

# **Household Wealth and Iodised Salt Consumption: Iodised Salt at Any Price?**

**A Report to the  
Network for Sustained Elimination of Iodine Deficiency**

**by**

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## 2. GLOSSARY

DHS	Demographic Health Survey
GDP	Gross Domestic Product
ICCIDD	International Council for Control of IDD
IDD	Iodine Deficiency Disorders
KIO <sub>3</sub>	Potassium Iodate
MI	The Micronutrient Initiative
IS	Iodised Salt
UI	Urinary Iodine
UNGASS	United Nations' General Assembly Special Session
UNICEF	United Nations Children's Fund
USI	Universal Salt Iodisation
WHO	World Health Organisation

### 3. EXECUTIVE SUMMARY

Salt iodisation is a proven strategy to prevent and alleviate iodine deficiency, yet a significant section of the world's populations still does not consume iodised salt despite the efforts of governments and the salt industry to the contrary.<sup>1</sup> Population surveys almost invariably show that poorer households are less likely to buy and use iodised salt<sup>2</sup>, although until now there has been little detailed analysis of the question as to why this occurs. The present study offers an analysis of DHS survey data from seven developing countries and explores the relationships between iodised salt consumption, household wealth, urban-rural status, educational attainment, administrative region and, where possible, the type of salt on sale in the markets.

Unfortunately, only the survey data collected in India and Benin data indicated which type of salt was found in households. In these countries, the type of salt proved to be by far the most influential factor in determining IS consumption.

In India, coarse salt was generally less likely to contain iodine than refined salt and, because the price in markets of coarse salt was cheaper, it was more likely to be purchased by poorer households. Iodised salt consumption in the poorest 50% of households was 16% lower than in the wealthiest 50%. However, after analysing the Indian dataset by salt type, this wealth effect disappeared in coarse salt users and was reduced to almost insignificant levels in refined salt users.

The association between household wealth and iodised salt use in India therefore appeared to operate by proxy whereby household wealth - an indicator for purchasing power - appeared to influence the choice for a certain salt type rather than a conscious decision to buy iodised salt *per se*.

In Benin the analysis of salt type was less straightforward. Initially, an inverse association for the entire country was found between the household consumption of iodised salt and wealth, although after adjusting for regional variation this relationship assumed a more conventional format. In the more affluent coastal Departments such as Atlantique there appeared to be a higher availability of uniodised salt compared to the poorer inland Departments such as Atacora and Borgou where almost all the coarse household salt was iodised.

The major cause of uniodised salt use in Atlantique Department appeared to be the supply of coarse, uniodised salt from many small-scale sea-salt harvesting businesses located near the capital Cotonou. Conversely in the coastal Mono Department, which borders on Togo, virtually all the coarse salt was iodised and refined salt was the main problem. Anecdotal reports suggest that this was due to the importation of uniodised refined salt from Ghana across the Togolese border.

The data from the Armenia survey also allowed the testing of any effects of knowledge of the benefits of iodised salt and the storage conditions under which it was kept. Neither variable was found to be very significant and “good storage” produced only a minimal effect (<5%) in raising the likelihood of household salt containing iodine. However, in provinces

where IS consumption was lower such as Shirak and Lori, knowledge of the beneficial effects of iodised salt may have had a much larger effect. Unfortunately low statistical power at provincial level precluded a definitive answer to this question.

Elsewhere data from Egypt, Malawi, Haiti\* and Tanzania generally showed positive wealth effects, though the lack of variables other than wealth, educational attainment and urban-rural status, combined with a general paucity of information about the salt production and supply situation in these countries made it difficult to determine what the underlying reasons may have been for these effects, especially in Tanzania where low sample size precluded a more detailed statistical analysis. In Egypt, wealth seemed to be the primary factor in determining IS consumption, whereas in Malawi it seemed to play only a minimal role after adjusting for educational attainment, region and urban-rural status. Interpreting the results from these countries was therefore more problematic than in countries where additional salt-related variables and background data were available.

In all countries, educational attainment and urban-rural status were shown to have at most a minimal association with household IS consumption. Therefore, whilst it cannot be denied that less educated, rural households are generally those most likely to use uniodised salt, it would appear that this disparity is mostly a product of poverty rather than a direct association with education or urban-rural status variables.

Overall, the results of this study indicate that in countries such as India where significant differences between the iodisation rates of coarse and refined salt exist, the resulting

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\* In Haiti the wealth effect was only apparent in the four Departments with significant availability of iodised salt (see p.59).

differences in household IS consumption will reflect household economic status – and thus purchasing power - in association with differences in the price of salt in the markets. From a policy perspective, an increase in the iodisation of coarse salt would be more likely to benefit poorer households in such cases, whereas increasing the iodisation of refined salt would benefit affluent households first and foremost. On the basis that poorer households are generally more likely to suffer from the consequences of iodine deficiency and malnutrition, public nutrition policy aimed at the reduction of inequity should be directed at removing the obstacles that prevent the iodisation of coarse salt rather than increasing the availability of refined salt.



## 4. INTRODUCTION

The effort to ensure the iodisation of all the world's edible salt over the last fifteen years has resulted in major progress towards the elimination of iodine deficiency. Some formerly severely deficient countries such as China, Nigeria and Iran now have an extremely low prevalence of iodine deficiency due to the fact that they have managed to achieve Universal Salt Iodisation (USI). Although many other countries have made substantial progress towards this goal, many have not yet achieved high enough levels of IS consumption to reach the goal of virtual IDD elimination.

On the basis that salt iodisation is a proven strategy to alleviate iodine deficiency in the population, an assertion for which there is ample evidence, only those people who are not consistently consuming iodised salt may remain at risk of iodine deficiency. Current efforts are therefore aimed at removing the constraints that prevent them from having access to iodised salt and to ensuring consistent quality of the product for all that do consume it. In order to remove these constraints, one must know (a) who the people are without access to iodised salt and (b) what factors are causing this lack of access. In countries where progress has been made but USI not yet achieved, it is often found that those who are not using iodised salt are mostly poor and uneducated, and more likely to live in remote or rural areas.

It is therefore important to understand how wealth, educational attainment and urban-rural status play a role in determining the chances that iodised salt is consumed in households. For instance, how much of an effect does wealth have in different areas and is this effect linear or merely a function of extreme wealth or extreme poverty? Is the urban-rural

disparity seen in many countries caused by rural populations being inaccessible and thus underserved, or is it merely because rural populations tend to be poorer than those in urban areas? Similarly, is the association between low household iodised salt consumption and the low educational attainment of its members caused by an ignorance or inability to grasp the beneficial effects of iodised salt, or again is it because the less educated are also more likely to be poor?

These questions are fundamental to our understanding and our ability to address the underlying factors that are preventing iodised salt being consumed in all sections of the population. Only once they have been answered can effective remedial action to remove these bottlenecks take place.

It should be stated from the start that the present study specifically deals with the issue of 'access to iodised salt'. The words 'adequately iodised' are not used anywhere below, nor are there any reference to biological outcomes such as urinary iodine levels or goitre prevalence. Whilst these are without doubt essential parts in our arsenal of knowledge when overcoming iodine deficiency in the world, they are not significant when trying to understand the reasons why some consumers buy and consume iodised salt and others buy and consume uniodised salt. This is the question of primary concern in this study.

Country reports are presented in an order based on the significance of the results obtained. For instance, the results from India and Benin were the most significant, followed by Armenia, as they contained additional salt-related variables which helped to provide a clearer picture of the patterns of IS use. In addition, because we were able to obtain meaningful

results from these countries, we were able to make detailed policy recommendations which might be of use to the respective national leaderships concerned with sustainable IDD elimination. As this level of detailed analysis was not possible in countries with only minimal data, only general policy recommendations could be made for those cases.

## 5. STUDY DESIGN AND METHODS

### 1) Country Selection

The data used in this study come from Measure DHS+ national household surveys carried out in developing countries. Criteria for inclusion were:

- 1) Measure DHS+ Data must be freely available and collected in the past five years (1998-2003);
- 2) Iodised salt presence in households should be between 20 - 90% to ensure a measurable degree of disparity amongst the sample;
- 3) At least 90% of participating households must have had their salt tested for iodine;
- 4) A geographical spread would be preferable.

Table 1: Available countries meeting study criteria, ranked by sample size

Country	Year of Survey	Households using Iodised Salt (%)	Household Sample Size	Total Population (000's)	Households' Salt Tested (%)
India	1998/99	71.4	92,486	1,000,849	99.3
Egypt	2000	55.9	16,957	68,360	99.9
Malawi	2000	82.0	14,213	10,386	90.4
Haiti	2000	23.1	9,595	6,965	91.9
Armenia	2000	90.0	5,980	3,336	99.3
Benin	2001	86.3	5,796	6,591	92.2
Tanzania	1999	58.4	3,615	32,793	95.8
<b>Total</b>	<b>n/a</b>	<b>n/a</b>	<b>148,642</b>	<b>1,129,280</b>	<b>97.7</b>

The resulting countries are shown in Table 1, above. Excluded countries were Mali and Zambia (low salt testing rates), Uganda and Rwanda (98-99% IS consumption rate) and Turkmenistan (restricted data).

## **2) Methods of Statistical Analysis**

Statistical Analysis was carried out using Intercooled Stata 7.0 for Windows (Stata Corporation, Texas, USA). Logistic regression was used to evaluate the significance of the variables available, these being wealth, educational attainment and urban-rural status, in determining the presence of  $KIO_3$  in household salt.

In addition, some countries' survey data contained supplementary information, which was useful in understanding their individual situations. This included whether the salt was coarse or refined (India and Benin), knowledge of the purpose of iodised salt (Armenia) and storage conditions within the household (Armenia and Benin).

Logistic regression modelling was used to evaluate the relative significance of the above variables in predicting the household usage of iodised salt. Once insignificant variables were excluded, adjusted probabilities were produced which took into account the effect of statistically-significant confounding variables.

All statistical analysis took into account the complex survey designs and sampling weights used when carrying out data collection in each country.

### 3) Analysis of the Effects of Household Wealth

By combining ownership of household assets such as agricultural land, radios, bicycles or pressure cookers and the facilities which the household enjoyed such as electricity, running water and sewerage, DHS was able to collect data on certain variables which reflected the long-term economic status of individual households.

Principal Component Analysis (PCA) was used to construct appropriately-weighted asset indices, or household wealth factor scores, for each country. As these indices were not normally-distributed, the scores were sorted into deciles, though in the datasets where the total sample size was limited, quintiles were used instead to preserve statistical power. The wealth quantiles therefore span a progressive, though not necessarily linear, increase in wealth from the poorest to the richest sections of the population.<sup>3</sup>

It is important to note that the household wealth quantiles are not directly comparable across countries. For example, Egypt's 5th decile does not reflect the same level of wealth as Benin's 5th decile in terms of GDP per capita as their median levels of wealth are greatly different. What it does reflect is each household's purchasing power relative to that of others within their own country.

The magnitude of each 'wealth effect' (defined in this study as the change in levels of IS consumption at different levels of household wealth) was measured by dividing the household samples into two halves based on their wealth factor scores and then computing the odds ratios for the presence of  $KIO_3$  in the salt samples of the wealthier half of

households compared to those of the poorer half. This rather crude approach reflects the lack of any appropriate non-parametric statistical test that can measure the strength of a correlation between a binary outcome (IS consumption) and a continuous variable (wealth) using data with a complex survey structure.

The best method of showing a dose-responsive effect of wealth is to determine the proportion of households consuming iodised salt within each wealth decile and demonstrate this in a graph. The graph shows how the levels of iodised salt consumption changes against equally-spaced household wealth increments.

#### **4) Analysis of the Effects of Educational Attainment**

There were several measurements of educational status in the DHS datasets. However, preliminary testing showed that 'highest level of education attained' had the strongest unadjusted relationship with IS consumption and this was therefore the measure chosen in our analysis. This variable represents the highest level of formal education successfully completed by a member of the household. There are four categories: no education, primary, secondary and higher education.

#### **5) Analysis of the Effects of Urbanisation or Urban-Rural Status**

'Degree of Urbanisation' is basically a detailed version of urban-rural status. It includes four categories: Capital / Large City, Small City, Town and Countryside. For a broader picture

though, this was condensed into urban-rural status by compiling all of the first three variables into 'Urban' and analysing this against 'Countryside'.



## 6. INDIA

India contributed by far the largest dataset to the present study and comprised over 90,000 households spread over 25 States and the Union Territory of Delhi.<sup>†</sup> Most survey data were collected from November 1998 to December 1999, except Tripura, which was collected between March and July 2000. The average duration of survey by State was  $4 \pm 1.44$  months. Therefore, the cross-sectional nature of this study may have been influenced by events occurring during this time.

### RESULTS

#### 1) Effect of State on IS Consumption

The geographical distribution of IS consumption showed a distinct regional pattern (see Figure 1.1). Generally, there was a north-south effect, whereby northern States, particularly those in the north-east, were more likely to have higher IS consumption rates than those in the south, particularly Kerala and Tamil Nadu (53.7% and 38.5% respectively). There was no significant relationship between IS consumption and State wealth, as expressed by State GDP per capita figures for 1998-99 compiled by the Government of India.

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<sup>†</sup> Since the time of survey, Delhi has become a State and three new States have been formed (Uttaranchal out of Uttar Pradesh, Chattisgarh out of Madhya Pradesh and Jharkand out of Bihar).

**Figure 1.1: Iodised Consumption by State**

Green: >90%, Yellow: 75-90%, Orange: 50-75%, Red: <50%



The mean IS consumption rate for the States with salt legislation in place at the time of survey was 73.9% (95CI[0.729-0.748]); in the four States without salt bans, namely Kerala, Goa, Andhra Pradesh and Maharashtra<sup>‡</sup>, the mean IS consumption rate was significantly lower ( $p < 0.0001$ ) at 61.3% (95CI[0.613-0.656]), though this difference may not necessarily reflect the effectiveness of salt legislation *per se*.

<sup>‡</sup> Andhra Pradesh and Maharashtra had only partial bans covering certain districts

## 2) Effect of Household Wealth on IS Consumption

There was a statistically-significant association between household wealth and IS consumption both for the country as a whole and in all States except Mizoram. Wealthier households were much more likely to consume iodised salt than poorer ones (OR: 2.260;  $p < 0.0001$ , 95CI[2.114 - 2.417]).

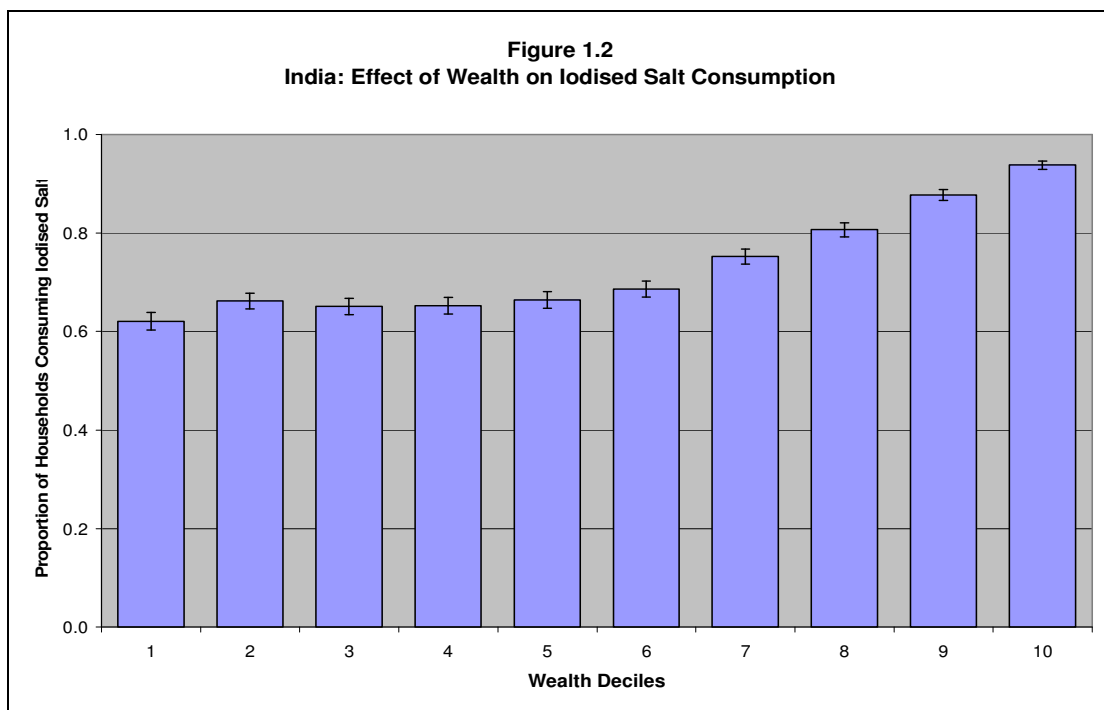


Figure 1.2, above, shows the relationship for the entire sample. This national curve is a composite of many different States with various degrees of association, ranging from Tamil Nadu, where a strong relationship existed, to the north-eastern States where the association was generally weaker, though still present (see Figure 1.3 for a sample of States).

In the States of Tamil Nadu, Kerala and Andhra Pradesh, household IS consumption reached to less than 90% even in the highest household wealth deciles, which would indicate that the general availability of iodised salt in the markets of these States determined the location of the wealth effect on the IS scale more than in other States.

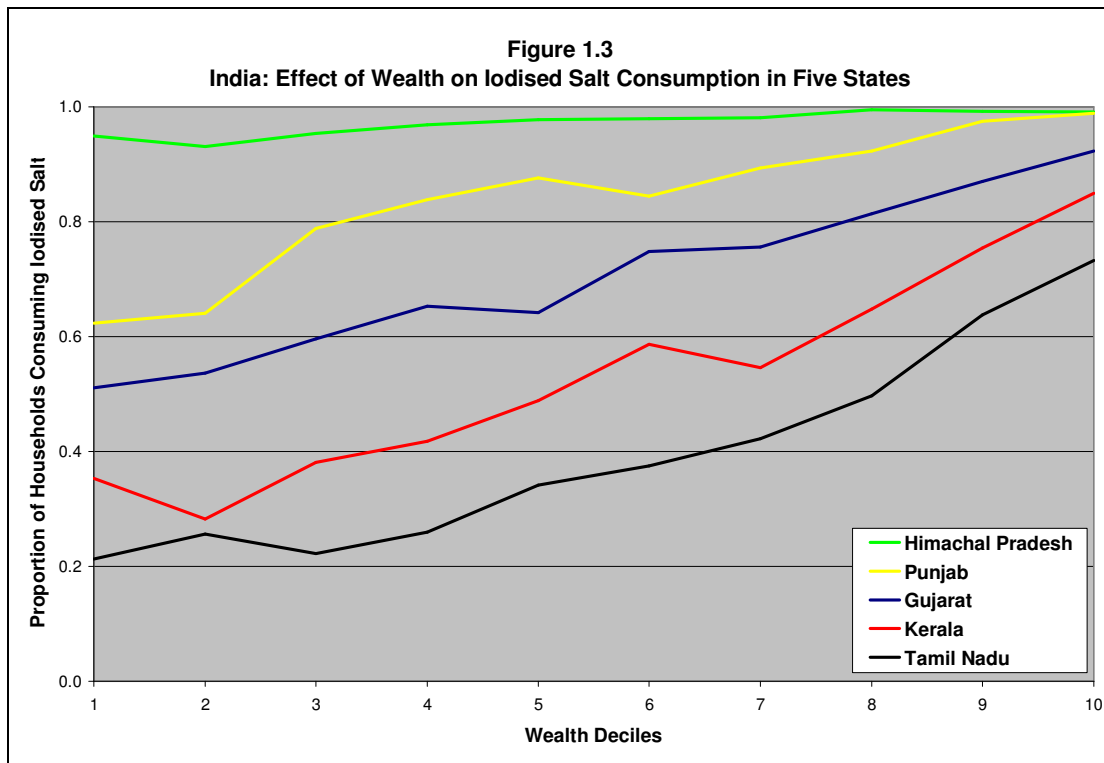


Figure 1.3, above, illustrates the nature of the relationships between household wealth and IS consumption in a selection of States. As IS availability, as defined by the overall rate of IS consumption in each State, increased, so the wealth effect, as defined by the steepness of the gradient, started to disappear.

