Economic Research Institute Study Paper

ERI #96-19

AN ANALYSIS OF IODINE DEFICIENCY DISORDER AND ERADICATION STRATEGIES IN THE HIGH ATLAS MOUNTAINS OF MOROCCO

by

ELIZABETH ANNE OLDHAM
Department of Sociology, Social Work and Anthropology

CHRISTOPHER B. BARRETT
Department of Economics

Utah State University
Logan, Utah 84322-3530

and

SABAH BENJELLOUN

BRAHIM AHANOU

Département de Nutrition Humaine et Economie Alimentaire
L'Institut Agronomique et Vétérinaire Hassan II
B.P. 6202, Rabat-Instituts
Rabat, Morocco

July 1996

AN ANALYSIS OF IODINE DEFICIENCY DISORDER AND

ERADICATION STRATEGIES IN THE HIGH

ATLAS MOUNTAINS OF MOROCCO

Christopher B. Barrett, Assistant Professor

Department of Economics
Utah State University
Logan, UT 84322-3530

Information on other titles in this series may be obtained from: Department of Economics, UMC 3530, Utah State University, Logan, Utah 84322-3530.

AN ANALYSIS OF IODINE DEFICIENCY DISORDER AND ERADICATION STRATEGIES IN THE HIGH ATLAS MOUNTAINS OF MOROCCO

Christopher B. Barrett

ABSTRACT

The population of the Ounein Valley in the High Atlas Mountains in Morocco is at high risk of iodine deficiency. We investigated local children's iodine deficiency and goiter patterns as well as food consumption habits through a household survey. Median urinary iodine content and goiter analysis both reflect moderate iodine deficiency. Total fish consumption has a statistically significant, positive effect on urinary iodine content. Fish consumption, like that of salt, is closely related to market access. Respondents are uniformly unaware of the dietary etiology of goiter. An effective strategy to reduce the high incidence of iodine deficiency disorder among children in the valley must attend to four crucial issues: fish consumption, salt iodization, nutrition education, and market access.

Key words: iodine deficiency, micronutrient deficiency, Morocco, nutrition education, salt iodization

AN ANALYSIS OF IODINE DEFICIENCY DISORDER AND ERADICATION STRATEGIES IN THE HIGH ATLAS MOUNTAINS OF MOROCCO

INTRODUCTION

Iodine deficiency disorders (IDD) are known throughout the world in developing and industrialized nations alike. The most common manifestations of IDD, goiter and cretinism, affect over 200 million and 6 million people, respectively, (United Nations, 1993). Iodine deficiency in general can be easily treated by iodine supplementation or the fortification of foods with iodine. Nevertheless, IDD remains a major problem in developing countries where geographic, economic, and political issues block progress towards its eradication (Hetzel et al., 1990; Koutras et al., 1993). Iodine deficiency is the single most important cause of preventable brain damage throughout the world (WHO, 1993), but it continues, despite over half a century of research and iodine prophylaxis programs, to exist untreated in many regions of the world.

Most industrialized countries control iodine deficiency through nationally legislated salt iodization programs. Salt is one of the most commonly used vehicles for iodine fortification programs as it is readily available, universally consumed and relatively inexpensive (Hetzel and Dunn, 1989; Mannar, 1993). Different methods of salt iodization exist, and these vary according to degrees of humidity, variations in quality and packaging, and fluctuations in storage and transportation time. Several countries have implemented iodine fortification programs using alternative food substances such as bread or candy (Stanbury and Matovinovic, 1983), and recent projects have indicated successful iodization of water sources in rural areas (Yazipo et al., 1995).

Aside from food fortification, IDD eradication efforts focus on either iodine supplementation or dietary modification. Supplementation through iodized oil injection or ingestion is advantageous in settings where the economy does not support the universal iodization of salt, where it is difficult to localize the importation of salt into a region, or when the lag time of a salt iodization program and urgency of the situation require an immediate interruption of the iodine deficient state (Stanbury, 1985). Modification of dietary patterns can provide a more permanent solution to dietary iodine deficiency, but it often requires a change in the attitudes and beliefs concerning certain foods and a shift in overall food consumption priorities that can be difficult in some communities given monetary, cultural, or social restrictions.

