Title: Iodine deficiency identified in the Riverina.

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Abstract: Iodine deficiency disorders (IDD) cause physical and neurological health deficits at all life stages. Australia was thought to be iodine replete until recent studies focusing on large, coastal communities reported mild to moderate iodine deficiencies. The paucity of published data for rural, inland areas prompted this study in the Riverina area, NSW.A cross sectional study was undertaken with 173 volunteers who provided an early morning mid-stream urine sample and who completed a questionnaire on demographic, dietary, medical and lifestyle matters. Urinary iodine concentrations (UIC) were determined using a micro plate assay based upon the Sandell-Kolthoff reaction. Statistical analysis was conducted using non-parametric methods. The median UIC for the group was 79Ág/L with 71.1% of the population showing a value of less than 100Ág/L and 18.5% of subjects less than 50Ág/L. Based on the WHO criterion for an iodine-replete population of100-200Ág/L, there results are consistent with a mild iodine deficiency. Significantly more females were moderately to severely deficient compared to males (23.2% versus 6.3% respectively, ??=7.96, p=0.0187). 10 of 16 towns had median a UIC under 100Ág/L with considerable variation of iodine values between them. Griffith (n=16) bordered on moderate deficiency with a median UIC of 50Ág/L. The age group 50-59 years had a median UIC of 67?g/L. The use of iodised salt did not significantly increase the median UIC (81?g/L) compared to non-iodised salt (71?g/L) (p=0.1907), however the regular use of iodine-containing vitamin supplements was associated with normal UIC levels (111?g/L) (p=0.0011).A mild iodine deficiency was identified in the Riverina community. This work is consistent with other studies done in Australia and supports the need for a national correction strategy to prevent the emergence of IDD. Currently salt iodisation appears to be ineffective as a tool for iodine supplementation.

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An evaluation of iodine levels in the Riverina population

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Good afternoon everyone. Today I am going to present the results of my thesis research that I conducted under the supervision of Helen Moriarty and Geoff McKenzie at Charles Sturt University in Wagga Wagga.

The title of our work was "An evaluation of iodine levels in the Riverina population". Professor Eastman has highlighted the importance of adequate iodine and consequences of deficiencies and also addressed the handful of Australian studies conducted. Much of the work done on iodine levels in Australia are limited to Tasmania and large coastal cities such as Melbourne, Sydney and the Central coast and so we endeavored to gather data from an inland regional area.

For those unfamiliar with NSW, the Riverina region is bounded by West Wyalong and Temora in the north and Tumut and Gundagai in the east, extending south to the Murray River and the Victorian border and west out past Hay.

It covers an area of about 100,000 square kilometres with major towns being Wagga, Griffith and Albury.

The area is largely based on agricultural activities such as producing canola, wheat, barley, rice, fruits and vegetables.

Nearly 20 per cent of all NSW crop production and two thirds of its total value comes from the Riverina.

The aim of our study was to assess the iodine levels of the Riverina to assess if a deficiency was present. Our work also aimed to identify if any subgroups were at particular risk of IDD and we aimed to identify factors that may be influencing iodine levels including such as dietary factors, location and age.

METHOD

The study had 2 major components. Firstly it involved the measurement of urinary iodine concentrations or UIC.

Secondly a questionnaire was used to collect dietary, medical and lifestyle data that could affect iodine levels, and variables from these correlated with UIC.

300 kits with a specimen jar and questionnaire were distributed to 14 collection centres organised throughout the Riverina.

Volunteers were recruited using TV, radio and newspaper and were required to collect an early morning midstream urine sample and return with the completed questionnaire to the collection centre.

At the end of the 5 month collection period, the urine samples were taken to the Institute of Clinical Pathology and Medical Research at Westmead hospital for analysis of iodine levels, using the ammonium persulphate on microplate method. Here, ICPMR kindly made the expensive and specialised equipment available to us, funded the technical side, and trained myself in the analytic techniques.