### 3) Effect of Educational Attainment on IS Consumption

Before adjusting for wealth, there was a significant relationship between IS consumption and education, with highly-educated households being nearly 20% more likely to consume iodised salt than those households without any formal education ( $p < 0.0001$ ). However, after adjusting for wealth, State and salt type, this association diminished to the point where it was only statistically-significant at secondary and higher education levels (OR: 1.20;  $p < 0.0001$ , 95CI [1.052-1.191] and OR: 1.38;  $p < 0.0001$ , 95CI[1.257-1.522], as compared to households with no formal education).

Although these differences were statistically highly significant, the magnitude of the effect of educational attainment on IS consumption was fairly marginal after adjusting for wealth. Those households with a member educated at secondary and higher levels were only 2% and 4% more likely respectively to consume iodised salt than those without a member with any formal education.

At State level, the adjusted effect of educational attainment was only significant in four out of five States without full legislative bans in place at the time of survey, these being Andhra Pradesh, Goa, Kerala and Maharashtra. For all other States there was no significant difference between the four educational groups after adjustment for wealth effect had been made.

#### **4) Effect of Urban-Rural Status on IS Consumption**

Before any statistical adjustment there was a clear urban-rural divide both nationally and in all States whereby urban households were on average about 15% (OR: 2.26;  $p < 0.0001$ , 95CI[2.027-2.508]) more likely to consume iodised salt than rural ones. However, after adjusting for the effects of wealth, State and salt type, this difference was reduced to insignificance ( $p = 0.153$ ).

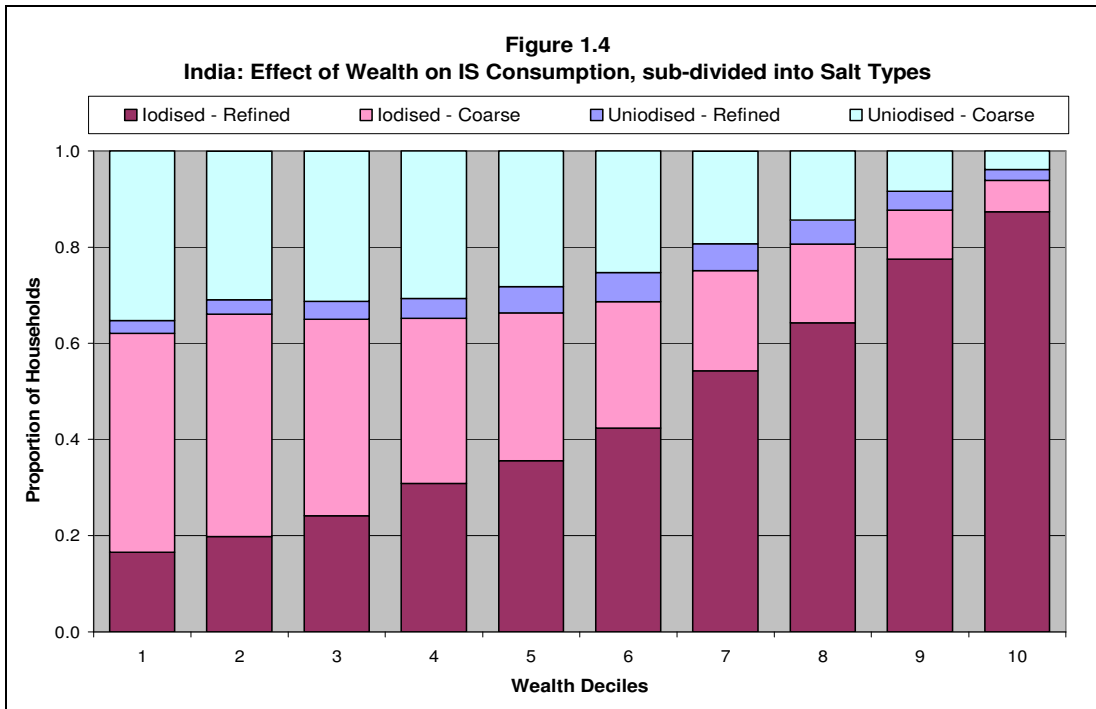
By State, the lack of a difference between urban (categories 1-3) and rural households generally held true, except for Bihar (8.3% less IS consumption in rural areas), Uttar Pradesh (rural 10% less) and Rajasthan (17% less).

Rather than 'Countryside' it was in fact 'Capital / Large City' that showed the most variation across States. For instance, in Andhra Pradesh, Gujarat, Goa and Orissa, households in the largest urban category showed much higher IS consumption rates than those in the other three categories, whereas in Tamil Nadu (containing Chennai) and Maharashtra (containing Mumbai) households in this category showed much lower rates, indicating a higher degree of competition from uniodised salt in the markets of these 'super-cities'.

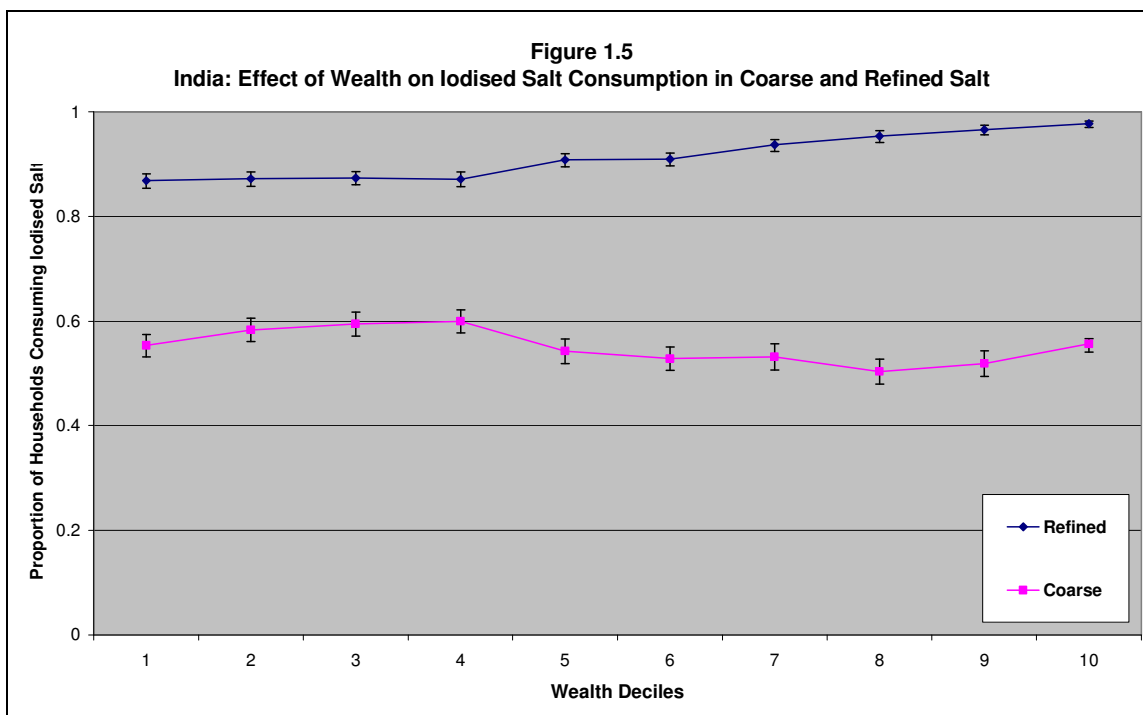
#### **5) Effect of Salt Type on IS Consumption**

At the time of survey, refined salt was much more likely to be iodised in India than coarse salt (91% and 55% respectively; OR: 11.76,  $p < 0.0001$ , 95CI[10.409-13.292]). On the other hand, more households in India bought coarse salt than refined salt (55% and 45%

respectively). Figure 1.4, below, shows how the consumption of coarse and refined salt changed with increasing wealth in the households of India and Figure 1.5 shows how this change, in turn, influenced the rates of IS consumption of refined and coarse salt by wealth deciles.



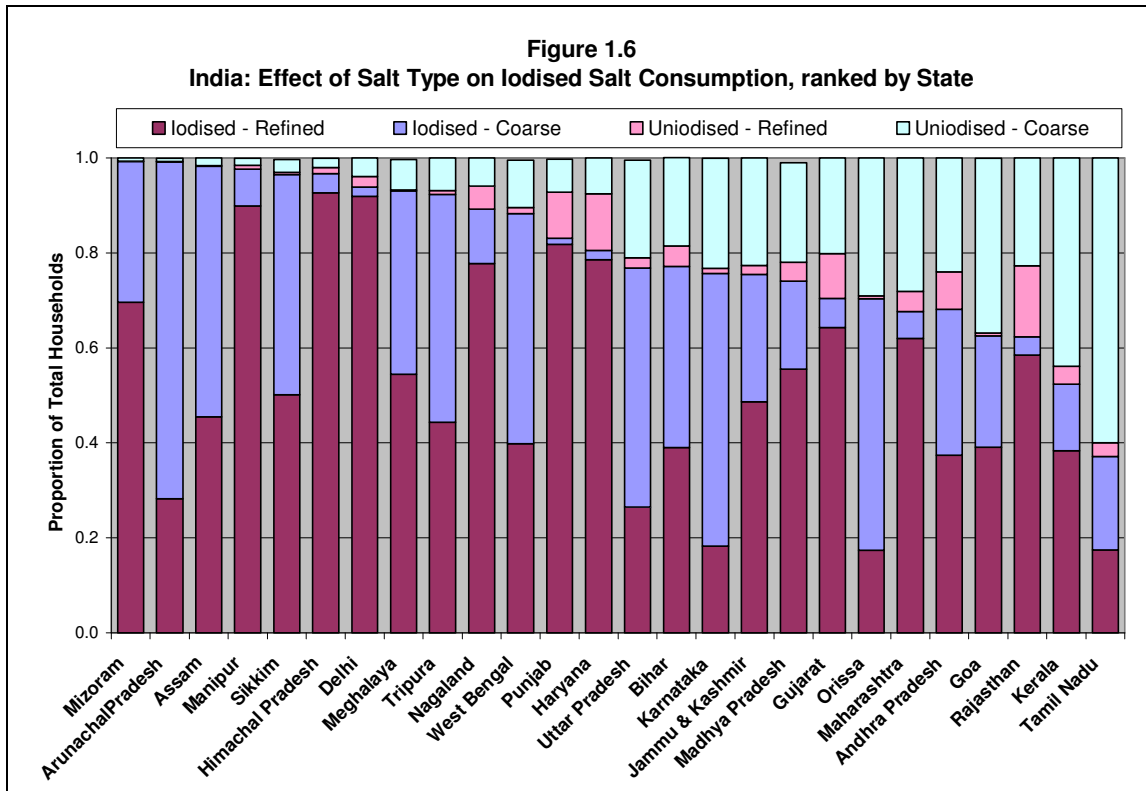
When analysed separately by salt type (Figure 1.5 below), a significant relationship appeared to exist between refined IS use and wealth, with the wealthier half of households more likely to purchase iodised refined salt (OR: 1.672;  $p < 0.0001$ , 95CI[1.556-1.797]). 5.7% more refined IS consumption was observed among the richer half of households. Analysis of coarse salt users indicated a very slight inverse wealth effect, whereby wealthier coarse salt users were less likely to purchase iodised coarse salt, but the magnitude of this effect was only marginal (1.0%)(OR: 0.924;  $p = 0.005$ , 95CI[0.874-0.977]).



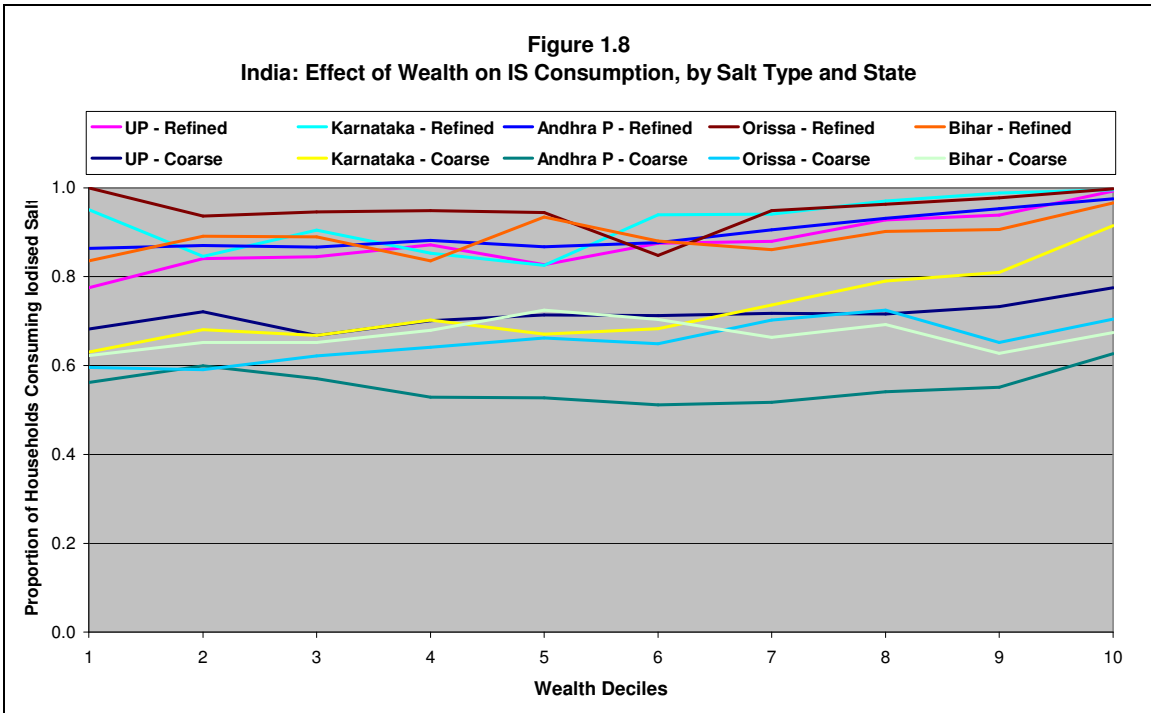
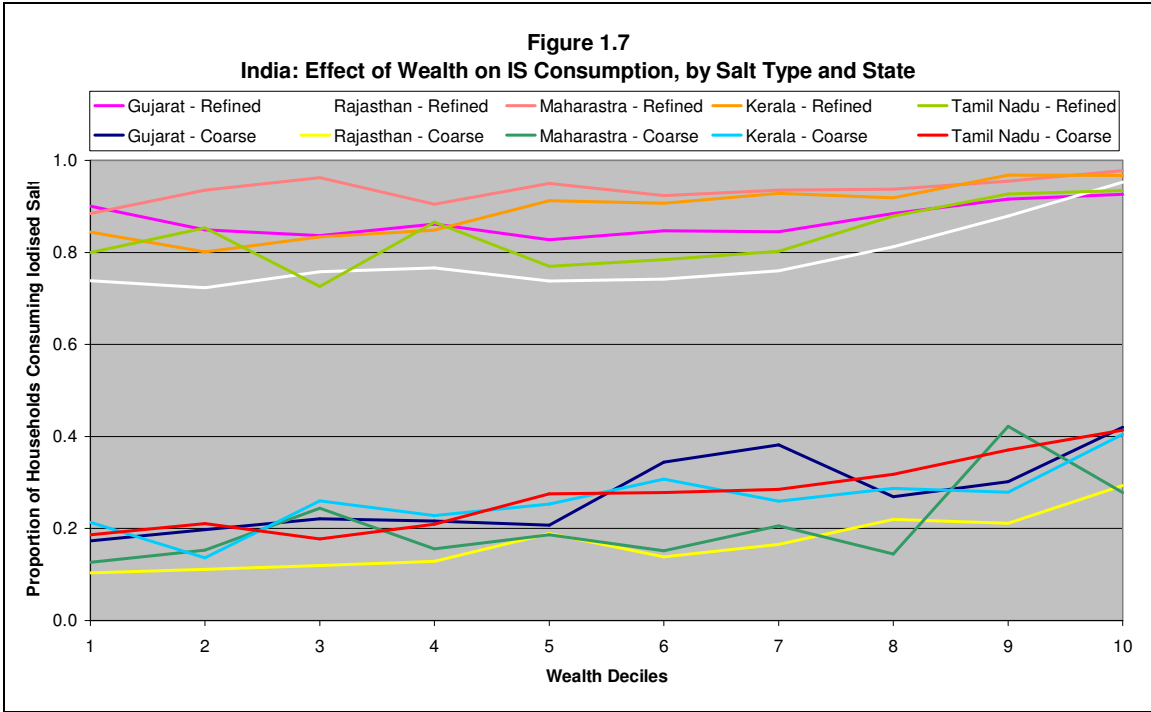
The consumption of different salt types varied considerably by State as Figure 1.6 (below) shows. The rank order of States in Figure 1.6 reflects the overall proportion of iodised salt found in the States' households. Generally, no relationships were found between levels of refined salt consumption and the overall levels of IS consumption within States. This was because in several States such as Orissa, Arunachal Pradesh and Uttar Pradesh, the majority of iodised salt was coarse (75%, 71% and 65% respectively). However, on the whole for India, refined salt accounted for only 14.3% of uniodised salt, the vast majority of uniodised salt in Indian households (85.7%) being coarse in nature. In all but a few States<sup>§</sup>, coarse uniodised salt was by far the main source of the problem.

<sup>§</sup> The States where uniodised refined salt was a major problem (i.e. where refined salt accounted for >10% of iodised salt) were: Rajasthan (20%), Haryana (13%), Gujarat (13%) and Punjab (11%).





The selected samples of States in Figures 1.7 and 1.8 illustrate various relationships that were found between household wealth and IS consumption for refined and coarse salt separately. Most States reflected the results as found in Figure 1.5 with little change of IS consumption with increasing wealth for each salt type. With the exception of Madhya Pradesh, no States showed any sizeable wealth effect within each salt type. Figure 1.7 shows the large difference between coarse and refined salt in their rates of iodisation and it is in these States that the most significant wealth effects were found. On the other hand, Figure 1.8 shows a sample of States where coarse salt was much more likely to have been iodised and in these States the wealth effect was less marked.



## **DISCUSSION**

### **1) State Differences in IS Consumption**

At the time of survey, the overall levels of IS consumption were much higher in northern than in southern States. No relationship was found between household IS use and State wealth, as reflected by GDP per capita. If anything, a slight inverse relationship with State GDP existed, although this was not statistically significant. Thus, the level of State wealth did not explain the variations in State IS use.

A more plausible explanation for these differences between the broader regions in India is related to the fact that iodine deficiency has historically been much more prevalent in the Himalayan and sub-Himalayan States, where the resulting attitudes and general awareness of the need for iodised salt are much higher than in the southern States where traditionally iodine deficiency is not thought of as an issue deserving priority.

Over time, these differences in the apparent severity of IDD and the resultant perception of the need for its alleviation have been translated into a national policy that the northern States, located at larger distance from the salt producing States of Tamil Nadu, Rajasthan and Gujarat, should be served by a preferential system of rail transport. Most of the salt sent to the northern States is therefore transported by rail, virtually all of it on the so-called 'Nominee system'. Access to this system is biased in favour of the larger, registered salt producers who are more likely to have their salt dispatches undergo inspections.

In association with the allocation within the Nominee system, salt transported by rail is subjected to monitoring and registration of the producer, whereas salt transported by road is much harder to oversee and control. At the time of survey, road haulage was by far the more common mode of transport for salt supplied to the southern States in India.

## **2) The Effect of Household Wealth and Salt Type on IS Consumption**

Within the variables available, household wealth was the factor most strongly associated with IS consumption in India, which was in turn largely caused by a wealth effect in the use of refined, iodised salt. Thus, salt type was by far the more important determinant of household use of iodised salt.\*\* Overall, 91% of refined salt, compared to only 55% of coarse salt, contained  $KIO_3$ , and in some States, such as Rajasthan, Kerala, Tamil Nadu and Maharashtra, this difference was far larger than the national average (78.7-93.7% compared to 16.8-27.2% for refined and coarse salt in these States).