Both goiter and cretinism exist in Morocco, but iodine deficiency has only recently received focus as a major problem, as preliminary studies of the severity of IDD were completed. For example, a study in the province of Azilal in 1990 revealed a 65.2% average incidence of goiter (Akalay, 1992). In 1993, a national program to counter IDD was begun by the Minister of Public Health in Morocco. A national survey of IDD prevalence initiated in 1993 and completed in 1994 showed a national prevalence rate of goiter to be 22%. The range of prevalence varied from 0-77% with the highest incidence found in the mountainous regions. In the north of the country along the Rif Mountains, goiter prevalence was found to be 50%. The prevalence in the Middle and High Atlas regions combined was 44%, and along the coasts and plains, only 19% of the population sample exhibited goiter. As part of the national survey, a national study of salt production and distribution was also undertaken to facilitate the implementation of a national program for the iodization of salt (Chaouki, 1995; Hakkaoui, 1995; Saad, 1995).

Iodine deficiency can be brought about by external and environmental factors limiting the presence of iodine within the diet of a population. Though iodine is found naturally in the soil, glaciation processes that have occured historically in mountainous regions combined with heavy rains and erosion have eliminated the iodine present in these soils (Subramanian, 1973). Iodine can be found in animal products, such as chicken, milk, and milk products (Muros et al., 1992; Dodd and Dighe, 1993) as well as certain vegetables, but the iodine content of these foods is not stable due to the external and environmental limitations discussed above.

This paper focuses on the valley of Ounein, an isolated region in the High Atlas Mountains in Morocco where geographical location both fosters iodine deficiency in the form of goiter and limits access of the population to treatment of goiter and to education or information concerning the causes and prevention of IDD. A multidisciplinary rural development project in the region involving the Moroccan Minister of Agriculture and various international agencies began focusing on iodine deficiency after preliminary studies reported that the dietary deficiency of iodine reaches 91.4% in some villages, touches more than 50% of households (Benjelloun, 1987), and affects more than 80% of women in the valley (Lakhsassi and Lemtouni, 1987). The current phase of this project is a joint effort between the Institute of Agronomy and Veterinary Sciences Hassan II (IAV) and the Austrian government and has targeted iodine deficiency eradication as a goal for the region. This paper presents the findings of a survey conducted under the auspices of this joint development project in 1995. We examine the correlates of iodine deficiency in the Ounein region and of dietary patterns with the intention of in forming the design of an effective IDD eradication program.

REGIONAL CHARACTERISTICS

Ounein is a region of approximately 200 square kilometers in the High Atlas Mountains located between 900 meters and 2,816 meters of altitude. The population of Ounein, approximately 8,000 people, is dispersed in the valley into over 60 villages and hamlets with an estimated 40 inhabitants per square kilometer. Natural springs are the water source for most villages, and agriculture depends on irrigation from these springs and rainfall. Crops cultivated in Ounein vary from cereal staples such as barley, wheat, and corn to supplementary vegetable products such as carrots, tomatoes, and potatoes. Animal husbandry practiced in Ounein focuses on small ruminants, sheep, and goats, though cattle are kept to a limited extent. Agropastoral activities in the region are linked to altitude, with a dominance of agriculture over animal husbandry in the lowest altitudinal zone (less than 1,300 meters) and a dominance of animal husbandry over agriculture in the highest zone (greater than or equal to 1,500 meters).

The educational system in Ounein is based on two types: the traditional Koranic school and the modern public school. Koranic schools are found in every village and are taught by the local religious leader, the *fquih*. The *fquih* instructs children from the ages of 5 and up on matters such as reading and writing, mathematics, and religion. Three central primary schools and several satellites exist and constitute the whole of public education in the valley. Children receiving education beyond that of a primary level must leave the valley to attend secondary schooling.

The health care system in the valley is also divided into modern and traditional structures. One dispensary exists in Adouz, the market town, and is operated by a single nurse who takes care of health matters and supplies medicines. Traditionally, the *fquih* also provides health care in the form of Koranic amulets, recitations, and various herbal treatments. The population of Ounein seems to visit the *fquih* more often than the nurse for monetary and distance-related reasons.

The market of Ounein is located in the village of Adouz on the valley floor. Market days are Wednesday and Sunday and are the only supply source for most of the households in the valley. Sunday is the more important market day of the two and serves not only as a source of provisions but also as a source of communication between villages and legislative fractions.

The population, living in an isolated mountainous region and consuming foods grown in iodine-poor soils is at high risk of endemic IDD. This risk is heightened by minimal consumption of seafoods naturally rich in iodine due to an inadequate transportational infrastructure and a lack of demand by the population of Ounein. The only seafood available in the valley is fish brought in during the winter months from the coastal city of Agadir several hours away. Canned fish, in the form of sardines, is sold in the market throughout the year.