Once the UICs were determined, the results were categorised according to WHO classification of median UICs for a population.

If the median for the population is less than 20µg/L, this indicates a severe deficiency. Between 20-49µg/L means moderately deficient whilst between 50-99µg/L is mildly deficient. Between 100-199µg/L is the optimal level.

Median urinary iodine (µg/L)	**Iodine intake (µg/L)**	**Iodine nutrition**
<20	Insufficient	Severe deficiency
20-49	Insufficient	Moderate deficiency
50-99	Insufficient	Mild deficiency
100-199	Adequate	OPTIMAL

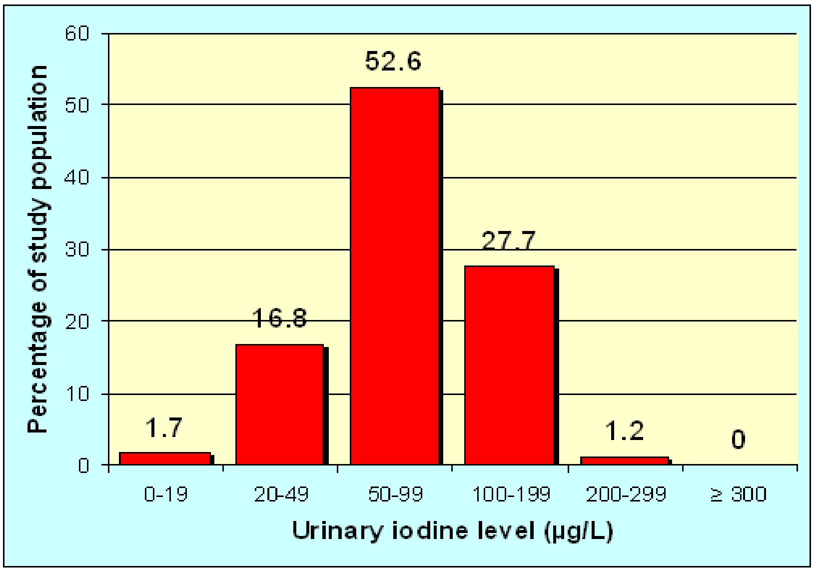
200-299	More than adequate	Risk of Iodine induced hyperthyroidism 5-10yrs
>300	Excessive	Risk of adverse health effects

WHO has an alternate classification based on the distribution of the where the majority of the people's UIC lies within the population. A population is considered iodine deplete if more than 20% of the people have a UIC of less than 50μg/L OR if less than 50% have a level above 100μg/L.

RESULTS

Of the 300 kits distributed, 173 samples were collected, making a 59% response rate. Samples were collected from 19 different towns, consisted of 125 females and 48 males.

This distribution graph shows the spread of urinary iodine concentrations for the population sampled.



As you can see, 52.6% of the population fell between 50-99 μg/L (or mild deficiency). 16.8% fell in the moderate deficiency range while 1.7% were classed as severely deficient.

Only 28.9% of the population had a level over 100µg/L while 71.1% had a level under 100µg/L. As you may recall, for a population to be considered iodine sufficient more than 50% of the population have to have a UIC of over 100µg/L. This, in combination of the median for the entire population of 79µg/L, meant that this sample of the Riverina that was analysed had a mild iodine deficiency.

These results were very similar to the other Australian studies.

The Melbourne study found a median UIC of 70µg/L, the Sydney study found a median of 64µg/L in the general population and 104µg/L in pregnant women, another Sydney study returned a value of 69µg/L in the general population to 88µg/L in the pregnant population, the 2002 study returned 84µg/L whilst the recent central coast study found a median UIC of 82µg/L.

So the Riverina median of 79µg/L is very close to these other studies and add to the evidence that a mild iodine deficiency in certain parts of Australia is present.

Our study validates the need for further research and monitoring for the prevention of treatment of IDD.