With increases in household wealth, the overall rates of iodisation of either coarse or refined salt did not change to a large degree. Instead, the relative proportions in which they were consumed did. Poorer households were much more likely to purchase coarse salt whereas richer households were much more likely to consume refined salt. Thus, household wealth levels determined salt type preference, which in turn determined the probability of consuming iodised salt.

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\*\* However, as explained above, other factors not included in the data analysis also play a major role, including modes of transportation, promotion practices and the rigour of monitoring, inspection and enforcement.

This finding, therefore, leads to two fundamental questions of great significance for India's efforts to progress towards USI. Firstly, why is coarse salt in India less likely to be iodised and, secondly, why are poorer households more likely to buy it?

**a) Why is coarse salt less likely to be iodised?**

Coarse (or common) salt is uncrushed and has a larger crystal size than refined salt. It has higher levels of impurities and a higher affinity to moisture. This can cause leaching of the  $KIO_3$  over time, especially if the salt is not packaged correctly and stored in optimal conditions. However, while this problem is generally accepted as a limitation of using coarse salt, the survey data analysed in this study demonstrated that USI was achieved in the north-eastern States primarily using coarse iodised salt. The real problem is therefore not so much in the physical or chemical properties of coarse salt, but rather the circumstances and conditions in which it is produced and traded.

Much of the common coarse salt in India is produced in smaller-scale salt enterprises that have made less investment in the technology needed to both crush and iodise salt. These producers may lack the sufficient conviction, incentive, and perhaps the skills necessary to carry out iodisation. The profit margin on salt production is slim; the income earned from small-scale salt-harvesting is roughly equivalent to that of unskilled agricultural labour and thus, at least in the case of individuals, the additional expenses of  $KIO_3$ , equipment and packaging can be burdensome. Also, they may lack a consistent electricity or water supply needed to process the salt efficiently, particularly in the rural inland areas of Gujarat and Rajasthan.

Reaching and ensuring the complete and permanent iodisation of salt in the small-scale sector is difficult, not least in India where small-scale production has enjoyed the attention and staunch support from highly influential lobby groups. Despite considerable progress being made in the salt industry in general, the supply of uniodised salt by this section of the salt industry has continued unchecked in recent years, primarily because of reluctance by the former government to engage this issue head-on. However, with the approaching UNGASS deadline of 2005 drawing ever nearer, engagement must happen very soon or else the government will fail in its efforts to meet the target of delivering adequate iodine nutrition to the most vulnerable sections of the population by the agreed-upon point in time.

**b) Why are poorer households more likely to purchase coarse salt?**

*"If iodised and non-iodised salt are both available in the market place, and if the iodised product is even slightly more expensive, the poor will be effectively excluded."*

***Vitamin & Mineral Deficiency: A Global Progress Report,  
MI / UNICEF, 2004***

The above statement made this year reflects the growing realisation within the iodine community that iodised salt must be competitively-priced to gain universal acceptance as a habitual product in all households, both rich and poor. The salt trade cannot solely rely on the status of iodised salt as a 'value-added' product as the means to convince consumers to pay more for it as long as a cheaper, non-iodised product is also available in the market. According to Mohan (2002), the retail price of free-flowing refined iodised salt produced and sold in Gujarat is 5-7Rs per kilo, compared with 1-2Rs per kilo for coarse uniodised salt.<sup>4</sup> However, coarse iodised salt is sold at 2-3Rs per kilo and is thus more affordable to

poorer households than the refined variety. Therefore, unless the salt industry can supply refined salt at 2-4Rs per kilo, which is highly unlikely to be profitable, the only product that can out-compete uniodised salt in the market is iodised coarse salt.

It should be noted that the product “salt” is in practice more diverse than merely ‘coarse’ or ‘refined’. There are several types of coarse salt in India alone. In the inland area of the Little Ran of Kutch in Gujarat a type of traditional coarse salt, named “Baragara”, is harvested annually. It is very impure with a large crystal size and is reputedly very difficult to iodise effectively. Coastal salt producers on the other hand make a purer coarse sea salt, which is easier to iodise and holds on better to its  $KIO_3$ . Also, the scale of salt manufacturing differs substantially between the inland and marine salt enterprises. At far-flung destinations, inland coarse salt from Gujarat is less likely to contain  $KIO_3$  than coastal coarse salt. The same reasoning and difficulties apply to the traditional inland coarse salt from Nawa in Rajasthan.

The main market for Baragara salt outside of Gujarat and Rajasthan is Madhya Pradesh, which was the only State in this study to show a sizeable wealth effect in the use of coarse, iodised salt. It is possible therefore that another wealth effect was occurring in this State, only this time it reflected a change in the relative proportions of inland or coastal coarse salt consumed with increasing wealth. However, more detailed survey data would be needed to test this theory.

### **3) Educational Attainment and Urban-rural Status**

Educational attainment and urban-rural location, whilst being statistically-significant, was found to play only a minor quantitative role, their combined effect producing only a difference of about 10%. Therefore, although this study's analysis concurs with the NFHSII Final Report<sup>5</sup> that there is a sizeable difference between urban and rural populations and between the educated and uneducated, the results above show that these disparities can be mostly attributed to the households' economic status and its relationship with salt preference and market price.

Therefore, it would not appear from the present analysis that rural or uneducated households have any less access to iodised salt but rather that, due to their generally lower purchasing power, they are more likely to buy cheaper coarse salt which in turn is less likely to be iodised.

### **POLICY IMPLICATIONS**

The long-lasting operational priority in India to increase refined salt production, and along with it, increase the amount of salt being iodised, has two major flaws. Firstly, while the refined salt market in India is growing, it is unlikely that the salt industry will be able to capture and saturate the entire domestic market with refined iodised salt without substantial additional capital investment and improvements in infrastructure, due to the need for industrial plant and a reliable electricity supply needed for the crushing and refining process. Secondly, the history of using salt legislation as an instrument of colonial oppression has



created a great respect for the fundamental principle of Indian social democracy that “a working man should have access to affordable salt.” Unfortunately, ‘iodised salt’ has come to be perceived as synonymous with ‘refined salt’, possibly because the proclamation of USI policy at national level coincided with the emergence of salt refineries in India. Refined salt is considerably more expensive than coarse salt and thus the perception has taken hold that iodised salt is beyond the means of common people.

Thus, despite its altruistic intent, iodised salt legislation in India has remained highly controversial because, by appearing to force the population to pay a higher amount for its salt, it resembles the old salt taxes. It is largely because of the misconception that iodised salt has to be refined that the central ban was rescinded in 2000 after sustained pressure from lobbyists with strong ideological roots in the independence movement. Future progress towards USI in India must address these concerns by showing that iodised salt does not necessarily have to be refined and that it can be sold at a universally-accessible price, i.e. at current market conditions not more than 2-3Rs per kilo.

The market share of uniodised salt can also be lowered through government action by creating a differential cost structure for iodised and uniodised salt through legislative and administrative means. It should be recalled, however, that government price interventions in commodity markets are as vulnerable to political influence as the practices of government food inspections.

Iodised common salt producers should be given all possible incentives and advantages, such as subsidised loans for the purchase of land and iodisation-related equipment together with

improved access to preferential rail transport and assistance with quality monitoring and assurance. In return, their traders should be asked to agree to a reasonable maximum sales price, which is more of a reflection of the cost of production than the preferred profit margins of traders.

Alongside these incentives, the production and trade of uniodised salt must be made more prohibitive, especially where it is illegal in view of a State ban. Higher transport costs (for instance by refusing border crossing between States) and a transparent, consistent and incremental penalty fine system (rather than imprisonment) and discontinuation of leases are all tools available to national and State governments should they wish to apply them. At present, the Salt Department has virtually no powers of enforcement and only limited monitoring facilities.

## **CONCLUSION**

As a general rule in India, household wealth increases a household's probability of consuming iodised salt mostly by increasing its likelihood of purchasing refined salt, not iodised salt *per se*. Educational attainment and urban-rural status play only a minor role in a few States and none in most. The results of this study suggest that when iodised salt is made available at a competitive price and fits in with consumer preferences, poorer consumers will be more likely to buy it.

On the basis that poorer households are more likely to suffer from a higher burden of disease and malnutrition, it would be most equitable to give them the highest priority with

regard to public health interventions. In this case, focusing on increasing the iodisation of coarse salt would be much more likely to increase iodine intake in poorer households compared to the current effort at increasing refined salt production, which would benefit wealthier households first and foremost.

Re-enactment of the central government salt ban will only occur once those parties instrumental in its withdrawal have been convinced that iodised salt is both achievable for the salt industry as a whole and, more importantly, that it is affordable for all households irrespective of their level of wealth. Until that time, State authorities should use their existing acts and powers more effectively in order to ensure enforcement practices that promote the trade supply and thus, household purchase of coarse, iodised salt. Meanwhile the assistance community should focus its considerable technical and funding support on enabling the small-scale inland and marine salt producers to provide a consistent and reliable source of common, iodised salt.

## **7. BENIN**

In 1994 the Government of Benin enacted legislation requiring that all edible salt, including that intended for animal consumption, should be iodised with 20-40ppm  $KIO_3$ . In 1995 about 80% of the country's salt was imported, mostly from other West African countries, about 60% of which was iodised. Local small-scale coarse salt production is concentrated along the southern coast.

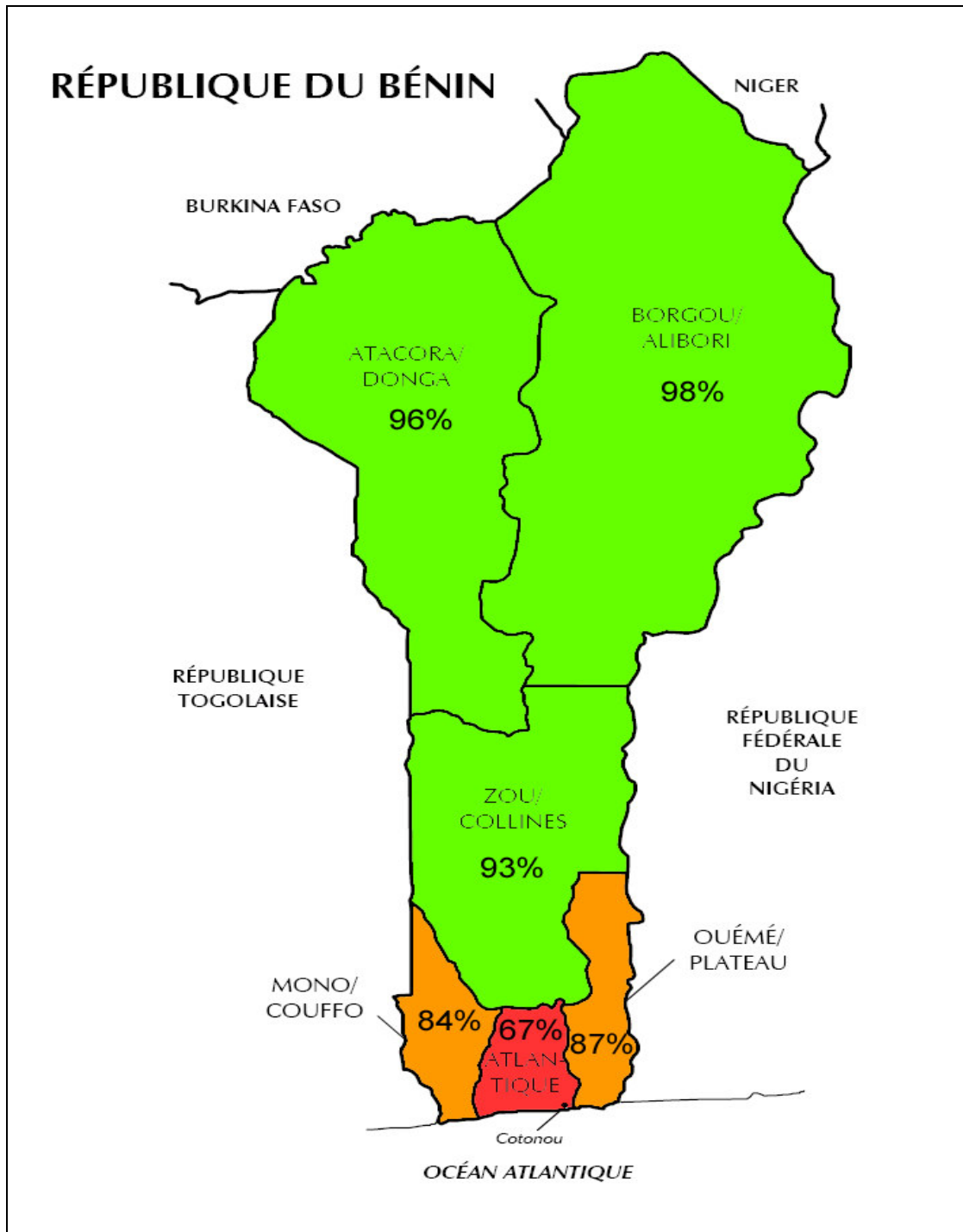
This survey by the National Institute for Statistics and Economic Analysis (INSAE) collected data from 5,796 households between August and November 2001. It is thus the smallest sample in this study except Tanzania.

### **RESULTS**

#### **1) Effect of Region on IS Consumption**

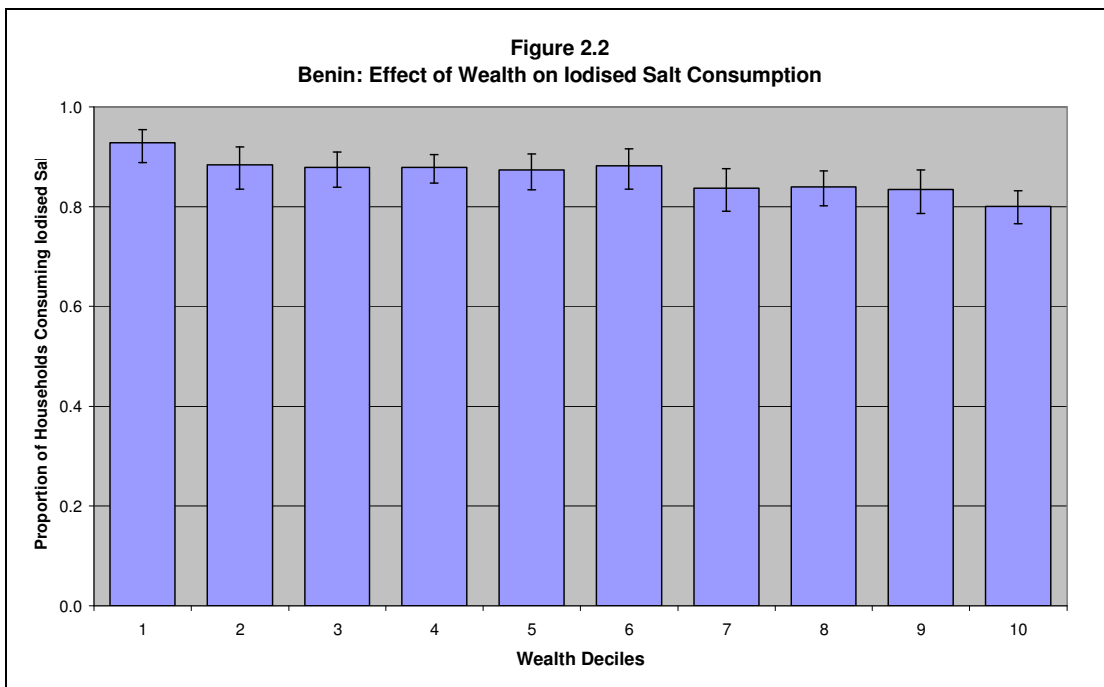
IS consumption varied greatly by region (see Figure 2.1, below); the regions furthest from the coast showed the highest IS consumption. Households in the northern Departments of Borgou, Atacora and Zou were much more likely to consume iodised salt than those in Oueme, Mono and Atlantique in the south (OR: 6.482;  $p < 0.0001$ , 95CI[4.803 - 8.746]). Atlantique stood out as the worst Department with only 67% of households consuming iodised salt.

Figure 2.1: Regional Map of Benin showing IS Consumption Rates  
(% Households with Iodised Salt), 2001

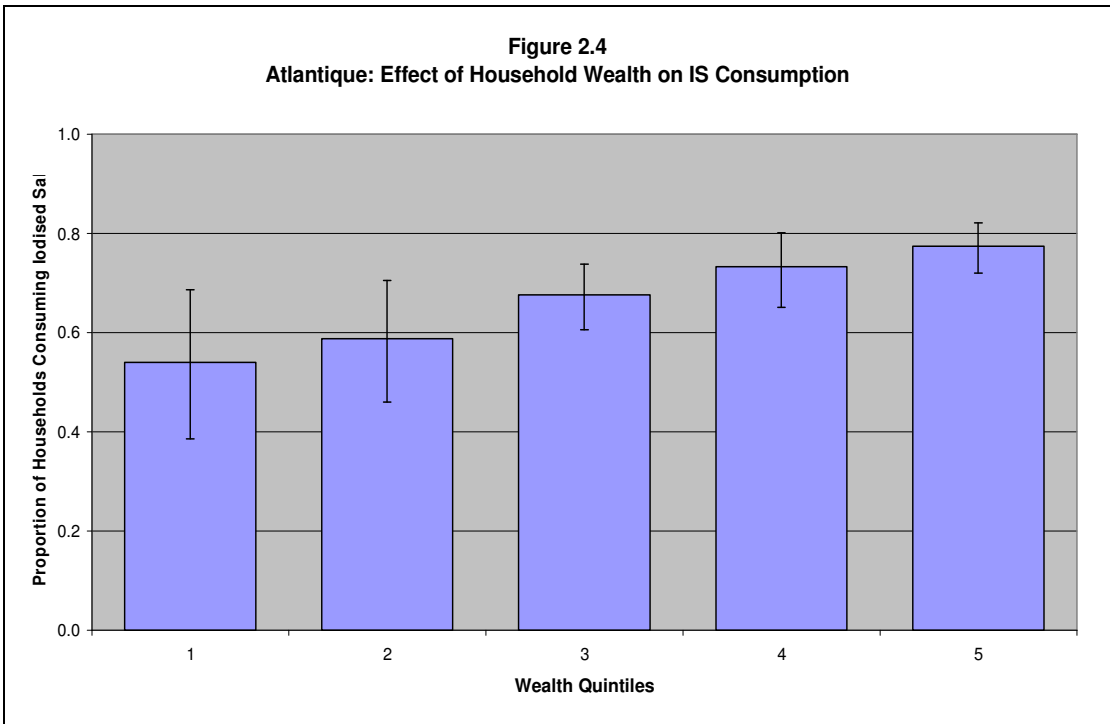
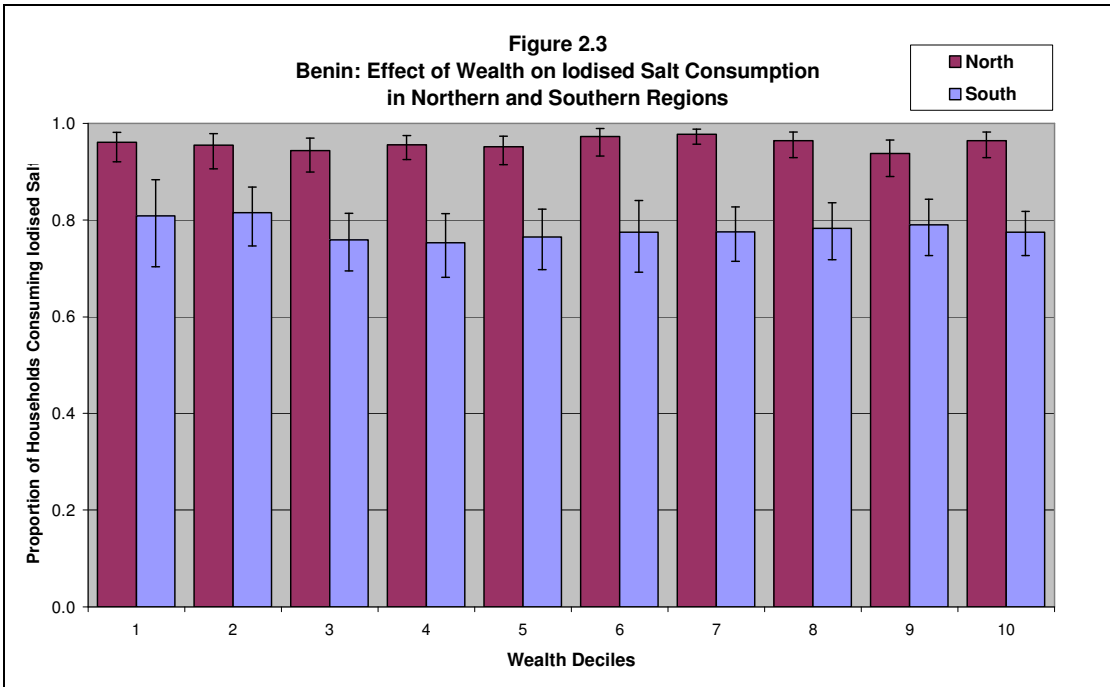


## 2) Effect of Household Wealth on IS Consumption

The results (Figure 2.2, below) showed a slight inverse association between household wealth and IS consumption. 83.9% of the wealthier half of the population consumed iodised salt, compared with 88.9% of the poorer half (OR: 0.647;  $p=0.002$ , 95CI[0.495 - 0.847]).