SURVEY DESIGN AND DESCRIPTIVE STATISTICS

The data were collected throughout the spring of 1995 from 110 households in 19 different villages. Heads of households or their wives were interviewed as part of a survey examining household salt, fish, and animal product consumption patterns, factors affecting market purchases, and social and cultural factors surrounding goiter and perceptions of goiter. From these 110 households, children ages 6-14 were selected to donate 24-hour urine samples in order to provide an accurate measure of the urinary iodine content of the population. A doctor later examined these same children for goiter using the palpation method recommended by the WHO, UNICEF, and ICCIDD (in Dunn and VanDer Haar, 1990).

In general, the male head of household (HOH) was interviewed. On some occasions when he was unavailable, his wife was interviewed. In all cases, women were asked to stay throughout the interview if possible. Due to cultural gender-based barriers, and the fact that one of the interviewers and the interpreter were male, access to women was limited. Thus, much of the data concerning women in the households came from male respondents and might be biased.

The food consumption data were gathered using household purchasing frequencies. Salt consumption was calculated by subtracting the amount of salt given to livestock from the amount purchased. Animal product consumption was recorded through respondents' recall of average consumption patterns. In this paper, all milk products are combined, and dairy product consumption is presented in grams per person per day. Salt and fish are also reported in the same manner. One problem inherent in this survey method, however, is the length of recall for food consumption. Actual food consumption itself was not recorded, and respondents reported food consumption data based on yearly estimations. Thus, while food consumption figures here are not exact measures of actual consumption patterns, they are representative as part of the larger study focusing on IDD in the valley.

Selected survey results are presented in Table I. Household decision-making and market participation are strongly associated with cultural gender roles. While women in the households play a key role in the management of salt storage and the decision-making process regarding household provisioning, none of them go to market. Almost all of the heads of households go to the market each week, but only one-quarter of them (25.5%) claimed responsibility for market purchases.

Table I: Selected characteristics of heads of households and their wives

Characteristics (Number)	Heads of Households	Wives
	(110)	(108)
Percentage with no education	30.0%	95.4%
	(33)	(103)
Percentage with Koranic schooling	43.6%	0.9%
	(48)	(1)
Percentage with public schooling	26.4%	3.7%
	(29)	(4)
Percentage who go to souk (market)	97.3%	0
	(107)	(0)
Percentage making decision regarding household purchases	25.5%	80.6%
	(28)	(87)
Percentage managing salt storage	4.5%	88.0%
	(5)	(95)

Women in 80.6% of households determine which supplies are needed, while in 6.1% of the households, decisions are made jointly. Eighty-eight percent of wives of HOHs manage salt usage and storage, while only 4.5% of HOHs take charge of salt once it is in the household.

Education is another area which finds a strong adherence to traditional gender roles. While only 30% of HOHs had no formal education, 95.4% of the wives of HOHs had never gone to school. Of those HOHs who had attended some schooling, 43.6% reported stopping at the Koranic level of education while 26.4% had gone on to receive some public schooling. The sex division in education is repeated among the children in the household as well.

Urinary samples of 197 children in the study households were evaluated for iodine content, and the results are shown in Table II. Of the 197 children sampled, 42.6% were found to be severely iodine-deficient, 41.3% moderately deficient, 3% mildly deficient, and another 3% normal. A slightly higher number (45.9%) of female subjects were found to be in the severe category than males (39.4%), though a higher number of males had moderate urinary iodine levels (54.5%) than females (48%). Six males (6.1%) showed mild iodine deficiency and no male subjects were in the normal level. No females had a mild level of iodine deficiency; however, six females (6.1%) had normal levels of urinary iodine. The median urinary iodine level of the sample was 2.1μg iodine per deciliter (I/dl), indicating a moderate deficiency within the population.

The children who donated urine samples were called back to be examined for goiter (Table III). One hundred eighty-eight children took part in the goiter palpation. The goiter prevalence in this population was evaluated to be 94.1%, i.e., quite similar to the 97% rate identified by urinary iodine content. Of the subjects affected by goiter, 18.6% had a goiter in the 1a grade, 33% were in

Table II: Levels of urinary iodine deficiency in children by sex

Level of Deficiency	Males	Females	Total
Severe	39.4%	45.9%	42.6%
	(39)	(45)	(84)
Moderate	54.5%	48%	51.3%
	(54)	(47)	(101)
Mild	6.1%	0 %	3%
	(6)	(0)	(6)
Normal	0 %	6.1%	3%
	(0)	(6)	(6)
Total:	100%	100%	100%
(N)	(99)	(98)	(197)

Note: Severe deficiency = <2.0 μg/dl urinary iodine.

Moderate deficiency = $\geq$2.0 and <3.5 μg/dl urinary iodine.

