status indices in school-age children and pregnant women in Azerbaijan were shown to be very similar, future surveys may also consider limiting the collection of biological data to pregnant women only. Due to their highest iodine requirements, any fall or variation in iodine supplies throughout the population will affect the pregnant women first, making them the most efficient and informative group for continued monitoring.