However, when the sample was stratified into the three northern and three southern regions, this inverse wealth effect disappeared ( $p=0.754$ ), indicating that the primary determinant of IS consumption was actually the households' geographical location rather than their wealth (see Figure 2.3, below).



At regional level, the only genuine wealth effect was seen in Atlantique, where wealthier households were more likely to consume iodised salt than poorer ones (OR: 1.784;  $p=0.027$ , 95CI[1.071 - 2.969]). The wealthier half of households in Atlantique was nearly 13% more likely to consume iodised salt than the poorer half (see Figure 2.4, above, for increases by quintile). No other regions showed a statistically-significant wealth effect.

### **3) Effect of Educational Attainment on IS Consumption**

At national level, before adjusting for wealth, there was a significant inverse relationship between IS consumption and educational attainment, where highly-educated households were 8% *less* likely to consume iodised salt than households without formal education ( $p=0.001$ ). However, after controlling for the confounding effects of region, those households with a member who had completed higher education were 4% *more* likely to consume iodised salt than those households with no formal education (OR: 1.574;  $p=0.049$ , 95CI[1.003 - 2.470]).

### **4) Effect of Urban-Rural Status on IS Consumption**

Even before adjusting for the effects of region, there was no statistically-significant difference between urban and rural households at national level ( $p=0.410$ ). Adjusting for the effects of wealth or region did not alter this lack of association.

The only significant differences between urban and rural households were found in Atlantique region, where urban households were approximately 20% more likely to consume

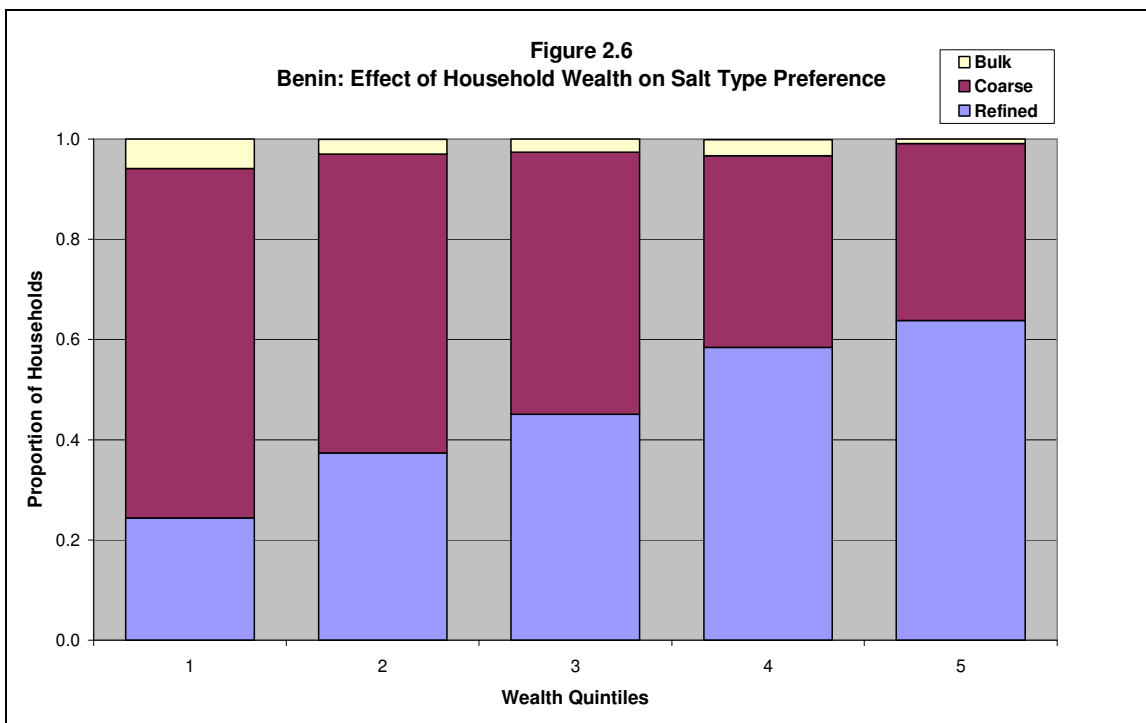
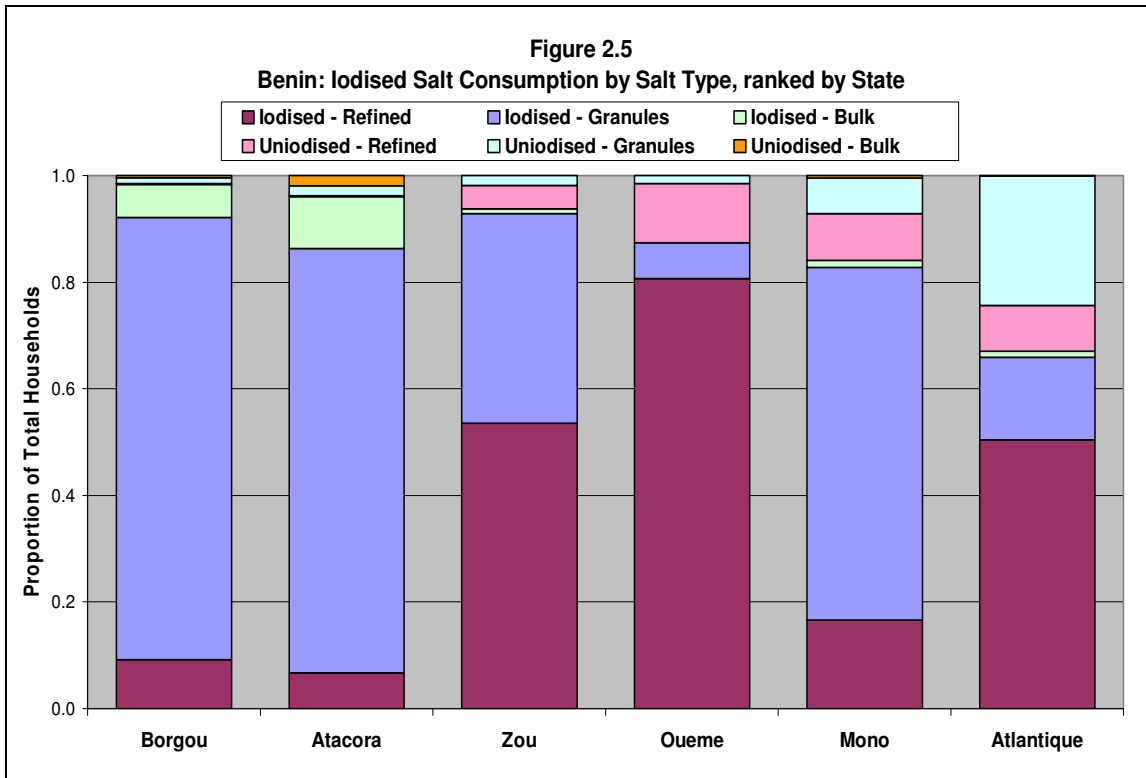


iodised salt than rural ones (OR: 2.334;  $p=0.04$ , 95CI[1.347-4.046]). However, this difference disappeared ( $p=0.134$ ) after adjustment for household wealth.

## 5) Effect of Salt Type on IS Consumption

Overall, 51.0% of salt tested in Benin was identified as 'coarse', 45.9% was 'fine', and only 3.1% was 'bulk'. For the sample as a whole, there was no statistically-significant difference between the three different types of salt in their likelihood of containing  $KIO_3$  ( $p=0.573$ ). Poorer Beninese households were more likely to consume coarse salt whereas wealthier households were more likely to consume refined salt (OR: 2.78;  $p<0.0001$ , 95CI[2.285-3.393]) (see Figure 2.6, below).

The only Departments where salt type made a significant difference in IS user rates were Mono and Atlantique. In Mono only 65% of refined salt was iodised, compared with 91% of coarse salt (OR: 0.189;  $p=0.014$ , 95CI[0.052 - 0.684]), whereas in Atlantique 85% of refined salt was iodised, compared with only 39% of coarse salt (OR: 9.270;  $p<0.0001$ , 95CI[5.171 - 16.615]). Figure 2.5 shows the relative contributions of each salt type to IS consumption in each region.



## **6) Effect of Storage Conditions on IS Consumption**

Analysis of this variable was limited by the large number of households which did not keep their salt in either open or closed containers. These households, classified as 'Other', comprised 22.2% of the sample (1,135 households). Dropping these households therefore casts serious doubt on the reliability of the subsequent analysis of the remaining households.

For the country as a whole, household salt kept in closed containers (51% of households) was at first inspection slightly more likely to contain  $KIO_3$  than salt kept in open containers (26.8%)(OR: 1.24,  $p=0.049$ , 95CI[1.001-1.557]). However, once salt type and region were added to the model, storage conditions became insignificant ( $p=0.252$ ).

## **DISCUSSION**

### **1) Effect of Region on IS Consumption**

Region was the variable most strongly associated with the use of iodised salt in households of Benin. At the time of survey, iodised salt consumption was much higher in northern inland regions than those near the southern coast. Controlling for wealth had no effect on this outcome.

The large majority of the approximately 3,000 small-scale domestic salt producers are located along the coast, 30-50km from the Capital Cotonou in Atlantique region. Their salt quality and production volume is insufficient for traders to move it long distance up north.

Thus it is sold uniodised at local markets along the coast, which causes the coastal Atlantique Department to lag in the progress toward USI.

## **2) Effect of Household Wealth and Salt Type on IS Consumption**

After controlling for regional variation there was no significant association between wealth and IS consumption for the sample as a whole. At regional level, the only significant wealth effect occurred in Atlantique, where the availability of iodised salt was lowest.

Salt type was not significantly related to IS consumption except in Atlantique, where coarse salt was much less likely to have been iodised than refined salt, as well as in Mono where the reverse was true. This led to a wealth effect in Atlantique salt whereby poorer households were more likely to purchase uniodised coarse salt and a weak inverse wealth effect in Mono due to a higher consumption of uniodised refined salt in wealthier households.

Although data were not available to compare prices, it would seem likely that in Atlantique the domestically-produced coarse salt was able to undercut imported coarse salt, but that the levels and perhaps quality of local salt production were insufficient for this effect to permeate throughout Benin. A large proportion of the uniodised refined salt in the households of Mono is most likely supplied from Ghana via Togo. In combination with the large share of uniodised coarse salt in Atlantique, these leakages indicate weak enforcement by officials in Benin.

### **3) Effect of Education & Urban-Rural Status on IS Consumption**

Educational status and urban-rural status showed no significant relationship with IS consumption once regional and wealth effects had been controlled for, indicating that these factors did not play any role in determining IS consumption in Benin.

### **CONCLUSION**

Wealthier households in Benin were more likely to consume refined salt whereas poorer households were more likely to consume coarse salt. Because for the country as a whole, the iodisation proportions of refined and coarse salt were not different; no wealth effect occurred in IS consumption except in Department Atlantique, which showed a weak but significant wealth effect. There were no significant effects on IS consumption either with educational attainment level or between urban and rural households.

The main predictor of IS consumption in Benin was the region in which the household was situated. However, in policy terms, the location of a household cannot directly influence the practice of iodisation; it only reflects other factors at work that are not contained within the data. At the time of the survey two related factors were influential in holding back the otherwise excellent progress toward reaching USI in Benin. First, uniodised refined salt from Ghana was, reportedly, supplied into Mono and second, in Atlantique, uniodised coarse salt was entering unchecked into the markets, having been produced by a large number of small-scale coastal sea-salt producers located near the Capital Cotonou.

As to improvements in the domestic iodised salt supply, Benin needs to focus its future efforts on supporting the iodisation of sea-salt by domestic salt producers. Also, urgent attention is required to stop the leakage of uniodised refined salt from Ghana through better border controls and enforcement. Otherwise, a significant proportion of households in the southern regions, particularly Atlantique, will continue to be at risk of iodine deficiency.

## 8. ARMENIA

Armenia is a small, mountainous country, which shares borders with Georgia, Azerbaijan, Turkey and Iran, though those with Azerbaijan and Turkey are closed due to territorial disputes. At the time of survey, salt iodisation was not compulsory in Armenia, though legislation specified that any iodised salt should contain 50ppm as KIO<sub>3</sub>.

Fortunately the country's only salt producer, Avan Salt Company in Yerevan, has been voluntarily iodising its salt since 1997<sup>††</sup> and it has enough production capacity to supply the entire domestic market. This survey was carried out from October to December 2000 in a joint venture between the National Statistical Service and the Ministry of Health. 99.9% of households' salt was tested for the presence of iodine.

## RESULTS

### 1) Effect of Province (known as “Marz”) on IS Consumption

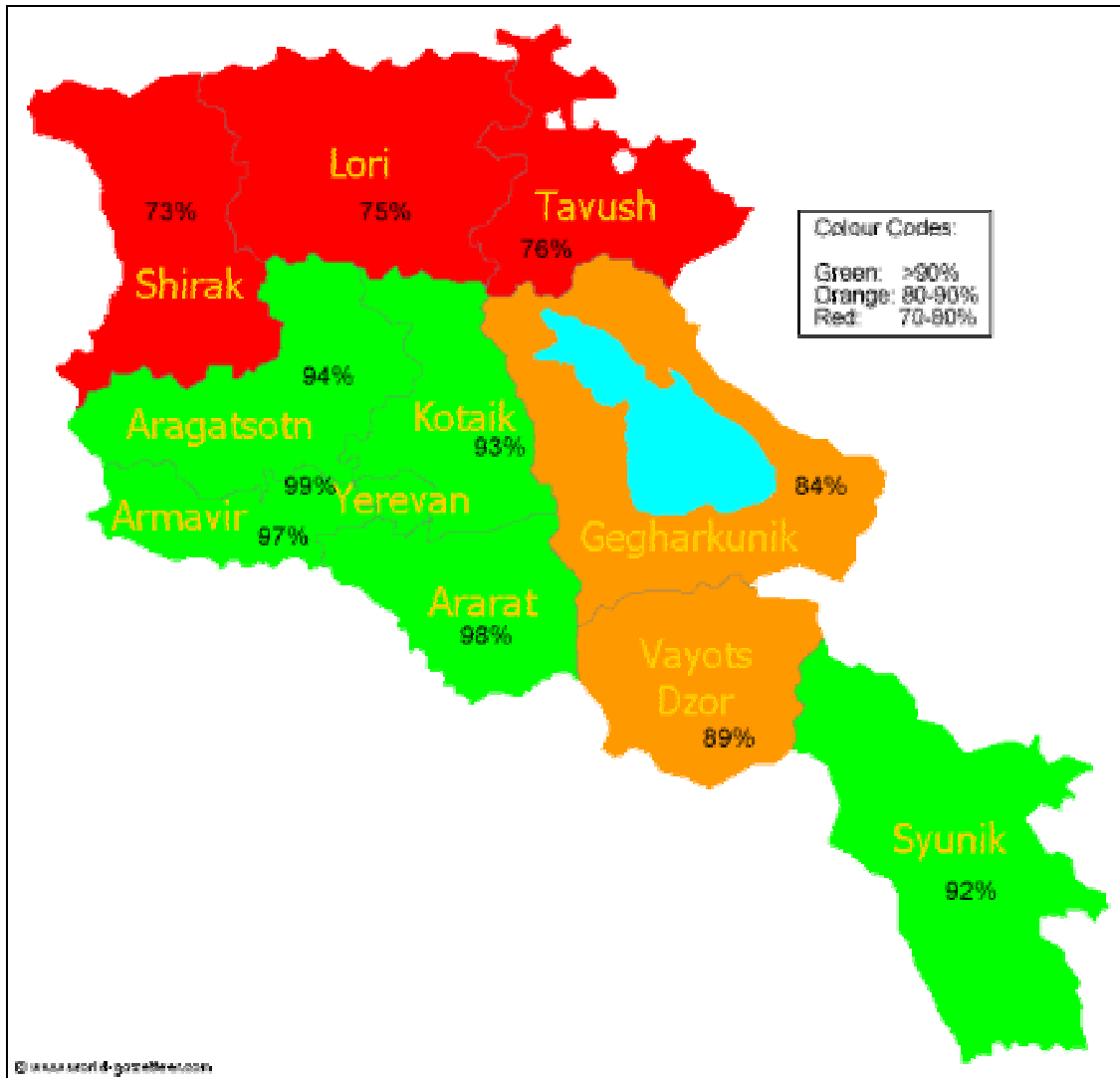
Iodised salt consumption was generally high; the mean level for the entire Armenian sample was 90.4%. The capital city, Yerevan, showed the highest levels (98.9%). The three northern provinces of Lori, Shirak and Tavoush were found to have significantly lower levels (75.4%, 72.7% and 75.7% respectively) than other provinces, even after adjusting for

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<sup>††</sup> The company first received assistance from UNICEF in 1997, but was producing iodised salt before the collapse of the central planning and direction system of the former Soviet Union.

wealth (OR: 0.158;  $p < 0.0001$ , 95CI[0.119 - 0.210]). Figure 3.1, below, shows the IS consumption rates for all provinces.