Mild deficiency = $\geq$3.5 and <5 μg/dl urinary iodine.

Normal = $\geq$5 μg/dl urinary iodine.

Table III: Goiter prevalence in the sample population of children by sex

Grade of Goiter	Males	Females	Total
Grade 0	4.4%	7.2%	5.9%
	(4)	(7)	(11)
Grade 1a	24.2%	13.4%	18.6%
	(22)	(13)	(35)
Grade 1b	33.0%	33.0%	33.0%
	(30)	(32)	(62)
Grade 2	38.5%	40.2%	39.4%
	(35)	(39)	(74)
Grade 3	0%	6.2%	3.2%
	(0)	(6)	(6)
Total	100%	100%	100%
(N)	(91)	(97)	(188)

Note: Grade 0 = no goiter.

Grade 1a = goiter not visible but larger than ends of thumbs.

Grade 1b = goiter visible when neck is tilted back.

Grade 2 = goiter visible with neck in normal position.

Grade 3 = goiter visible from about 10 meters.

the grade of 1b, 39.4% were at grade 2, and 3.2% had a grade 3 goiter. As with the urinary iodine measure, the sex difference in goiter does not appear great.

Of the three types of fish available in the valley (canned, fresh, or cooked), canned fish is the most widely consumed, by 92% of households. A large number of households view both fresh or cooked fish with suspicion as it travels several hours to get to market. Seventy-three percent of the households consuming canned fish limit their consumption during summer, primarily because canned fish is perceived by 82% of respondents to make them feel too warm in the summer heat. Table IV shows that total average fish consumption per household varies considerably across categories of child urinary iodine deficiency. Severely and moderately deficient children come from households consuming 12-14 kilograms of fish per year. The households of children with mild iodine deficiency consume about twice as much fish: 27.6 kilograms annually. The households of the few children with no urinary iodine deficiency consumed almost six times as much fish as households with severely or moderately iodine-deficient children.

Goiter is a universally recognized problem in Ounein, but none of the households surveyed identified a link between goiter and diet. Many (40.0%) say they do not know the origin of goiter. The most common belief (held by 38.2% of respondents) is that goiter is an hereditary problem. This seems to derive from the fact that moderate and severe goiters are often concentrated in families and villages. While there appear to be genetic factors that predispose particular individuals to develop goiters when deprived of iodine (Koutras et al., 1993), we suspect some of our respondents' observation is likely attributable also to microvariability within the region in soil and water conditions that influence the iodine content of locally produced foodstuffs.

Table IV: Household fish consumption patterns by children's urinary iodine deficienc y level (kilograms per year)

Level of Iodine Deficiency	Fresh Fish	Cooked Fish	Canned Fish	Total
Severe	3.93	3.18	6.89	13.99
Moderate	3.49	2.38	6.03	11.91
Mild	8.08	2.89	16.58	27.55
Normal	22.15	22.40	26.53	71.08

REGRESSION ANALYSIS

The survey data permit more careful statistical analysis of the correlates of IDD. This section explains the regression technique employed and reports our statistical findings. We find that urinary iodine deficiency among children in the Ounein region is strongly and positively correlated with dietary intake of fish. A household's proximity to the market town and the occupation of the male head of household, which together influence ease of market access, are in turn positively related to fish consumption.

IDD is caused primarily by insufficient dietary intake of iodine. Thus, we initially estimated the relationship between a child's urinary iodine content (measured in µg/dl) and household-level consumption of fish and dairy products (measured in grams consumed per day), normalized by household size, as measured in adult male equivalent (AME) units.[1] We also included village dummy variables to proxy for local water and soil conditions that may result in the natural iodization of fruits, grains, or vegetables grown for home consumption. While there is no evidence of biological sex bias in IDD, there could be gender discrimination in the intrahousehold distribution of food and, thus, in dietary iodine intake, so we included a dummy variable for the child's sex (male = 1). For instance, if boys receive disproportionately large shares of food—especially protein-rich foods like fish or dairy products that may also contain much of the household's dietary iodine—the sex variable should proxy for the IDD consequences

---

[1]Based on FAO/WHO (1974), we used the following equivalence scales:

adult male age > 19 = 1	boy age 10-12 = .87
adult female age > 19 = .73	boy age 13-15 = .96
child age < 1 = .27	boy age 16-19 = 1.02
child age 1-3 = .45	girl age 10-12 = .78
child age 4-6 = .61	girl age 13-15 = .83
child age 7-9 = .73	girl age 16-19 = .77 .

of unequal intrahousehold distributions. One would expect it to be nonnegative, i.e., intrahousehold inequities, if there are any, probably advantage male children. Finally, since dietary intake requirements increase with a child's age but our consumption data are household-level means, we also include age (measured in years). Since a given per caput availability of fish, dairy, or other iodine-carrying foods satisfies a lower proportion of an older child's micronutrient requirements, one would expect the estimated coefficient on the age variable to be nonpositive.