We also examined UIC with other factors including

- Gender
- Age
- Towns
- Dietary factors

Gender: The median UIC was the same for the genders; both 79µg/L HOWEVER, the distribution was different between genders was significantly different, with relatively more females falling in the moderate to severe deficiency level than males ($\chi^2=7.96$, $p=0.0187$)

This finding correlates with the Melbourne study and also many other studies that show that females are more likely to be at risk of iodine deficiency disorders

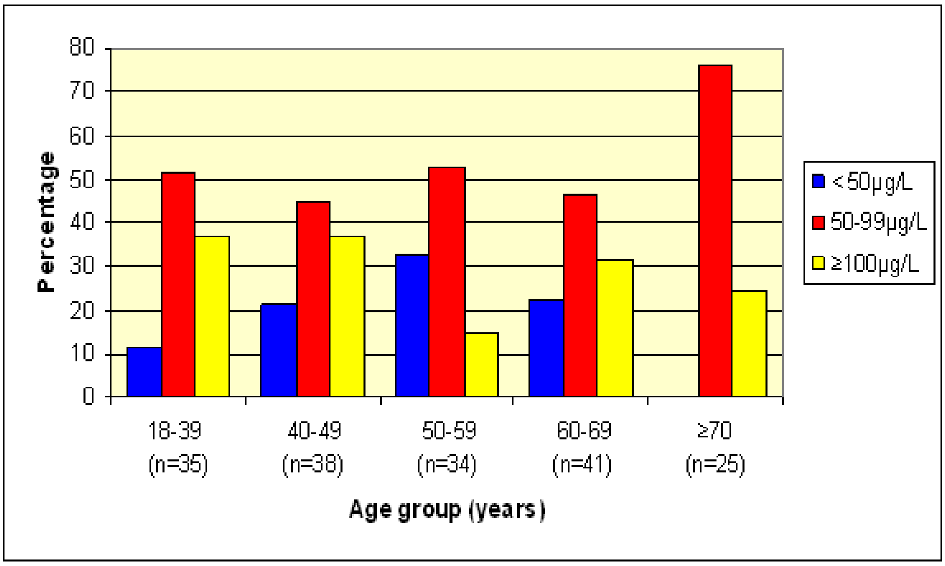
Now going onto the results of the pregnancy and breastfeeding women, unfortunately there were no breastfeeding females that entered in the study. However, 5 pregnant women participated and they were found to have a median UIC of 93mcg/L. Now, although this is only a small number of subjects, the median UIC is consistent with elevated UIC levels that occur during pregnancy, and the results are consistent with other Australian studies of pregnant females. This elevated level during pregnancy is due to increased glomerular filtration rate which actually leaves the women in negative iodine balance. And so a level of 93µg/L reflects a more severe state of deficiency in a pregnant woman that the rest of the population, given that they have increased iodine needs. So taking all these factors into consideration, the sample tested were at least mildly deficient and in addition probably reflected the wider Riverina community of pregnant females. This is of particular concern given that iodine deficiencies are most severe and irreversible when acquired through foetal development.

There were 25 women of childbearing age (18-39 years) and they were found to have a median UIC of 89μg/L. This is alarming since these women had the potential to conceive and enter first trimester in a state of iodine deficiency.

Age: Many iodine studies choose to test iodine levels in children because it is logistically easier. We chose to focus on adults and look at iodine levels across the age groups. No Australian studies have yet researched this; however 2 large studies have been conducted overseas, one being the NHANES (National Health And Nutrition Examination Survey) in America and the other in Switzerland. We adopted the age categories of NHANES that is 18-39 years, 40-49, 50-59, 60-69 and 70 and over.