Figure 3.1: Iodised Salt Consumption by Province

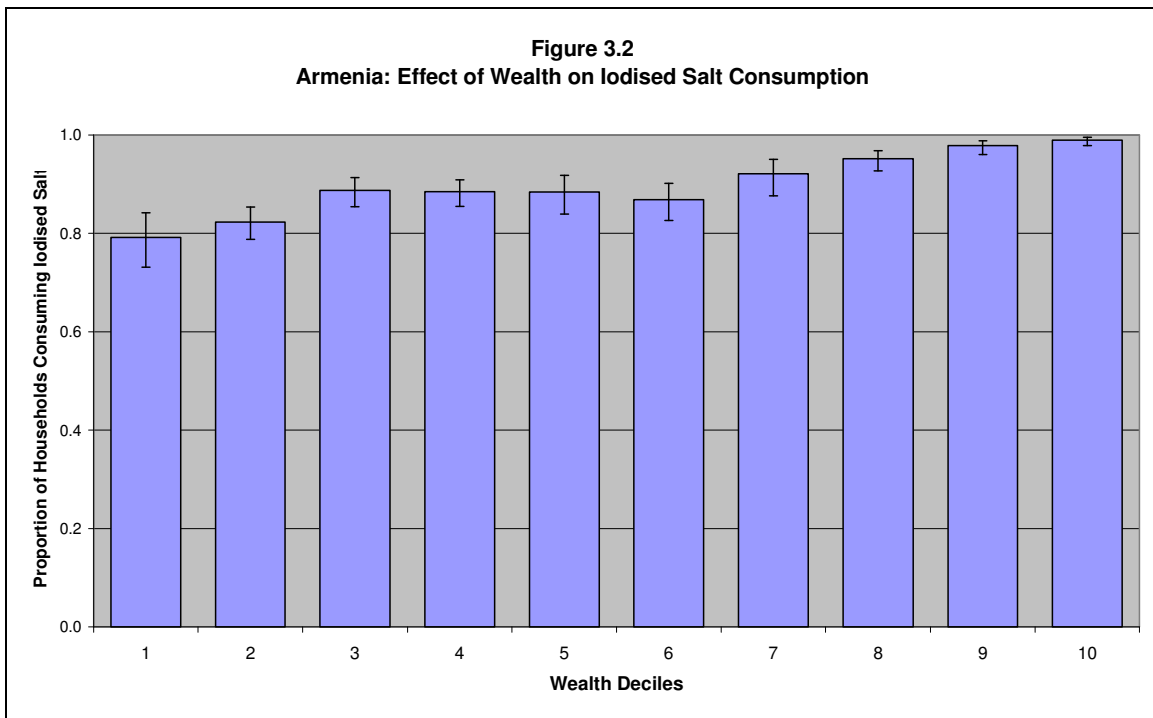


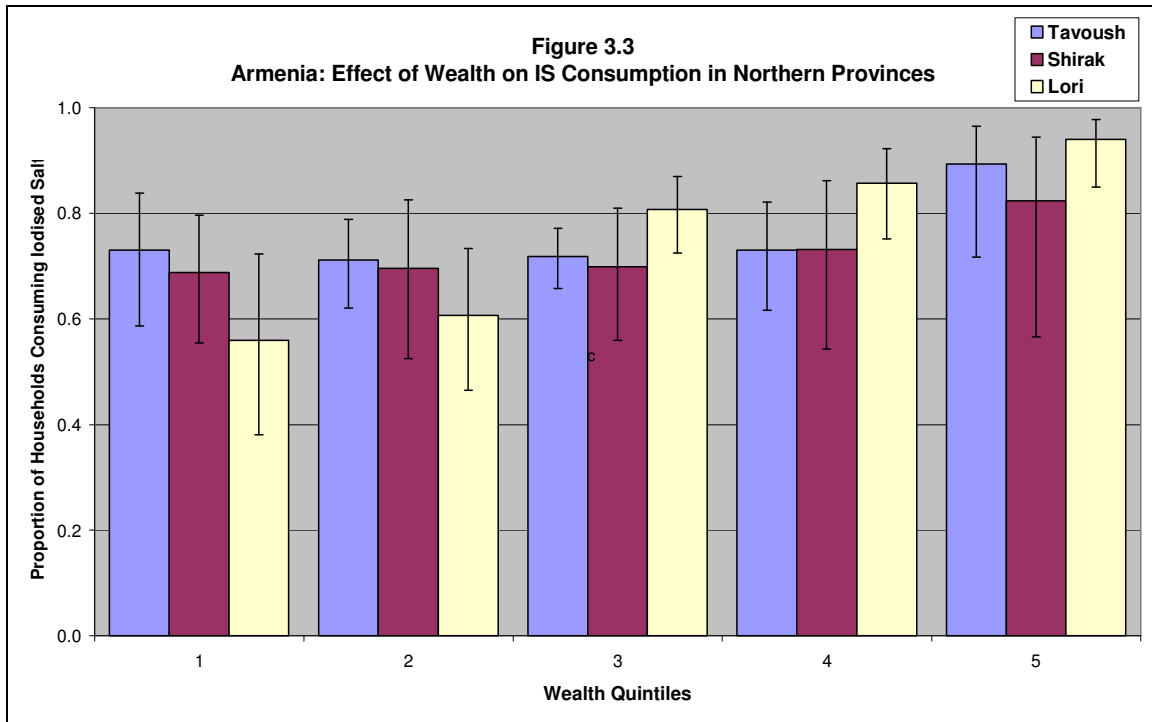


## 2) Effect of Household Wealth on IS Consumption

For the entire sample there was a statistically-significant association between household wealth and iodised salt consumption (OR: 2.840;  $p < 0.0001$ , 95CI[1.992 - 4.050])(see Figure 3.2, below).

At provincial level, Lori showed the strongest wealth effect (OR: 4.684;  $p = 0.009$ , 95CI[1.606 - 13.664]). However, neither of the other two northern provinces produced a statistically-significant wealth effect, even Shirak where IS consumption levels were marginally lower than Lori (see Figure 3.3, below).





### 3) Effect of Educational Attainment on IS Consumption

Before adjusting for the effects of wealth, only highly-educated households showed any significant difference from the other educational categories, these households being 7.2% more likely to consume iodised salt than uneducated ones (OR: 2.34;  $p=0.003$ , 95CI[1.353-1.048]). After adjusting for wealth, however, this difference disappeared ( $p=0.748$ ).

### 4) Effect of Urban-Rural Status on IS Consumption

Before adjusting for the effect of wealth, urban households were 6.8% more likely to consume iodised salt than rural ones (OR: 2.14;  $p<0.0001$ , 95CI[1.652-2.763]). Again, after adjusting for wealth this difference disappeared ( $p=0.246$ ).

The only provinces to show a statistically-significant urban-rural difference after adjusting for wealth were Shirak and Lori. In Shirak, those households located in the ‘small city’ category were much less likely to consume iodised salt than those located in rural areas (61% in the city compared to 89% in rural areas, (OR: 5.586,  $p=0.002$ , 95CI[2.282 - 13.672])). It would therefore seem likely that Gyumri, the capital city of Shirak, was the main source of uniodised salt in this province. In Lori, the opposite held true; urban households were significantly more likely to consume iodised salt than rural ones (84% compared to 72%, OR: 0.461;  $p=0.037$ , 95CI[0.219 - 0.971]) after adjusting for wealth.

#### **4) Effect of Knowledge of the Benefits of Iodised Salt on IS Consumption**

About 75% of all households were aware of the benefits of iodised salt. Having such knowledge improved a household’s probability of consuming iodised salt by 3.7% (OR: 1.380;  $p=0.005$ , 95CI[1.103 - 1.727]).

Low statistical power at provincial level prevented statistically-significant differences from being seen in all provinces except Shirak, where there was a 22% difference between those with knowledge and those without. A general trend could be seen whereby, the lower the general level of iodised salt consumption, the more significant knowledge seems to have been.

## 5) Effect of Storage Method on IS Consumption

The survey discerned two categories of salt storage to approximate 'good' and 'bad' storage conditions. 'Good' included being kept in a closed container, away from the cooker or in a dark place. 'Bad' was classified as being stored in an open container, close to the cooker or in direct sunlight.

Unfortunately, neither the DHS Final Report nor the household questionnaire provide guidance as to whether a closed container when stored next to the cooker would be either 'good' or 'bad'. All that can be assumed is that 'good' storage methods were generally better than the 'bad' ones.

About 80% of all household salt was kept under 'good' storage methods and was 7.3% more likely to contain iodine than that stored under 'bad' conditions (OR: 2.04;  $p < 0.0001$ , 95CI[1.664-2.509]).

Good storage conditions therefore increase the likelihood of consuming iodised salt, though probably only to a small degree. In any case, the validity of this result is open to discussion given the ambiguity over what constituted 'good' or 'bad' storage conditions.

## DISCUSSION

Despite the generally high levels of IS consumption, a significant wealth effect was found for the sample as a whole. At provincial level those with the lowest IS consumption rates did not necessarily have the strongest wealth effect. Although the effect of household wealth status was strong in Lori, it was much weaker in Shirak and Tavoush, despite Shirak having the lowest level of IS consumption. This suggests that in these provinces factors other than purchasing power played a significant role in the use of iodised salt.

Anecdotal evidence collected from interviewers suggests that, in many of the households with uniodised salt, the salt's packaging indicated that it had been produced in Ukraine or Iran. At the time of survey the only salt producer in Armenia, the Avan Salt Company, produced iodised salt which was supplied throughout Armenia. On the basis that it is highly unlikely that this producer would systematically under-iodise salt destined for specific provinces, this would suggest that imported salt was most probable source of the problem.

This would explain some of the differences in IS consumption between the provinces, since it was those bordering Georgia that had the lowest levels. At the time, most of Georgia's salt originated from Ukraine and was largely uniodised (8% in 2000)<sup>6</sup> despite legislation in Georgia being in effect that prohibited the sale of uniodised salt.

Due to the lack of salt legislation in Armenia this uniodised salt could legally be imported from Georgia where it competed with Armenian iodised salt. However, if it were considerably cheaper than Armenian salt, one would expect poorer households to have been

its main consumers. While this seems to be the case in Lori, the wealth effect is much less pronounced in Shirak and Tavoush, suggesting either that its competitive advantage is slim or else some other factor is at work.

## **POLICY IMPLICATIONS**

### **Legislative Reform**

At the time of this writing, Armenia still had not passed legislation requiring the mandatory iodisation of edible salt; the system as it stands remains totally voluntary. Thankfully the sole producer in Armenia has an excellent track record of iodising its salt, which means that the vast majority of the population is not at risk of the damaging effects of iodine deficiency.

However, approximately 10% of households were found to use uniodised salt during the Armenian survey in 2000, which is still a significant proportion of the population. There is also no guarantee that the Avan Salt Company will remain the only salt producer in Armenia or even that it will continue to iodise its salt. The creation of comprehensive legislation that prohibits the importation or sale of uniodised salt would ensure that any future changes in the salt supply would not reverse the excellent progress made thus far.

### **Monitoring and Enforcement**

The Armenian situation provides an excellent opportunity for a demonstration of cost-efficiency in assuring the points in the salt production and supply chain that are crucial to

ensuring universal IS consumption in the country. For instance, the data from the present survey show that 90% of the entire iodised salt supply was effectively controlled by regular internal and external checks on the salt being produced at one source, the Avan Salt Company's factory in Yerevan.

For imported salt, at present only the borders of Iran and Georgia are open to the trade of goods due to ongoing territorial disputes with Turkey and Azerbaijan. The present analysis indicates that once legislation is enacted, the Armenian Border Service should focus their efforts on the six customs points on the Georgian border. Border officials could be provided with cheap yet effective salt-test kits which require virtually no training or expertise to use.

Effective customs inspections would be able to prevent any further importation of uniodised salt. Anyone attempting to import uniodised salt could be liable either to have the goods seized or else be refused entry. Fines or arrest may not be the most suitable methods of control in this case, given the opportunities it would present for abuse and corruption.

## **CONCLUSION**

For the sample as a whole, wealth was significantly associated with IS consumption, but at provincial level the only wealth effect found to be statistically-significant occurred in Lori. In all other provinces the wealth effect was less than significant due to a combination of the generally weaker effects associated with almost universal IS use and low statistical power.

In Shirak, the main origin of the problem seemed to be the provincial capital, Gyumri, which had markedly lower levels of IS consumption than the rest of the province for reasons that could not be ascertained. In Tavoush, no significant associations or differences could be found in the data to explain its low IS consumption levels. The common factor shared by all three northern provinces was their border with Georgia, where at the time a very low proportion of households used iodised salt. It would seem highly likely therefore that imported Georgian salt was the main source of uniodised salt, at least in these provinces, though the survey did not collect data to test this assumption.

Armenia's general progress towards USI has been outstanding, although significant problems appear to remain. Unless legislation prohibiting the importation or sale of uniodised salt is brought into effect, these problems will continue to threaten the public health of the population. Once legislation comes into effect, monitoring and enforcement would be most efficient by focusing control operations on the small numbers of critical border points to ensure compliance.



## 9. EGYPT

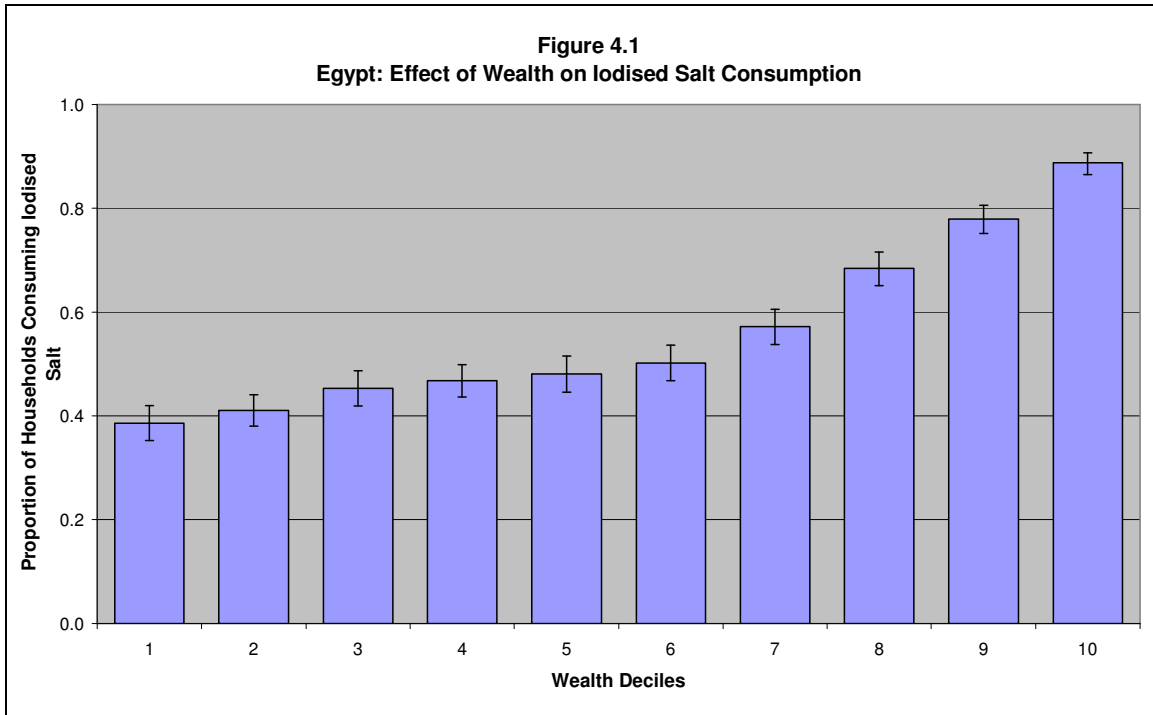
Egypt is the second largest sample in this study, comprising 16,957 households. Data were collected by the National Population Council from July to November 2000. Overall, 90.4% of sampled households' salt was tested for the presence of iodine.

The government enacted salt legislation in 1996 requiring the iodisation of table salt with 50-80ppm  $KIO_3$ . The country's largest salt producer, El Nasr Salines Company, is based in Alexandria with additional salt mines in Port Said and El Beheira. It produces both refined and coarse iodised salt for the domestic and export markets, though in unknown quantities. In 1997 it claimed to have a domestic market share of 96%. More recent figures are not available to us.

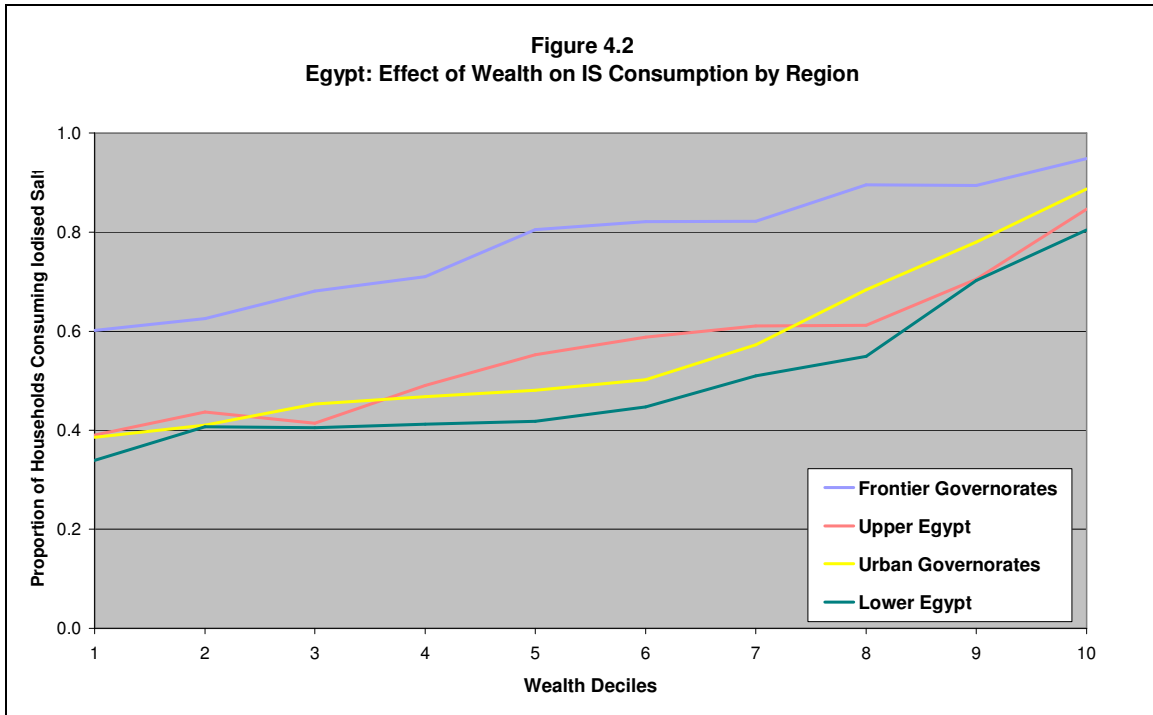
## RESULTS

### 1) Effect of Household Wealth on IS Consumption

For the entire sample, a statistically-significant difference existed in IS consumption between wealthier and poorer households (OR 1.548;  $p < 0.0001$ , 95CI[1.360 - 1.763]). The relationship across wealth levels in Egyptian households was not linear, however. Figure 4.1 below shows the nature of the association. It starts as weak yet significant in the poorest third the population (OR: 1.302;  $p < 0.0001$ , 95CI[1.167 - 1.452]), becoming only slightly stronger in the second third (OR: 1.430;  $p = 0.001$ , 95CI[1.164 - 1.758]) and then in the highest third of wealth becomes very strong (OR: 8.770;  $p < 0.0001$ , 95CI[6.785 - 11.335]).



At regional level, the Urban Governorates showed by far the strongest wealth effect (OR: 6.383;  $p < 0.0001$ , 95CI[4.847 - 8.407]) whereas the other regions were broadly similar to each other (Frontier Governorates: OR: 3.311;  $p = 0.005$ , 95CI[1.528 - 7.173], Upper Egypt: OR: 2.529;  $p < 0.0001$ , 95CI[2.095 - 3.052], Lower Egypt: OR: 2.269;  $p < 0.0001$ , 95CI[1.894 - 2.718]). These regional wealth effects are illustrated in Figure 4.2, below.



## 2) Effect of Governorate and Urban-rural Status on IS Consumption

Before adjusting for the effect of wealth, the highest iodised salt consumption occurred in the Frontier Governorates (78.0%), particularly in the New Valley (93.8%) and Sinai (87.0%). Elsewhere, the urban categories were broadly similar (61.3 - 70.0%) as were the rural areas of Lower and Upper Egypt (43.4% and 50.2% respectively), indicating an urban-rural divide of 18.8% on average.

After adjusting for the effects of wealth, however, this urban-rural difference disappeared ( $p=0.456$ ) and a much more regionally-based pattern emerged. Frontier Governorates showed the highest consumption rate, followed by Upper Egypt, with Lower Egypt and the Urban Governorates jointly lowest.

Some specific locations were identified as having particularly low levels of IS consumption, such as Qena (34.9%), Kafr-el-Sheikh (32.3%) and Fayoum (23.4%). Further analysis showed that it was mainly in the rural parts of these locations that the low rates were found. Due to a lack of statistical power in the data at this level, however, it was not possible to determine whether these rural areas were merely poverty hotspots or whether there was a problem with iodised salt availability *per se*.

### **3) Effect of Educational Attainment on IS Consumption**

At national level, before adjusting for wealth, there was a very significant difference in IS consumption between all levels of education, with highly-educated households being nearly 36% more likely to consume iodised salt than households without formal education (OR: 5.062;  $p < 0.0001$ , 95CI[4.204 - 6.094]).