While dietary intake appears a leading cause of IDD, there is evidence of genetic factors that predispose individuals toward the development of IDD when subject to insufficient iodine intake. Since we are unable to observe the genetic patterns of the surveyed children, such genetic factors should show up in the regression residuals. Given that siblings often share genetic traits, this implies that one would expect the regression residuals to be correlated across observations. One can test for such serial correlation using Llung-Box-Pierce Q-statistics (Judge et al., 1985).

In the presence of correlated residuals, the ordinary least-squares estimator is inefficient, so we opt instead for a generalized least-squares technique which takes the form[2]

$$\mathbf{y} = X\mathbf{b} + \mathbf{e}, \text{ with } E[\mathbf{e}] = 0 \text{ and } E[\mathbf{ee}'] = \Sigma \,, \qquad (1)$$

where **y** is the dependent variable (urinary iodine content), X is the matrix of regressors identified above, **b** is the vector of coefficient estimates, **e** is the vector of residuals, and Σ is the (unknown) covariance matrix. One can consistently estimate Σ from the **e**'s derived from the ordinary least-squares regression of **y** on X, imposing some structure on the n(n+1)/2 elements of Σ, and

[2]Boldface, lowercase characters denote vectors, uppercase characters denote matrices.

thereby get consistent and efficient **b** estimates (Judge et al., 1985). Since we are concerned about genetic correlations among siblings, we restrict the σ_{ij} elements of Σ as follows:

$\sigma_{ii} = \sigma \geq 0$ $\forall$i (homoscedastic errors with nonnegative variance)

$\sigma_{ij} \geq 0$ $\forall$i,j in same nuclear family (nonnegative intrafamily correlation)

$\sigma_{ij} = 0$ $\forall$i,j in different nuclear families (zero interfamily correlation).

This restriction permits nonzero correlation among that portion of siblings' urinary iodine content that cannot be explained by the structural regressors. Given this structure to the estimate of Σ, the coefficient estimates are computed by $\mathbf{b} = (X'\Sigma^{-1}X)^{-1} X'\Sigma^{-1}\mathbf{y}$.

This regression technique yields the estimation results reported in Table V. The residuals from the ordinary least-squares variant of (1) were indeed serially correlated as evidenced by a Q-statistic with a p value of 0.011 against the null hypothesis of no serial correlation. In cross-sectional data, this serial correlation suggests relationships between observed individuals and is thus consistent with the expectation of unobservable genetic factors in IDD patterns. The GLS method yielded residuals that satisfied diagnostic tests for serial correlation and heteroscedasticity; i.e. our construction of Σ seems to accomodate unobservable, genetically determined correlations in children's urinary iodine content, providing us with an efficient estimator for the structural relationships of interest.

Urinary iodine increases by a statistically significant amount with fish consumption. The elasticity of urinary iodine with respect to a change in fish consumption equals 0.257 at the sample means, indicating that a doubling of household fish consumption is associated with more than a 25% increase in its children's urinary iodine. The coefficient on dairy consumption was not statistically significant nor was it of the expected sign. The age and sex variables were of the expected sign, but both were statistically insignificant, indicating that intrahousehold food distribution does not seem

Table V: Correlates of children's urinary iodine content

Variable	Coefficient Estimate	Standard Error
Constant *	3.241	1.020
Fish *	0.091	0.021
Dairy	-0.002	0.012
Age	-0.134	0.231
Sex	-0.015	1.681
Village Dummy Variables		
Ait Zekri	0.109	0.187
Tignziw*	0.387	0.128
Tinsmlal	0.213	0.227
Takordmi	-0.098	0.101
Tamsoult n'Ougard	0.674	0.988
Doutkad*	-0.544	0.321
Agard*	-0.433	0.206
Imirguen*	0.766	0.308
Ait Tadrart	-0.332	0.431
Aghilas	-0.227	0.967
Afla n'Oufra*	0.087	0.034
Tamdghoust	-0.004	0.027
Ait Tachrift	0.018	0.022
Ait Masoud	0.208	0.345
Tawarda	0.355	0.283
Talat Nd Raman *	-0.227	0.121
Tinmslal	-0.433	0.497

*Statistically significant at the 10% level (p value ≤ 0.10).

serious with respect to dietary iodine intake. Several of the village-specific variables are statistically significant. We interpret this as an indication that local soils and waters affect dietary iodine intake through fruits, grains, and vegetables produced for home consumption. If these village dummy variables indicate locally iodized soils and plants, that may also explain the counterintuitive negative coefficient estimate on dairy consumption, since the iodine content of the milk from a family's livestock depends fundamentally on the nutrient content of local fodder.