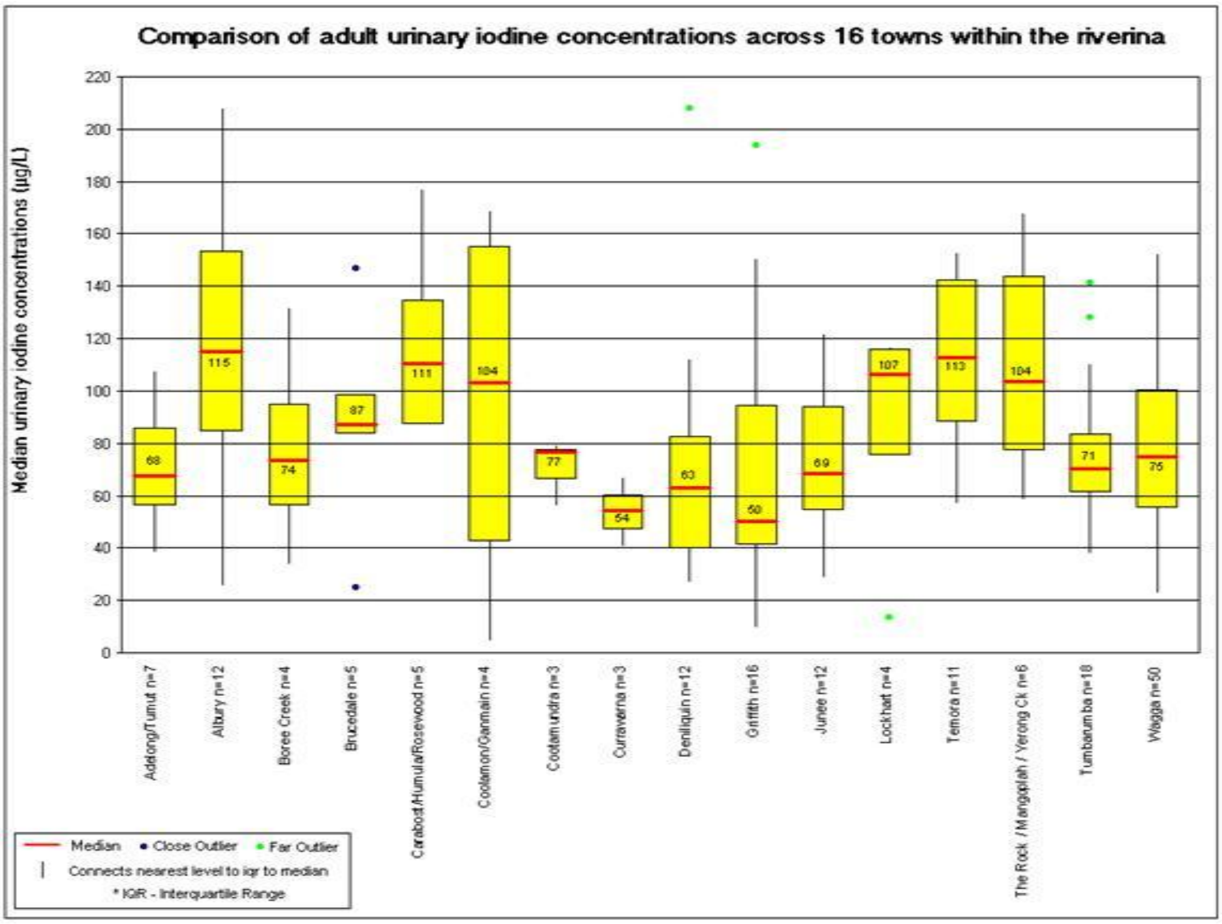
What we found was that the 50-59 year age group had a significantly lower median than the 18-39 year group. Significantly more fell into the moderate to severe iodine deficiency that the 18-39 year age group ($p=0.0332$) and the over 70's ($p=0.0068$). Furthermore there was a negative correlation with age until the age of 59 years ($p=0.0208$).

The Switzerland study found a continuing negative correlation of UIC with age right up to oldest age groups where as the American study found the same results as our Riverina study, that is the lowest median at 50-59 years of age, and a negative correlation of UIC and age that ceased at this point.