However, after adjusting for the confounding effects of wealth and region, this association diminished to the point where it was only statistically-significant at secondary (OR: 1.252;  $p < 0.0001$ , 95CI[1.132 - 1.385]) and higher levels (OR: 2.234;  $p < 0.0001$ , 95CI[1.880 - 2.656]). There was no significant difference between households without formal education and those educated to primary level ( $p = 0.351$ ).

Adjusted for the effects of household wealth and Governorate, iodised salt was 4% and 15% more likely to be present among households with a member educated up to secondary and higher levels. At regional level, the effects of educational attainment were consistent with those above, except in the Frontier Governorates (i.e. the Governorate where the IS

consumption level was highest) where no significant difference in IS consumption remained between any of the levels of educational attainment ( $p=0.198$ ).

## **DISCUSSION**

### **1) Effect of Region on IS Consumption**

The New Valley desert area in the southwest of the country is traditionally associated with Egypt's highest prevalence of iodine deficiency. In this study it was also found to have the highest level of iodised salt consumption (93.8%), which may suggest that efforts to facilitate the consumption of iodised salt in this historically most iodine-deficient area are showing a substantial effect.

However, other than the New Valley, other areas previously reported with severe deficiency disorders were Kafr El-Sheikh and Aswan, which in this study had IS consumption levels of 32.3% and 76.0% respectively. It would seem therefore that at the time of the survey not all populations where iodine deficiency had been documented were being protected by sufficient IS consumption.

### **2) Effect of Household Wealth on IS Consumption**

The relationship between iodised salt consumption and wealth was strongest in the richest half of the population, with little difference between lower deciles. One might at first suspect this to be the result of a large proportion of poor people having relatively little

difference in absolute levels of wealth. Yet Egypt's wealth structure does not show this to be the case.

The results would therefore more likely reflect a threshold effect, though further data was not available to explore what this threshold might involve. Based on the results from other countries in this study though, it might well involve a transition whereby, at increasing levels of wealth, the purchasing preference in the population shifts from mostly cheaper, coarse salt to instead mostly refined salt, which would in turn would be more likely iodised.

Unfortunately, the DHS2000 survey in Egypt did not report on the type of salt found in households, and therefore this hypothesis is impossible to test with the data from this country.

### **3) Effect of Education and Urban-Rural Status on IS Consumption**

At the time of survey, iodised salt consumption was generally much higher in urban areas than in rural ones, the difference in the raw data being 18.8%. After adjusting for the effect of household wealth, however, this urban-rural divide was replaced by a regional distribution, indicating that urban-rural status *per se* was not a significant factor in explaining IS consumption.

Those households in which a member had completed higher education were significantly more likely to use iodised salt in all regions except the Frontier Governorates. Perhaps in Egypt highly-educated households were more likely to make conscious decisions to buy iodised salt than less educated ones, but the effect might also have been caused by the

purchasing preference of wealthier households for refined salt referred to above. This may mean that factors other than wealth such as educational attainment come into higher significance only once a certain wealth threshold has been reached. As remarked above, it is unfortunate that the Egyptian dataset does not permit this hypothesis to be analysed and tested.

## **CONCLUSION**

Within the constraints of the dataset from Egypt, household wealth was found to be the main determinant of household IS consumption in Egypt, with those households in higher wealth deciles being significantly more likely to consume iodised salt than those in lower ones. A threshold effect was likely, but the data from the DHS survey did not allow further exploration of the main factors that may explain why this threshold effect was seen.

There was considerable regional variation in iodised salt use in households with generally lower IS consumption levels in Lower Egypt than in Upper Egypt. Urban-rural differences were minor after adjustment for wealth; in fact the most significant wealth effect occurred within the Urban Governorates. Rural populations were less likely to consume iodised salt only because they were more likely to be poor. Educational attainment was found to have a significant influence at secondary and higher levels, although the effects in terms of IS consumption were not large.

In 1995 the New Valley governorate was reported as having the highest prevalence of iodine deficiency in Egypt. The results of this study show that 93.8% of the population in New

Valley was consuming iodised salt. The reasons behind this success could not be determined due to the limitations of the data available. However, other locations previously identified as having a high prevalence of iodine deficiency were found to have maintained low levels of IS consumption and their populations therefore remained at high risk of the dangers of iodine deficiency on their health and development.



## 10. HAITI

This survey was carried out from February to July 2000 by the Haitian Children's Institute, shortly after a "salt iodisation initiative" had started around Port-au-Prince. The sample size included 9,595 households and 91.9% of the household's salt was tested for the presence of iodine.

Haiti is a relatively small nation and it shares the island of Hispaniola with the Dominican Republic, which has similar levels of iodine deficiency and iodised salt consumption. Salt in Haiti is generally produced using very simple methods; the harvest is impure and iodisation without prior washing is greatly ineffectual. Approximately 1% of salt is imported, most of which is iodised, but this does not constitute a significant proportion of the population's use. At the time of survey, salt iodisation was not mandatory in Haiti, but it was in the neighbouring Dominican Republic, though compliance was reportedly poor.

The political situation in Haiti is precarious. Following severe civil unrest and the departure of President Aristide earlier in 2004, an interim multi-national peacekeeping force supports a transitional government. The ability to formulate long-term public health strategies is therefore rather limited.

## **RESULTS**

### **1) Effect of Department on IS Consumption**

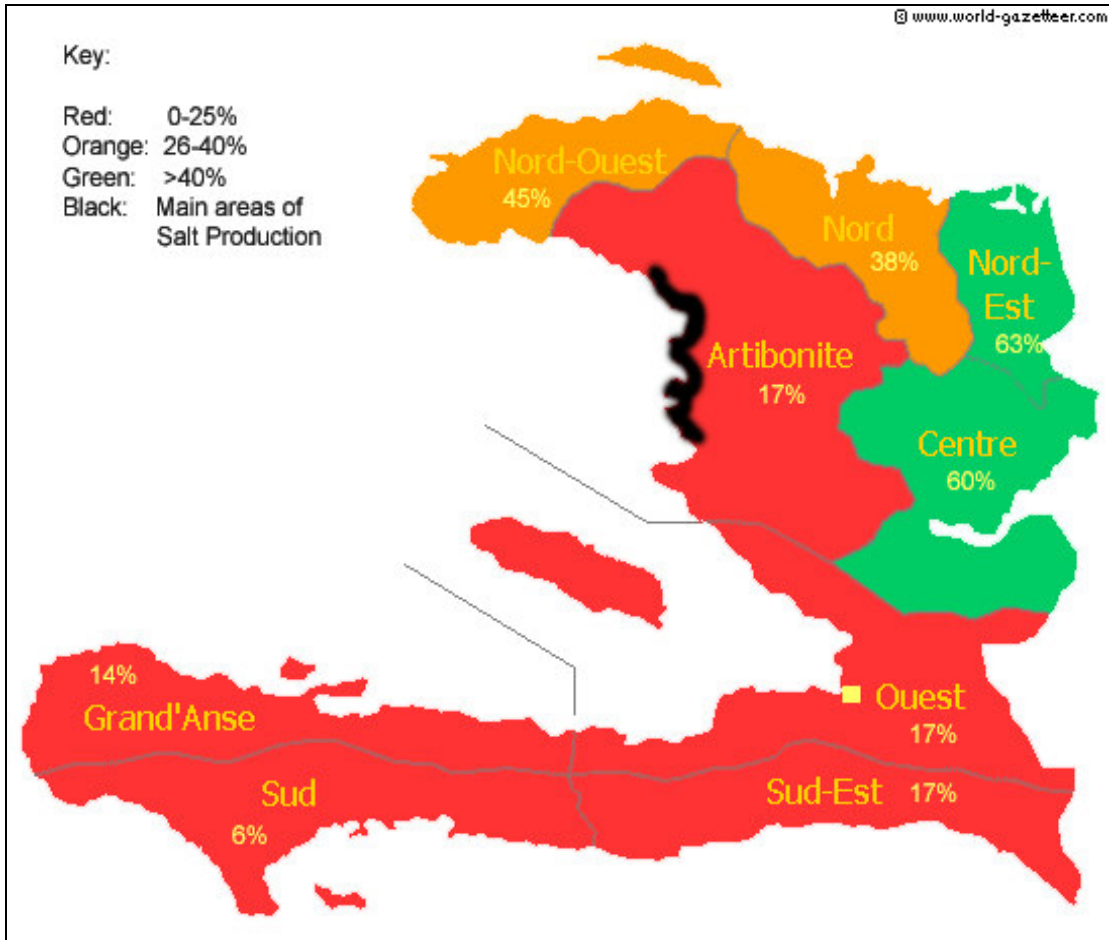
For the entire sample, 23.2% of households consumed iodised salt. The highest use was in North East where IS consumption was 63%, followed by Centre with 60%, North West with 45% and North with 38%. Figure 5.1, below, shows the IS consumption rates for all Departments. The black zone in Artibonite Department indicates areas of significant salt production, and the yellow square is Port-au-Prince, the capital city and main locale of the Government's efforts to promote the iodisation of salt as of late 1999. As at July 2000, household IS consumption in Port-au-Prince was only 14%, indicating that the efforts had been largely unsuccessful in encouraging IS use in the capital's households.

### **2) Effect of Household Wealth on IS Consumption**

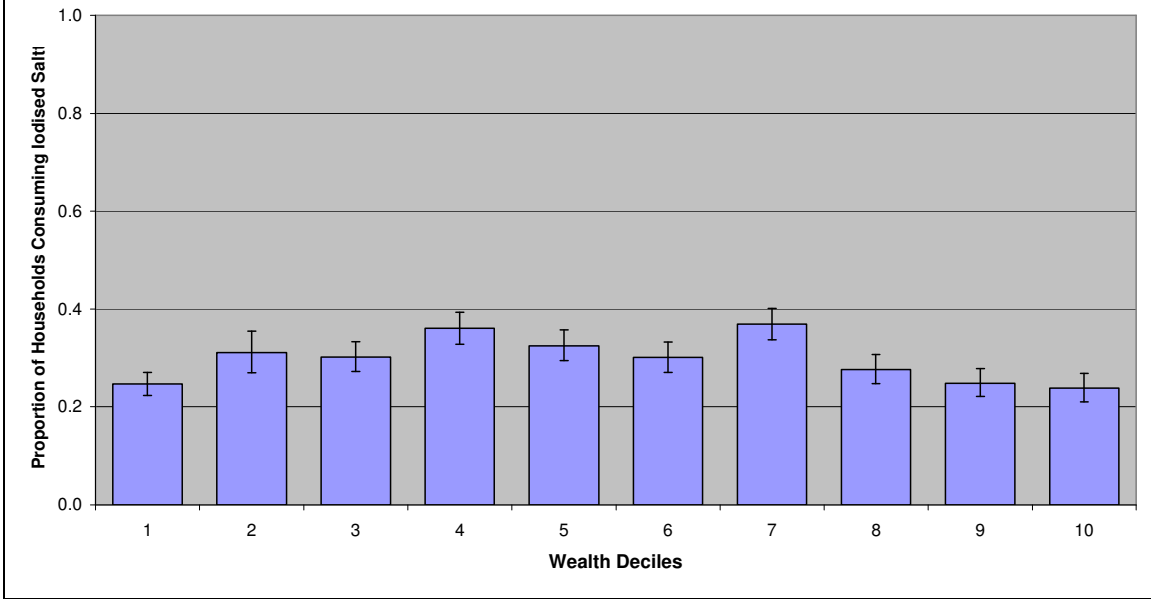
For the entire sample there was no association between household wealth and iodised salt consumption ( $p=0.701$ , see Figure 5.2, below).

At Departmental level, however, North and North East showed statistically-significant differences in IS consumption between wealthier and poorer households (see Figure 5.3, below). North showed a very strong, almost linear, wealth effect (OR: 6.848;  $p<0.0001$ , 95CI[2.875 - 16.313]), whilst that in North-East was weaker (OR: 2.105;  $p=0.006$ , 95CI[1.283 - 3.451]). No wealth effects were found for any other Department.

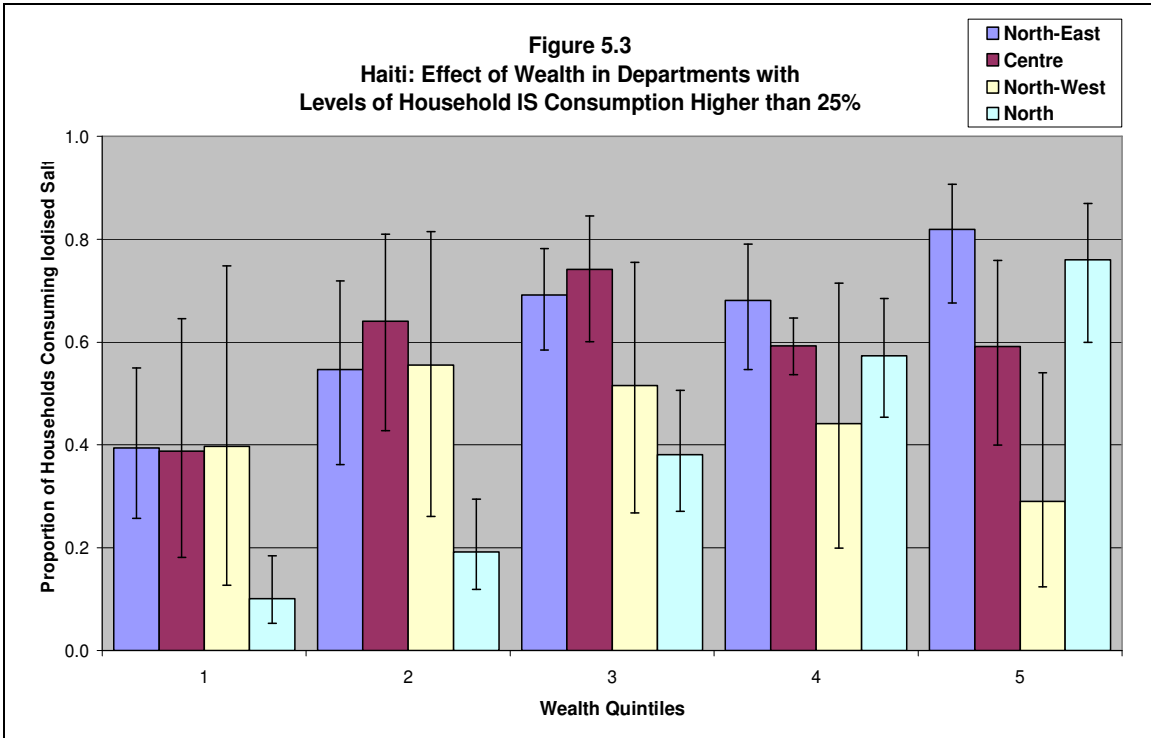
Figure 5.1  
Haiti: Iodised Salt Consumption by Department



**Figure 5.2**  
**Haiti: Effect of Wealth on Iodised Salt Consumption**



**Figure 5.3**  
**Haiti: Effect of Wealth in Departments with Levels of Household IS Consumption Higher than 25%**



### **3) Effect of Educational Attainment on IS Consumption**

For the whole sample, no significant differences were found in IS use between households of different levels of educational attainment (Primary:  $p=0.197$ , Secondary:  $p=0.796$ , and Higher:  $p=0.716$ ). At sub-national level, adjustments for wealth were made in those Departments with significant wealth effects (North and North East), but this did not result in any significant differences between educational levels.

### **4) Effect of Urban-Rural Status on IS Consumption**

No significant difference was found between urban and rural households ( $p=0.109$ ) in IS consumption for the whole sample. At sub-national level, only the Departments with significant wealth effects showed significant differences between urban and rural households. However, after adjusting for wealth these differences disappeared (North-East:  $p=0.335$ , North:  $p=0.205$ ) indicating the urban-rural differences had been primarily wealth-related.

## **DISCUSSION**

### **1) Effect of Department on IS Consumption**

The household usage of iodised salt in most Departments was low, including in the capital city, Port-au-Prince, where efforts to promote salt iodisation had been ongoing since the year before the survey. It would appear that these efforts were not effective in generating

significant interest in using iodised salt for the metropolitan population. Also the fact that the main areas of salt production were situated along the coast of Artibonite Department seemed to count for little; IS consumption in Artibonite was at a similar level to several other poorly-performing Departments (17%).

The reasons why the Centre and North-Eastern Departments had much higher IS consumption levels relative to the rest of the population could not be ascertained either through analysis of the data or through background research on Haiti and its salt industry. Whilst they did border the Dominican Republic, so too did the West and South-West, both of which showed low levels of IS consumption (17%). There would seem to be nothing ongoing with regard to salt iodisation in the North-West of the Dominican Republic that might have a beneficial effect on North-Eastern Haiti's salt supply at the time of survey. In fact, the overall salt situation in the Dominican Republic was not much better than that of Haiti, though again data are limited.

Any future salt situational assessment in Haiti should examine whether these relatively high levels of IS use still exist in these Departments and should attempt to determine the underlying causes so that any positive findings could be applied to the rest of the country.

## **2) Effect of Wealth on IS Consumption**

For the majority of the sample, there was little if any association between IS consumption and wealth. In most Departments even the very wealthiest of households were just as unlikely to consume iodised salt as the poor.

However, in North and North-East, there were significant wealth effects, with a very strong and almost linear relationship existing between wealth and IS consumption in the North.

However, given the limited data from the survey, it is very difficult to form conclusions or even hypotheses as to what factors might have been creating the wealth effects in these Departments. They did have 2-3 times higher IS consumption levels than elsewhere, but then so did Centre and North-West, yet these latter Departments failed to demonstrate any wealth effect. In this case, it would seem, only a detailed salt situational assessment would be able to clarify the reasons for this mixed result.

### **3) Effect of Education and Urban-Rural Status on IS Consumption**

No significant differences in household IS consumption were found in Haiti between educated and uneducated households or urban and rural households. This held true also in those Departments with higher rates of IS consumption, after adjusting for the effects of wealth, so it is unlikely that these factors lack significance due to the generally-low levels of IS consumption throughout most of the country.

## **CONCLUSION**

For the sample as a whole, wealth was not significantly associated with IS consumption but within Departments wealth effects were found in North and North-East. In all other Departments a wealth effect was less than significant or non-existent. Educational attainment and urban-rural status were not significant factors.

In Port-au-Prince, the capital city and location of the government's salt iodisation initiative, IS consumption was well below the national average, indicating that the campaign did not yield results on the doorstep of the high-level decision-makers. If anywhere, IS use in the northeastern parts of the country may have been influenced by the initiative. On the other hand, none of the four Departments with significantly higher IS use showed any significant associations or differences which might help to explain why the IS consumption was much higher than in the rest of the country.

The DHS2000 household survey of Haiti indicates that over three-quarters of the population remain at risk of disorders due to iodine deficiency. Given the upheaval that Haiti has experienced in the recent year, it is highly likely that IS consumption has decreased since the time of survey and that even more of the population is exposed. The current politically-volatile situation in Haiti, however, severely hampers the chances of the country making any progress towards USI in the near future by its own efforts.



## **11. MALAWI**

The data used to analyse the patterns of iodised salt consumption in this study come from the Malawi DHS 2000, which took place from July to November 2000, soon after a bumper maize harvest and before the floods and subsequent famine of 2001-2. The MDHS included data on IS use of 14,213 households and 90.4% of household's salt was tested for the presence of iodine. The dataset did not include information of the type of iodised salt found in the households.

Malawi has a historical track record of severe iodine deficiency. Legislation was enacted in 1995 and specifies that all salt imported or sold for human consumption should be iodised at 50-70ppm  $KIO_3$ . Most salt is imported from Botswana and Mozambique, though some small-scale domestic production takes place in Machinga District in the South-east.