The regression results reported in Table V also lead naturally to the question: what are the correlates of fish consumption within the region? From basic microeconomic theory, one would expect consumption to increase with household income or discretionary expenditures and to decrease with price, but, unfortunately, we have no reliable data on household expenditure or income nor on prices. However, market access likely also matters since all fish consumed in this interior region are imported from the coast and purchased in town. We measure market access by two variables: distance from market, and household head's occupation. Intuitively, the further one lives from the market center, the less likely is the household to go to market regularly and purchase fish. Thus, we group all households into one of three categories: those living within 5 kilometers of the market, those living 5-10 kilometers distance, and those living more than 10 kilometers away. Dummy variables for the latter two categories capture the effects of living beyond a 5 kilometer radius from the market. Second, some men have occupations which cause them to be in the market town regularly, regardless of whether they wish to purchase foodstuffs. The marginal cost of market access is thus quite low for such households, irrespective of where they live.[3] We thus constructed a dummy variable for all households for which the male head had an occupation requiring his presence in the market town at least every market day.

If more educated adults are more likely to be aware of and to understand the inverse relationship between fish consumption and iodine deficiency, then one would expect fish consumption to increase with the education level of the household head. One must be careful, however, to distinguish between the education level of the female head, who prepares the food and may request particular food purchases of the male, and the education of the male, who undertakes all market purchases. Thus, we include two education variables as regressors: the years of formal education for both the male and female heads of each household.

Given these considerations, we estimated the relationship between household fish consumption per AME (in grams per day) as a function of distance from market, the occupation of the male household head, and the years of schooling of the female and male household heads by ordinary least squares. The results are reported in Table VI. Fish consumption indeed appears related to market access, as the coefficient estimates on the distance-from-market variables are both negative and statistically significant and the coefficient estimate associated with the household head's occupation is positive, if of only modest statistical significance. The coefficient estimates on the male and female education level variables are of low magnitude, of mixed sign, and not significant at any meaningful level of statistical significance. This is unsurprising given the universal lack of awareness in the surveyed population of the dietary etiology of IDD.

---

[3]Perhaps surprisingly, the correlation coefficient between living within 5 kilometers of the market and having a market town-based occupation was only 0.132 in sample.

While it is clear that fish consumption offers a natural source of dietary iodine, policymakers seem more focused on the possibility of IDD eradication through salt iodization. Whether salt

Table VI: Correlates of household fish consumption/AME

Variable	Coefficient Estimate	Standard Error
Constant*	9.803	2.535
5-10 km distant*	-6.555	2.542
> 10 km distant*	-4.182	1.802
Occupation	4.443	2.872
Female education	0.085	1.360
Male education	-0.124	0.217

*Statistically significant at the 10% level (p value ≤ 0.10).

iodization offers a promising solution to IDD throughout the population depends, however, on salt consumption patterns. So just as we earlier estimated fish consumption patterns from the survey data, so, too, have we estimated salt consumption patterns. Given the broad-based incidence of IDD in the Ounein region and the fact that all survey households purchased and consumed salt, the simplest answer is that salt iodization clearly can help. But the impact of salt iodization need not be uniform across households because not everyone purchases and consumes the same amount. Toward this end we estimated the relationship between household salt consumption per AME (in grams per day) as a function of distance from market, the occupation of the male household head, and the years of schooling of the female and male household heads, again by ordinary least squares.

The estimated correlates of salt consumption are reported in Table VII. As with fish, it appears that market access matters considerably to salt consumption, as represented both by proximity of the household's residence to market and by the household head's occupation. The coefficient estimates, with respect to the distance and occupation dummy variables, are all of the expected sign and statistically significant. Salt consumption is also positively correlated with the male head of household's education.