It would appear that the 50-59 year age group is at particular risk of iodine deficiency disorders. It is vital that this issue is researched further, since a major factor limited the acceptable of universal iodine fortification programs is the fear of iodine-induced hyperthyroidism. The age groups most predisposed to this disorder are known to be the elderly. By prevention of iodine deficiency in the 50-59 year age bracket, it may be possible to reduce the incidence of iodine-induced hyperthyroidism, a fear that currently limits the application of iodine fortification to all of the other age groups.

Towns: The median UIC for each town is indicated by the red bars. As the graph shows, 10 towns had a median UIC of less than the health 100µg/L. No towns were below 50µg/L however Griffith was borderline, at exactly 50µg/L. Wagga Wagga had a median of 75µg/L which was similar to Junee. Tumbarumba and Adelong were also quite low at 71µg/L and 68µg/L and this was to expected given that these are mountainous areas and it has been shown that iodine levels are lower in mountainous areas due to soil leaching of iodine. The very low level of Griffith was unexpected since it is not a mountainous area, however this could be due to the intensive irrigation farming that occurs in this area that might be causing soil leaching similar to mountainous areas. A few important points can be derived from this graph, that is, certain areas need further evaluation for low levels. Furthermore, it illustrates the variability in levels that might mean that it is not the entire Riverina that is mildly deficient but instead a few areas that are more severely deficient.



Diet: The questionnaire collected dietary intake of certain food groups using food frequency questionnaire. Food frequency questionnaires inherently have problems such as over reporting, underreporting or forgotten foods. However it is thought that over a population basis this may be largely unimportant, and as such this type of questionnaire has been used by other authors overseas (Rasmussen et al 2002).

We specifically collected information on iodine rich foods, iodine poor foods and goitrogens. Subjects indicated how often they consumed each food over a span of a month and then the number of serves per month was correlated with UIC.

- *No correlation* between UIC and most foods
  - Fish
  - Goitrogens
  - Iodised salt

- *Negative* correlation between UIC and:
  - Nuts (p=0.034)
  - Fruits (p=0.0007)

- *Positive* correlation between UIC and:
  - Milk (p=0.0046)
  - Total dairy (p=0.013)
  - Coffee (p=0.0069)
  - Vitamins (p=0.0011).

Fish is reported to be a rich iodine source – and we would expect a positive correlation with UIC, so our findings were unexpected. However other authors have obtained similar results overseas and one suggestion is the varying, and possibly low content of iodine in the fish, as well as soil and air pollution, a situation that could be occurring in Australia.

Goitrogens are substances that interfere with thyroid function by a number of mechanisms, including reduction of iodide uptake, decreased organification and coupling, and decreased conversion of thyroid hormones by blockage of enzymes such as thyroperoxidases. They are found in various types of food including rapeseed, soy, millet, cruciferous vegetables cabbage and broccoli. They are known to cause goitre in large amounts however we could not find any studies into the correlation between UIC and goitrogen intake which is why we specifically looked into this. Although we did not find any correlation between a list of commonly known goitrogenic foods and UIC, one exception was coffee which I will discuss shortly.

We found there was a negative correlation of fruits and nuts. This was expected since these are both reported to be very low iodine foods. One would expect that diets high in such foods may be replacing other high-iodine containing foods. It has been shown that fruit consumption has increased over the last 50 years, especially over the last couple of years. Perhaps the increased consumption of healthier, low iodine foods may be contributing to the emerging iodine deficiency in Australia.

A strong positive correlation was milk intake and UIC was found as was expected and milk appeared to be a factor increasing iodine levels. However given that the population was still found to iodine deficient, this would suggest that milk alone is not a reliable source of iodine anymore.