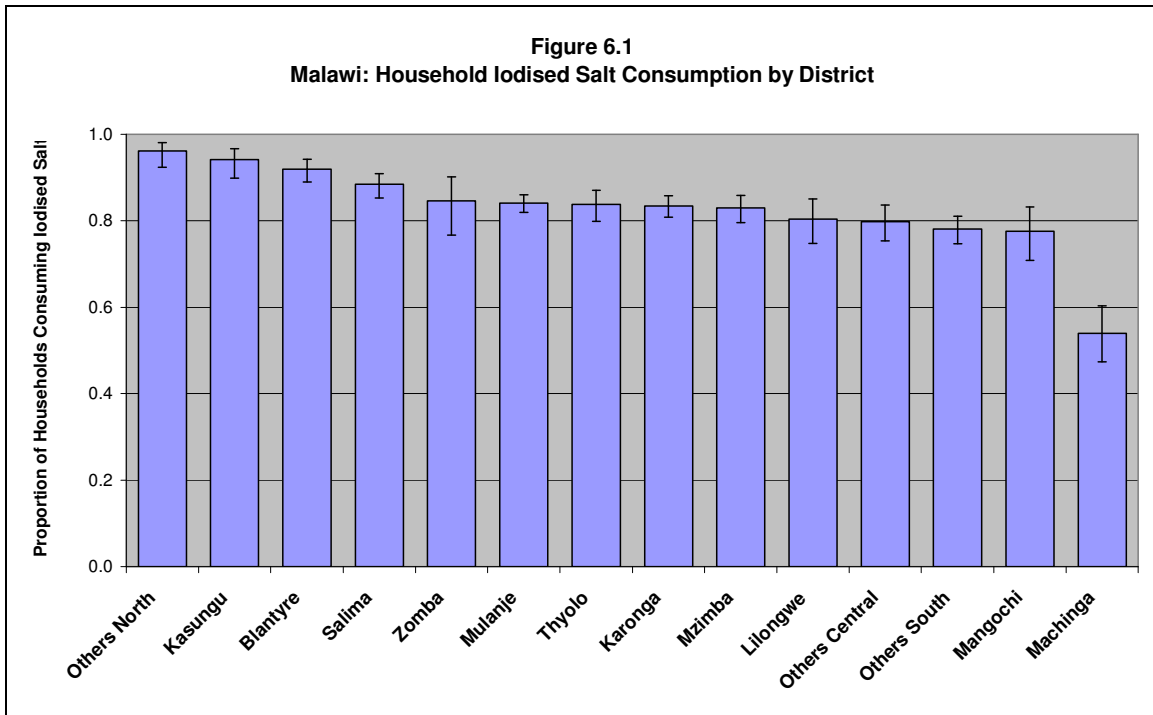
Domestic salt is of poor quality due to the crude methods used to extract it but overall the amount of production is not significant at the national level.

## **RESULTS**

### **1) Effect of Region and District on IS Consumption**

In Malawi in 2000, 82.0% of households consumed iodised salt. However, there were statistically-significant regional differences in IS consumption: Household IS use was higher in the North than in the Central and South regions (OR: 1.723;  $p < 0.0001$ , 95CI[1.274-2.329]), though these differences were not large (North: 88.2%, Central: 81.9% and South:

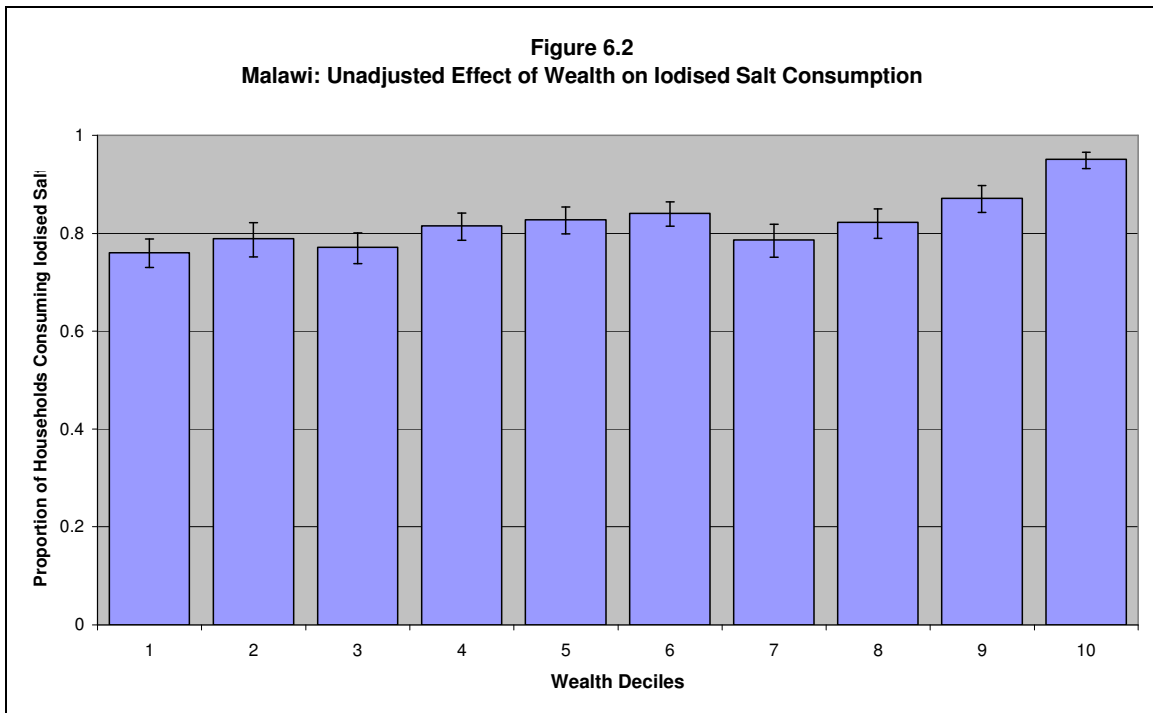
80.8%). At District level there was also little variation, though Machinga district did emerge as having particularly low IS use (53.9%). Figure 6.1, below, shows the IS consumption rates for all Districts.



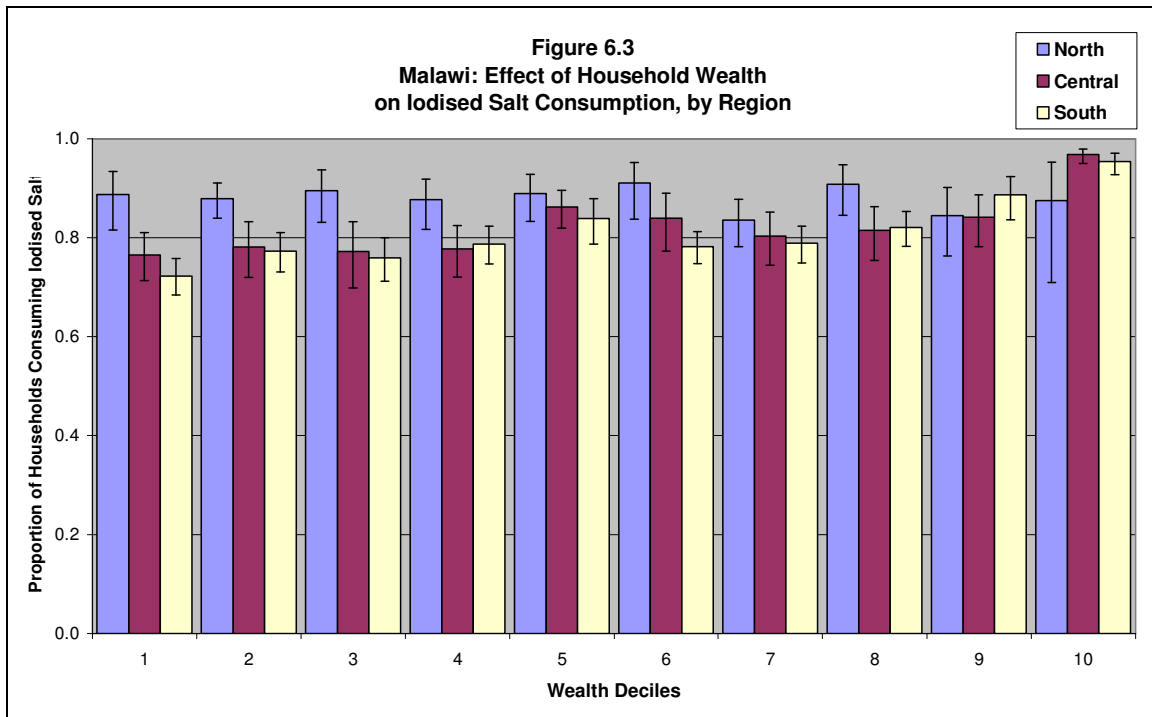
Unfortunately, a true geographical pattern or gradient could not be obtained from the data because many districts were classed only as ‘Others’. ‘Others - North’, which included the districts of Chipita, Rumphi and Nkhata Bay, showed very high levels of IS consumption (96.2%), whereas ‘Others – South’, which included Balaka, Chiradzulu, Chikwawa, Nsanje and Phalombe, and ‘Others - Central’ (Dedza, Dowa, Mchinji, Nkhotakota, Ntchisi and Ntcheu), were among some of the lowest (78.1% and 79.8% respectively).

## 2) Effect of Household Wealth on IS Consumption

For the unadjusted dataset, a statistically-significant difference existed in IS consumption between wealthier and poorer households (OR: 1.548;  $p < 0.0001$ , 95CI[1.360 - 1.763]) (see Figure 6.2, below).



At regional level, one can see from Figure 6.3 (below) that the national wealth effect (above) remained in effect only in the Central (OR: 1.484;  $p < 0.0001$ , 95CI[1.222 - 1.802]) and Southern (OR: 1.620;  $p < 0.0001$ , 95CI[1.344 - 1.953]) regions. There was no evidence of a wealth effect in the North ( $p = 0.746$ ).



When all significant variables (wealth, educational attainment and urban-rural status) were entered into a single national model, the relative contribution of household wealth was reduced to an almost insignificant level (OR: 1.142;  $p=0.046$ , 95CI[1.002 - 1.300]).

Therefore, it may have been that household wealth was more of a confounder than a direct causal factor in explaining the variation of the household IS use in Malawi. In order to verify this unexpected finding, the Central and Southern regions, which had both shown strong unadjusted wealth effects, were combined and then stratified into urban and rural households. The results of subsequent analysis confirmed weak, yet significant wealth effects in both urban (OR: 1.334;  $p=0.029$ , 95CI[1.031 - 1.727]) and rural (OR: 1.151;  $p=0.024$ , 95CI[1.018 - 1.300]) households, once adjustments had been made for the effects of educational attainment.

In Machinga, the district with the lowest levels of IS use, the adjusted wealth effect was slightly more pronounced (OR: 1.848;  $p=0.014$ , 95CI[1.153-2.962]), though it was still less significant than the effects of educational attainment to secondary level (OR: 3.675;  $p=0.003$ , 95CI[1.681-8.033]) and urban-rural status (OR: 2.208;  $p=0.009$ , 95CI[1.249-3.900]).

### **3) Effect of Educational Attainment on IS Consumption**

For the entire sample, significant increases in household IS consumption were found at each increasing level of educational attainment after adjustment for the effects regional variation, urban-rural status and wealth (Primary OR: 1.325;  $p<0.0001$ , 95CI[1.170 - 1.500]); Secondary OR: 2.052;  $p<0.0001$ , 95CI[1.607 - 2.620]; Higher OR: 3.432;  $p=0.037$ , 95CI[1.080 - 10.900]). In terms of IS consumption these worked out as differences of approximately 4%, 9% and 12% respectively, though the low sampling power at the higher education level ( $n=112$  out of a total sample of 12,954) meant that this last estimate was fairly imprecise.

Regionally, educational attainment was statistically-significant in the South and Central regions, but not in the North ( $p=0.458$ ). The most convincing differences were between those households with no formal education and those with secondary education (South OR: 2.101;  $p<0.0001$ , 95CI[1.517 - 2.909]; Central OR: 2.180,  $p=0.004$ , 95CI[1.300 - 3.656]).

When the data for Central and Southern regions were combined and stratified into urban and rural subsets, however, educational attainment was only found to be significant in rural households (Primary: OR: 1.304;  $p<0.0001$ , 95CI[1.142 - 1.488], Secondary: OR: 2.229;

$p < 0.0001$ , 95CI[1.637 - 3.035]), but not in urban households (Primary  $p = 0.969$ , Secondary  $p = 0.921$ ). The small number of households with a member who had completed higher education (South:  $n = 61$ , and Central:  $n = 32$ ) precluded statistically-useful odds ratios to be found for those households.

The results therefore indicate that educational attainment was a significant and wealth-independent factor only in rural households in the Central and Southern regions.

#### **4) Effect of Urban-Rural Status on IS Consumption**

For the whole sample, there was a statistically-significant difference in IS consumption between urban and rural households after adjusting for wealth, regional variation and educational attainment. Urban households were approximately 12% more likely to consume iodised salt than rural ones (OR: 2.626;  $p < 0.0001$ , 95CI[1.793 - 3.847]).

At regional level these figures again diverged. No significant difference was found between urban and rural households in the North ( $p = 0.731$ ), but large differences occurred in the Central (OR: 3.887;  $p < 0.0001$ , 95CI[2.437 - 6.199]) and Southern regions (OR: 3.042;  $p < 0.0001$ , 95CI[1.836 - 5.038]).

The results therefore suggest that urban-rural status was a very significant factor in the consumption of iodised salt in the South and Central regions, even once the effects of wealth and educational attainment had been adjusted for. However, in the North region

there were no significant differences between urban and rural households in their use of iodised salt.

## **DISCUSSION**

### **1) Effect of Region on IS Consumption**

A significant regional contrast existed between the North region on the one hand and the Centre and South regions on the other. Household IS consumption was highest in the North (88.2%) and, in contrast to the Centre and South regions, none of the variables in this study had any significant effect in explaining the difference in IS use between households in the North region.

Salt import licences are controlled from three locations in Malawi: one in Lilongwe, one in Blantyre and one in Mzuzu, the capital of the North. Perhaps officials in the North region, which historically had the highest prevalence of iodine deficiency, were more 'switched on' to the importance of iodised salt than in the other regions at the time of survey and were thus more diligent in prohibiting the import of uniodised salt. Alternatively or in combination, it may have been that more of the salt consumed in the North was sourced from Botswana (via Zambia), which tends to produce more consistent levels of iodised salt, whereas more of the salt consumed in the Central and Southern regions might have been supplied from Mozambique, where reportedly iodisation is not always reliable. Most of the North region borders only Zambia by land, whereas most of the Centre and South regions

also border Mozambique. Without further information on Malawi's salt situation, however, it would be difficult to verify these explanations.

## **2) Effect of Wealth on IS Consumption**

Little if any association was found for household wealth and IS use in Malawi. In the South and Centre, wealth seemed to be fairly significant at first, but once adjusted for region, education and urban-rural status, the wealth effect was found to be much weaker.

A wealth effect normally indicates a difference in price between iodised and uniodised salt. This price difference presents an obstacle at a given purchasing power of a large proportion of the population; under such a circumstance, poorer households are more likely to purchase cheaper, uniodised salt. On this basis it would seem that if in Malawi there was any price difference between iodised and uniodised salt it did not have a significant effect, except perhaps in urban locations in the Centre and South regions.

## **3) Effect of Educational Attainment on IS Consumption**

Educational attainment was found to be significant ~~only~~ in rural households in the Centre and South. In these regions, more educated households, particularly those with a member educated to secondary level, were found significantly more likely to consume iodised salt. The reasons for this are unclear. Assuming that the adjustments for wealth have effectively taken into account the economic benefits of education, such a result would clearly suggest that more educated households were more likely to make a conscious decision to buy



iodised salt rather than uniodised salt. Was this because public health messages in Malawi were more comprehensively understood and acted upon by the better-educated rural households? We would suggest that this is unlikely since IS promotion does not generally make a distinction between rural and urban populations, and given that iodised salt social marketing messages are generally pitched at fairly basic level.

When this effect was analysed in the poorer half of the Central and Southern sample only, household wealth was equally as significant as educational attainment, with increases in both predicting a higher probability of IS use. Yet when this effect was observed in the wealthier half of the same sample, wealth became irrelevant and educational attainment assumed a much more dominant role. This finding suggests that once a certain level of household wealth has been attained, the benefits of educational attainment are more likely to come into play, while economic constraints may negate the effects of education below this level.

#### **4) Effect of Urban-Rural Status on IS Consumption**

Significant differences in IS consumption were found between urban and rural households in the Centre and South, though not in the North. Urban households were significantly more likely to consume iodised salt than rural ones, once adjustments for confounding variables had been made.

Given the fact that no wealth effect was apparent in the rural areas of the Centre and South regions and therefore no price difference is assumed between iodised and uniodised salt, the results suggest that there may have been problems with the trade and/or transport of

iodised salt to rural communities, or perhaps in the Centre and South regions small-scale producers were selling uniodised salt locally. This may indeed have been the case in Machinga, where there were reports of significant numbers of these small producers extracting surface salt using very crude techniques.

Further research into the sources of uniodised salt in rural areas would inform officials and policymakers in Malawi as to where the problems have arisen so that they could adapt their monitoring and enforcement methods accordingly.

## **CONCLUSION**

Household wealth was significantly, though only weakly, associated with IS consumption in the Centre and South regions. Educational attainment was significant in the Centre and South, but only in rural households. Urban-rural status *per se* was a more significant factor in these regions, with IS consumption approximately 10% higher in urban households after adjustment for confounding variables.

There were no significant factors among the variables available that explained patterns of IS consumption in the North region where household usage of iodised salt was almost universal. Further research into the sources of uniodised salt in the Centre and South, along with efforts to tackle the obstacles preventing the sale of iodised salt in rural areas, such as more rigorous monitoring and enforcement, would greatly speed up progress towards IDD elimination in Malawi.

## 12. TANZANIA

The data in this study were collected from September to November 1999 as part of an interim Measure DHS+ survey conducted by the National Bureau of Statistics. As it was an interim survey, the sampling size was only 3,615 households and this left sampling power much reduced compared to other countries in this study. Therefore it was not possible to carry out any detailed analysis of data at anything less than the national level, other than merely reporting household usage of iodised salt. 91.9% of the households in the survey had their salt tested for the presence of iodine.

Salt iodisation was made mandatory in Tanzania in 1979, though most progress towards USI has occurred only during the last decade. Legislation was revised in 1995 and requires iodisation of all salt intended for human consumption with 75-100ppm  $KIO_3$ .