DISCUSSION AND POLICY IMPLICATIONS

Urinary iodine deficiency among children in the Ounein region is widespread, relatively severe, and strongly and positively correlated with dietary intake of fish. A household's proximity to the market town and the occupation of the male head of household, which influence ease of market access, are in turn strongly and positively correlated with fish consumption. All surveyed households

Table VII: Correlates of household salt consumption/AME

Variable	Coefficient Estimate	Standard Error
Constant*	34.491	6.735
5-10 km distant*	-3.722	1.655
> 10 km distant *	-6.333	2.779
Occupation *	2.918	1.572
Female education	-2.444	1.645
Male education*	1.800	0.877

*Statistically significant at the 10% level (p value ≤ 0.10).

purchase and consume salt, with salt consumption likewise strongly affected by household market access. However, households were uniformly (and surprisingly) unaware of the dietary basis of IDD. An effective strategy to reduce the incidence of IDD in the valley clearly must attend to four crucial issues: fish consumption, salt iodization, education, and market access.

Fish Consumption

While the iodization of salt is a sensible step towards the eradication of IDD, increased dietary intake of iodine more generally is clearly the key. Fish is naturally high in iodine content. Indeed, the evidence is strong that an increase in fish consumption can translate into higher urinary iodine contents. Unfortunately, the valley of Ounein is isolated from the sea, and fish intake is limited. The fresh and cooked fish available in Ounein is not considered desirable. A large majority of households consume canned fish, though this consumption varies radically with season. Communication efforts concerning fish consumption should mention fresh and cooked fish as important sources of iodine, but efforts should concentrate on the most available and preferred type of fish consumed in the valley. Over 90% of households reported they would consume more canned fish if they knew it could aid in the prevention of goiter. Ninety-two percent said they would increase canned fish consumption if they knew it was good for their health generally. Messages should thus promote increased consumption of canned fish and link it with the eradication of goiter, advancing the notion of canned fish as a food item that enhances good health. The seasonal consumption pattern of canned fish should be addressed through the idea that fish can also be consumed with "cool" foods such as salad; most households in the sample do not do this at present.

Iodization of Salt

Perhaps the single most important dietary consideration within the valley is the planned introduction of iodized salt. The presence of iodine in the new type of salt and the link between dietary iodine intake and goiter should be stressed during an education program to increase awareness of iodine itself as well as differences between the “old” salt and the “new” one. It might be impossible to eliminate the presence of noniodized salt; consequently, villagers must actively want to choose the iodized salt. The connection between iodized salt and goiter prevalence reduction must be made clear, and households without goiter must know that the iodized salt is important as goiter prevention for themselves and their children. Since the cost of iodization will raise the price of salt, communication must focus on the benefits to be gained from its purchase.

Education

The most striking feature of local perceptions of goiter in Ounein is that none of the population understands its etiology. The relation between diet and goiter (the only recognized form of IDD in the valley) must be approached from a logical and uncomplicated position. The concept of iodine as an element discussed apart from concrete dietary examples is likely too abstract an idea in this population. The connection between iodine and certain food items—fish or iodized salt—can be promoted and absorbed more easily than a simple recitation of the importance of iodine.

Given that virtually none of the wives of HOHs have received any education and few are literate and yet they are the mutually acknowledged decision-makers regarding purchases in the majority of households, education efforts should focus on oral communication rather than written literature. Animated presentations, cooking sessions where women can participate in trying new recipes and taste iodized salt, and group discussions should be considered as educational strategies. Issues such as the storage of iodized salt need explicit attention since women are in charge of salt storage. Yet, men must also be included in educational efforts since they make the market purchases. Cultural mores in the area dictate that the nutritional education of men and women cannot be integrated in practice, but the parallel programs must obviously be closely coordinated.

The logical choice as an iodine deficiency educator in the valley is the *fquih*. The local population express little faith in the dispensary and most do not have the money to visit a hospital. Thus, most of the population turns to the *fquih* for treatment. Forty-three percent of the surveyed individuals with goiter had sought treatment from the *fquih*. Informal discussions with *fquih*s in villages found them willing to serve as IDD educators. But presently they are no better informed than the general population as to the etiology of goiter or IDD more generally. The *fquih* leadership would also enhance the informal nutritional education of women who are culturally permitted to visit the *fquih* on matters of health or religion.

The dispensary nurse, as the only local source of medical supplies and knowledge, is clearly also indispensable to IDD education. Regardless of the fact that villagers do not seek treatment for goiter at the dispensary, they do recognize the dispensary as the valley's only source of modern medicine.

<u>Market Access</u>

One important variable in the strategy to reduce IDD in the region is the access of households to the market. The strong, negative correlation between distance from the market and both fish and salt consumption and the corresponding positive relation between fish or salt consumption and a town-based occupation for the male head of household indicates that households with poor market access would reap less benefit from salt iodization. This should alert educators to the special importance of reaching more remote villages with targeting efforts and educational strategies. Furthermore, heads of households who are not required to go to market twice a week for occupational purposes should be targeted since they generally buy less salt.