A positive correlation of coffee with UIC was unexpected and this could be simply explained by inaccurate reporting i.e. counting milk served in coffee as a daily milk serving. However it could be a goitrogenic effect whereby the coffee is inhibiting thyroidal iodine uptake and increasing iodine secretion, yet paradoxically leaving the body in negative iodine balance, such as is seen in pregnancy. Coffee has been shown to induce goitres when consumed in large amounts by rats (Tahomi et al 2003) but the mechanism is not yet elucidated. Further research is needed into this area given how widely consumed this beverage is within Australia.

From the population tested, 76 subjects were taking some form of vitamin or mineral supplement. However, out of these only 14 were actually taking a vitamin that contained iodine on a regular basis. These 14 subjects had a significantly higher UIC than the rest of the population, indicating that correct types of vitamin supplementation could increase iodine levels to a sufficient amount.

Yet we also found that of the 77% of our population were not aware whether their supplement contained iodine. Any sort of vitamin supplementation on a population levels is impractical, but this lack of awareness adds another element of difficulty.

What was surprising was the results of the comparison of median UIC of iodised salt users with non-iodised salt users. We specifically addressed iodised salt usage because iodised salt is largely used in overseas fortification programs and also because it is often referred to as the solution to iodine deficiency for Australia in local literature and yet there appeared to be a gap in actual research surrounding this area. 41% of the population reported using iodised salt, 36% did not, and 26% did not know what they used. Although the median UIC was slightly higher in the iodised salt users, this was not significant. Furthermore, a Chi-test analysis found that there was no significant difference between type of salt and grade of iodine deficiency.

This leads us to ask why salt might not be making a difference. It may be that people are not using enough salt due to increased cardiovascular health awareness. Perhaps salt is being lost in transport and cooking, a common problem seen overseas. It may even be that salt is not being adequately iodised during manufacturing, which is also seen in overseas iodisation programs.

Given the inherent problems with salt seen overseas and the nature of Australia's diet, it leads us to question whether salt iodisation would be appropriate for Australia. Our study found that almost 34% were actively restricting their salt intake and 32% had never even thought about iodised salt.

However these results suggest that iodine fortification in another form would most likely be successful. Bread would appear to be a viable option. Unlike salt, bread does not conflict with dietary guidelines. Bread is cheap and widely consumed by most Australians; we found that over 71% of our population consumed at LEAST one serve a day. We also found that 99% of subjects would be willing to make small changes to their diet if found to be iodine deficient , indicating that if introduced on a large scale level it would most likely be accepted by the public. Iodised bread has been trialed here in Tasmania in the last few years with great success, pushing the median UIC from 75μg/L to 97μg/L.

CONCLUSION

In conclusion, we identified a mild iodine deficiency in the test population of the Riverina. Particular subgroups were found to be at particular risk of iodine deficient disorders, these being females who were pregnant or childbearing age, the age group 50-59 year olds, and certain towns including Tumbarumba, Adelong, Griffith. The emerging iodine deficiency appears to be possibly due to combination of healthier diet and decline of iodine in milk. Clearly some type of prophylaxis needed, and iodised table salt may be inadequate in a country like Australia. The introduction of iodised salt in a commonly consumed foodstuff, such as bread, may be more successful in a country like Australia

Our research also identified areas of further research that are required. More detailed studies into the specific effect that coffee is having on iodine status are necessary given the high consumption of coffee within Australia. Further research may chose to look at iodine handling in the older age group and certain town given our results and the lack of Australian studies into these areas.

Further, this was the first Australian study that attempted to correlate dietary data with UIC and population levels. Future studies with fully quantitative questionnaire would prove beneficial. For such work to be accurate a national database of iodine levels in Australian foods needs to be compiled as is for most of the other vitamins and minerals. This is currently lacking and there is a pressing need for such work to be initiated.

Thank you to Professor Eastman and the staff at ICPMR. Professor Eastman offered the use of the specialised iodine-free lab at Westmead and absorbed the cost of the analytical side of the project while his staff at ICPMR taught me the analytical techniques I needed to test the urine samples for iodine concentration. We would also like to thank South West Pathology Service, particularly John

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