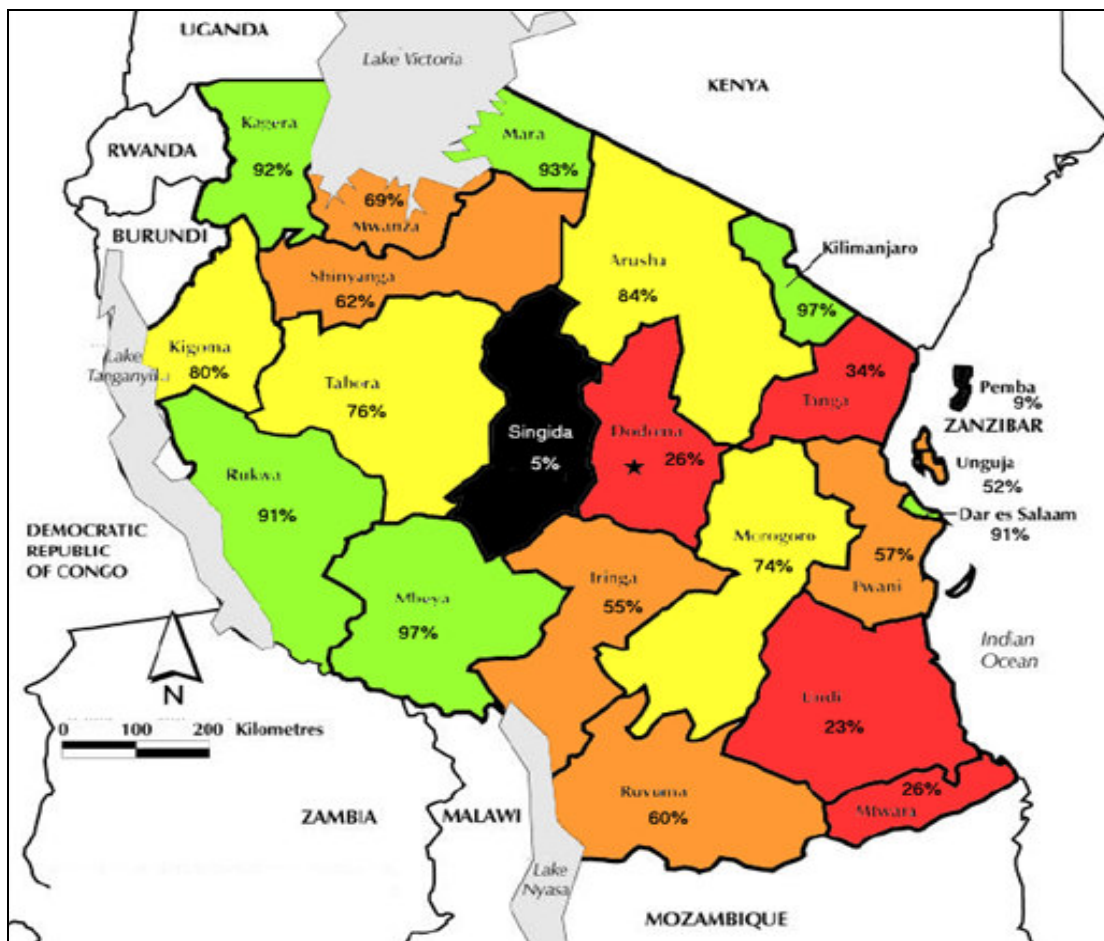
The country is largely self-sufficient in salt, though occasionally small amounts are imported from Kenya and India, most of which is likely to be iodised. The domestic salt industry is dispersed along the Indian coast and various inland locations and is diverse both in scale and primary production methods. Iodisation rates therefore vary considerably.

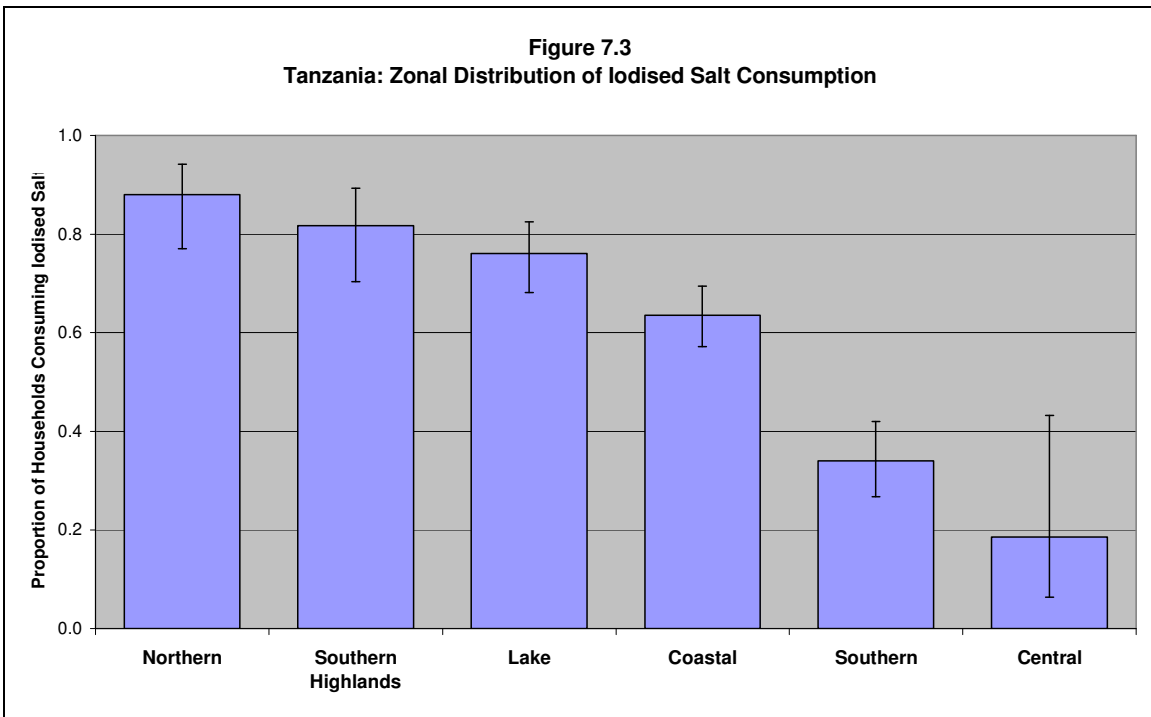
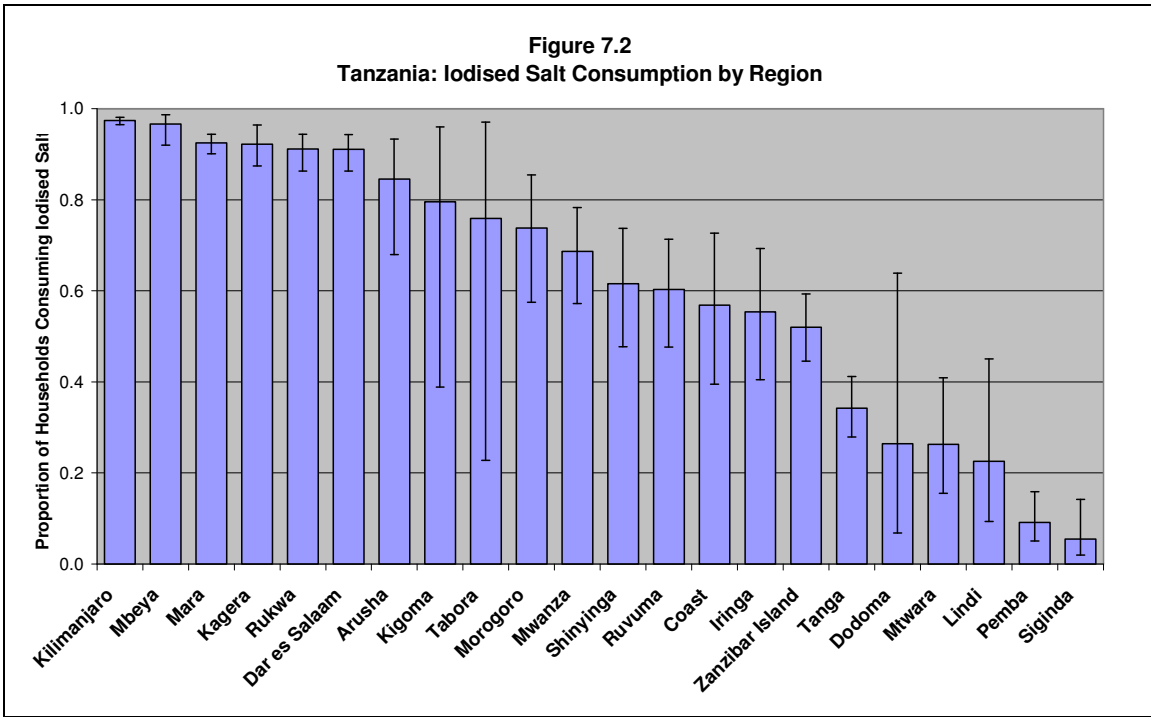
## RESULTS

### 1) Effect of Region and District on IS Consumption

For the entire sample, 58.4% of households consumed iodised salt. There was a high degree of variability in IS consumption between regions. Figure 7.1, below, shows the worst zones of IS consumption as being Singida and Pemba, where IS consumption was 5.5% and 9.1% respectively.

**Figure 7.2: Household Consumption of Iodised Salt by Region**  
Green: >90%, Yellow: 70-90%, Orange: 50-70%, Red: 20-50%, Black: <20%

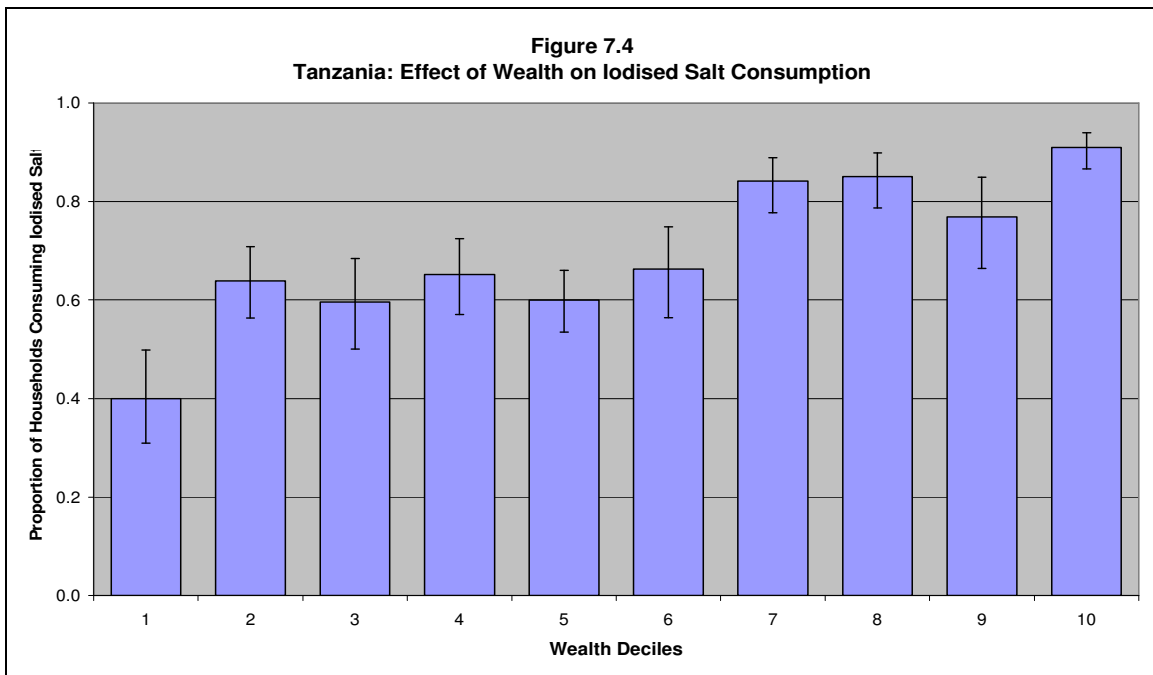




The low levels of IS consumption found in coastal, southern and central areas of the country may be related to the nature and dispersion of the salt industry. Salt production in these areas is generally carried out by small-scale producers using extremely crude methods. These producers are reportedly less concerned about the need for iodisation of their product and often claim to lack the capacity or know-how to put it into operation.

## 2) Effect of Household Wealth on IS Consumption

There was a statistically-significant difference in IS consumption between wealthier and poorer households (OR: 1.597;  $p < 0.005$ , 95CI[1.154 - 2.210])(see Figure 7.4, below).



Unfortunately, although it was possible to adjust for urban-rural status and educational attainment, it was not possible to control for regional variation due to the loss of statistical power when stratifying an already small sample into many different regional sub-groups. It

could be that the wealth effect in Tanzania was in part caused by regional variation in household IS use. With the small sample size it was not possible to determine whether this was in fact the case, however.

### **3) Effect of Educational Attainment on IS Consumption**

After adjusting for the effects of urban-rural status and wealth, the only statistically-significant difference between levels of educational attainment and their IS consumption remained between those households with no formal education and those educated to primary level (OR: 1.342;  $p < 0.002$ , 95CI[1.116 - 1.614]). This difference reflected approximately 4% higher IS consumption in ~~those~~ households with a member having been educated to primary level than those without formal education.

However, low sampling power prevented those households with higher levels of educational attainment from achieving statistically-significant differences and, as mentioned above, also prevented regional variation from being taken into account. The results are therefore not particularly reliable.

### **4) Effect of Urban-Rural Status on IS Consumption**

There was a statistically-significant difference between urban and rural households in their consumption of iodised salt, even after adjusting for wealth and educational attainment (OR: 2.202;  $p < 0.002$ , 95CI[1.359 - 3.569]). This reflected approximately 9% higher IS

consumption in urban households than in rural ones. Again, this figure does not control for regional variation, which might, at least partially, account for this urban-rural effect.

## **DISCUSSION**

### **1) Effect of Region on IS Consumption**

It is highly likely that the regional variation in IS use observed in this survey is related to the nature of the salt industry in Tanzania and the conditions in which it operates. Salt production takes place at various locations throughout the country and methods of production are highly variable. For instance, in Bagamoyo, just north of the capital Dar es Salaam, private sea salt production is high-volume, cost-efficient and mostly iodised to consistent levels by trained personnel who are both 'visible' to the authorities and well aware of the legal and ethical need to carry out iodisation. They trade their iodised salt through the major trunk roads and railway to the capital and major population centres in Pwani, Morogoro, Iringa, and Arusha/Kilimanjaro regions.

This bears a stark contrast to the small-scale salt businesses in the central regions of Singida and Dodoma, which consists mostly of unskilled, lowly educated female workers using crude methods to extract salt and who are reported for the most part as having inadequate knowledge about either the need to iodise salt or how it can be carried out effectively. The only reason that these two industries can successfully coexist is because most of Tanzania's transport retailing system remains poorly developed. The prohibitive cost and uncertainty



of inland transportation buffers the small-scale producers in the central regions against competition from more efficient producers located elsewhere in the country.

Low iodisation rates also were observed in Pemba, Tanga, Lindi and Mtwara. All of these coastal provinces are in close proximity to poorly-developed small-scale sea salt production sites along the Indian coast. It would seem therefore that, regardless of the inadequacies of the transport system, the enforcement practices of food inspectors may play a significant role in explaining the regional differences observed in household IS use in Tanzania.

## **2) Effect of Wealth on IS Consumption**

There was an association in Tanzania between IS consumption and wealth, with wealthier households being significantly more likely to consume iodised salt than poorer ones.

Probably due to small sample size, the trend was not as consistent as expected, but overall the pattern was clear.

The low statistical power caused by the small sample size and large number of regions prevented making statistical adjustments for the effects of regional variation, the data being unable to accommodate stratification at so many levels. It was therefore very difficult to determine whether IS consumption was higher in the wealthier households of Dar es Salaam because of their higher purchasing power or merely because they were located in an area with a higher availability of iodised salt. From this study's analysis viewpoint therefore, the Tanzanian dataset is fatally flawed and any conclusions as to the causative effects of wealth *per se* cannot be drawn with any confidence.

### 3) Effect of Education and Urban-Rural Status on IS Consumption

The associations between IS consumption, education and urban-rural status are especially confounded by the effects of regional variation. Although it is possible that both education and urban-rural location indeed played a significant role, the degree to which they are important is impossible to determine given the limitations of the data.

### CONCLUSION

For the sample as a whole, wealth was significantly associated with IS consumption but, due to low sampling power, it was not possible to determine whether this finding was confounded by regional variations in iodised salt availability which would appear to be a significant factor given the diversity of the Tanzanian salt industry. With the small sample size it was impossible to assess, for example, whether IS consumption was higher in the wealthier households of Dar es Salaam because of their higher purchasing power or merely because they were located in an area with a higher availability of iodised salt.

Significant differences were also found for educational attainment and urban-rural status, but again the differential effect of these factors was impossible to determine. From this study's point of view therefore, the Tanzanian dataset is fatally flawed and any conclusions as to the causative effects of wealth *per se* cannot be drawn with any confidence.

Therefore, other than merely describing the distribution of household IS consumption, which was not the primary objective of this study, the results are not particularly useful in

determining the factors that explain the differences in household IS consumption in Tanzania. The DHS results merely show that significant differences in household IS use persist, despite the significant history of efforts in Tanzania to make progress toward IDD elimination through USI.

### 13. GENERAL CONCLUSIONS

This study has demonstrated that household wealth is a significant variable in determining IS consumption in a sample of developing countries. All of the countries' data showed that with increasing household wealth, the likelihood of the household consuming iodised salt also increased, even in Benin once regional variation had been taken into account.

Educational attainment and urban-rural status were rarely important factors; only the poverty, and thus purchasing power, associated with low educational status and rural location predisposed these segments of the population to lower IS consumption rates.

Analysis of the Indian data showed that the main mechanism by which increased wealth determined higher IS consumption was through an increased preference for purchasing refined salt. Refined salt was much more likely to have been iodised than coarse salt and, because it was also more expensive, this in turn created a wealth effect in terms of IS consumption. Further evidence of this effect was shown by the data from Benin. In Atlantique Department, where coarse salt was less likely to have been iodised, a positive wealth effect was found because poorer households were less likely to buy refined salt. In Mono, where coarse salt was more likely to have been iodised, an inverse wealth effect occurred.

In most situations, however, refined salt will be the salt type most likely to contain  $KIO_3$  due to the greater efficiency with which refined salt producers can iodise their product, although its higher purchase cost dissuades poorer households from purchasing it. Because poorer

households opt to buy cheaper coarse salt, they are less likely to buy salt containing  $KIO_3$ . Thus the wealth effect is created.

However, the results of this study have also shown that in situations where coarse salt was widely being iodised, this wealth effect was attenuated and in some cases disappeared altogether, especially where there was a low availability of uniodised salt, such as in Northern Benin, Northern Malawi and the north-eastern States of India. In such situations USI was achieved and the factors such as wealth, education, etc could no longer play a significant role.

In countries with a dual salt market, future policymaking should therefore focus on removing the obstacles that prevent the iodisation of coarse salt, rather than on increasing the availability of refined salt, as the latter will benefit more affluent households first and foremost rather than the poorer households that are most in need of supplementary iodine nutrition.

The obstacles facing producers in iodisation of coarse salt can be considerable. For instance, coarse salt is mostly produced by small-scale salt producers who are often incapable of iodising their salt, either for economic reasons or because they lack the necessary skills and know-how to carry it out, especially to the levels of consistency demanded by legislation. In addition, few national governments have promoted adequate incentives and infrastructure for small-scale salt producers to overcome these constraints in iodising their product. Whilst the results of this study do not identify any new and wide-ranging solutions to these problems, they do indicate that the majority of end-users of the

salt produced by small-scale producers will generally be poorer households due to the cheap price of the product.

The other often controversial issue regarding the iodisation of coarse salt is its propensity to hold  $KIO_3$  long enough to deliver sufficient quantities of iodine to the consumer and effectively eliminate iodine deficiency. Due to the high levels of impurities and its higher innate humidity, coarse salt is more likely to leach  $KIO_3$  than refined salt, especially when ineffective packaging fails to seal out environmental influence. In defeat of this reasoning, however, the data in this study from India, Malawi, Tanzania and Benin demonstrates that coarse, iodised salt can retain  $KIO_3$  until its consumption in households even in more challenging conditions of temperature and humidity. The iodisation of common salt can therefore make a major contribution in reaching universal IS consumption in the populations of developing countries. Whilst refined salt may technically be a better vehicle for iodine fortification, coarse salt is in practice often the most effective and appropriate vehicle for fortifying salt in the diets of poorer households who require it most urgently.

## 14. RECOMMENDATIONS FOR FUTURE DHS SURVEYS

At present, only 11 of the 35 DHS surveys carried out during the last five years include data on IS consumption. While it is recognised that certain factors such as the cost of including salt testing may sometimes prevent the inclusion of IS-related variables in household questionnaires, it should be noted that the DHS are a very cost-effective tool of obtaining data on this essential component of global nutrition development objectives. There are very few countries without the need to monitor IS consumption in their populations and we therefore strongly support that IS-related variables be included in future household surveys.

In addition, the authors strongly recommend that salt type be recorded alongside the testing of household salt for the presence of  $KIO_3$ . Where only one type of salt is found in a certain country, the source or brand of salt should be identified either through questioning of the interviewee or by inspection of the packaging.

Knowledge of the benefits of iodised salt may be considered a useful variable in some instances. Though this study was unable to accurately ascertain its importance, the data from Armenia suggested that in areas where household IS consumption was lower it may have been more significant.

Storage conditions were not found to be significant either in Armenia or Benin and therefore this variable should not be considered a high priority.

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