CONCLUSIONS

Survey data suggest that the introduction of iodized salt in the Ounein Valley of Morocco must be accompanied by increased fish consumption and nutrition education, as well as by careful targeting of populations living more than 5 kilometers from the market, if the alarmingly high prevalence of IDD is to be reduced substantially. Nutrition education efforts must target both women and men in accordance with their gender-specific roles in household provisioning, and local religious leaders could be enlisted as effective nutrition educators.

REFERENCES

Akalay, O., Ministère de la santé publique (1992). Enquete sur le goitre par carence iodée au maroc. Bulletin Epidémiologique, 7, 1-9.

Benjelloun, S. (1987). Consommation alimentaire. In L'Ounein: Essai d'Ecologie Sociale d'une Vallée du Haut-Atlas Occidental (Maroc), CRDI-IAV Hassan II: Direction du Développement Rural, Rabat, pp. 236-286.

Chaouki, N. (1995). Présentation des résultats de l'enquete nationale sur les TDCI. Presented at the Conference Nationale sur les Troubles Dus à la Carence en Iode, March 8, Hotel Tour Hassan—Rabat.

Dodd, N., and S. Dighe (1993). Iodine content of diets of the people of different regions living in Bombay. Journal of Food Science Technology, 30, 134-136.

Dunn J., and F. VanDer Haar (1990). A Practical Guide to the Correction of Iodine Deficiency. ICCIDD, The Netherlands.

Food and Agriculture Organization, and World Health Organization (1974). Handbook on Human Nutritional Requirements. FAO Food and Nutrition Series, No. 4, FAO, Rome.

Hakkaoui (1995). Présentation des résultats de l'enquete nationale sur les TDCI. Presented at the Conference Nationale sur les Troubles Dus à la Carence en Iode, March 8, Hotel Tour Hassan—Rabat.

Hetzel, B., and Dunn, J. (1989). The iodine deficiency disorders: Their nature and prevention. Annual Review of Nutrition, 9, 21-38.

Hetzel, B., B. Potter, and E. Dulberg (1990). The iodine deficiency disorders: Nature, pathogenesis and epidemiology. World Review of Nutrition and Diet, 62, 59-119.

Judge, G.G., W.E.Griffiths, R.C. Hill, H. Lütkepohl, and T.-C. Lee (1985). The Theory and Practice of Econometrics. John Wiley and Sons, New York.

Koutras, D., G. Piperingos, J. Mantzos, M. Boukis, K. Karaiskos, and S. Hadjiiloannou (1993). Iodine nutrition and iodine deficiency disorders in Greece: Signs of improvement. In Delange et al. (Eds.), Iodine Deficiency in Europe. Plenum Press, New York.

Lakhsassi, L., and A. Lemtouni (1987). Santé et nutrition. In L'Ounein: Essai d'Ecologie Sociale d'une Vallée du Haut-Atlas Occidental (Maroc), CRDI-IAV Hassan II: Direction du Developpement Rural, Rabat, pp. 193-235.

Mannar, E. (1993). Control of iodine deficiency disorders through the iodization of salt with specific references to the situation in the Phillipines. Bulletin of the Nutritional Foundation of the Phillipines, 33, 3, 5-8.

Muros, P., D. Ruiz-Lopez, and F. Olea (1992). Intake of iodine and major nutrients in an area of endemic goitre. Journal of Nutritional Science and Vitaminology, 38, 603-607.

Saad (1995). Présentation des résultats de l'enquete nationale sur les TDCI. Presented at the Conference Nationale sur les Troubles Dus à la Carence en Iode, March 8, Hotel Tour Hassan—Rabat.

Stanbury, J., and J. Matovinovic (1983). Interventions for the prevention of endemic goiter. In Underwood, B. (Ed.), Nutrition Intervention Strategies, Academic Press, New York, pp. 325-341.

Stanbury, J. (1985). Iodine deficiency disorders: Clinical presentations and continuing problems. Food and Nutrition Bulletin, 7, 2, 64-72.

Subramanian, P. (1973). Production of iodized salt and prevention of goitre in India. Current Science, 42, 73-79.

United Nations (1993). Micronutrient deficiency—the global situation. SCN News, 9, 11.

World Health Organization (WHO) (1993). Global Prevalence of Iodine Deficiency Disorders. MDIS Working Paper N°1. WHO, Geneva, Switzerland.

Yazipo, D., L.F. Ngaindiro, and L. Namboua (1995). Combatting iodine deficiency: The iodization of water in the Central African Republic. American Journal of Public Health, 85, p. 732.