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**COMMON NUTRITIONAL DEFICIENCIES IN THE THREE RICHEST VERSUS THE
POOREST COUNTRIES IN THE WORLD:
WHY ARE THEY SIMILAR OR DIFFERENT?**

by

Ginger Ann Bailey

**Thesis submitted in partial fulfillment
of the requirements for the degree**

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DEPARTMENTAL HONORS

in

**Dietetics
in the Department of Nutrition and Food Sciences**

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Spring 2007

1 **COMMON NUTRITIONAL DEFICIENCIES IN THE THREE RICHEST VERSUS**
2 **THE POOREST COUNTRIES IN THE WORLD:**
3 **WHY ARE THEY SIMILAR OR DIFFERENT?**

4
5 **Ginger A. Bailey**

6
7 **INTRODUCTION**

8 Over one billion people suffer from nutritional deficiencies, and they reside in both
9 the poorest and the richest countries in the world (1). What needs to be determined is if the
10 deficiencies are similar or different, and most importantly *why*. By learning what nutritional
11 deficits exist in these countries and why they occur, we are then able to create appropriate
12 interventions in order to improve the nutritional status of populations worldwide.

13 The most common micronutrient deficiencies are Vitamin A, iron-deficiency anemia,
14 zinc, and iodine (1). These deficiencies have detrimental effects such as poor growth,
15 increased morbidity, intellectual impairment, and increased mortality (1). Many people view
16 these deficiencies as problems only in developing countries, but is it possible that they can
17 exist in even the wealthiest countries in the world? Studies have found that even developed
18 countries have pockets of malnutrition (3). The disparity between rich and poor countries is
19 increasing, which becomes an important factor in mortality (3).

20 In order to examine this topic further, it is necessary to determine which countries are
21 among the wealthiest and which are the poorest. The most common way to classify
22 countries in this manner is by gross domestic profit (GDP) per capita. Based on the statistics
23 found in the CIA World Factbook from 2006, the three poorest countries in the world, in

1 descending order are: Somalia at \$600 per capita, East Timor at \$800 per capita, and Sierra
2 Leone at \$900 per capita (3). The three richest countries in the world in ascending order are:
3 Luxembourg at \$68,800 per capita, Norway at \$48,800 per capita, and the United States at
4 \$43,500 per capita (3). The difference in GDP between the richest and poorest country is
5 \$68,200.

6 By looking at each country individually, we can determine what nutritional deficiencies exist
7 and possibly what is causing them. While economics is a major factor contributing to
8 nutritional status, it is important to ask ourselves: what other factors could be playing an
9 important role? Available food supply and/or purchasing power are not necessarily the only
10 factors that causes/increases nutritional deficiencies. So, what else contributes to a
11 population's nutritional status? Let's start first by examining each of the poorest countries.

12

13 **SELECTED COUNTRY PROFILES**

14 ***East Timor***

15 East Timor is the first country to look at. It has a population of about 1,062,888
16 (2006 estimate) (3). It is located in Southeastern Asia on an island just north of Australia.
17 On this small island, two out of five people live in poverty and twenty percent of the
18 population lives on less than one dollar per day (4). The life expectancy is only 66 years, and
19 half the people are illiterate (3). In this country, protein-energy malnutrition is extremely
20 prevalent, especially among children (5). Of children under five years old, 40% are
21 moderately to severely malnourished, 10% are wasted, and 50% have stunted growth due to
22 poor nutritional status (5). About 50% of people live without safe drinking water. This
23 creates a downward cascade that ultimately ends in death. Contaminated water leads to

1 parasitic infections. In a normal healthy person, it would cause illness, but for those that
2 have nutritional deficiencies, the immune system is compromised to the point that the body is
3 not able to fight the infection. The result is inevitable (5). Nearly 45% of children under five
4 years old have a parasitic infection related to a Vitamin A deficiency (6), and 80% of all
5 children have intestinal parasitic infections with related nutritional deficiencies (7). Among
6 women of childbearing age, there is a major problem with both iron-deficiency anemia and
7 zinc deficiency, which is the main cause of their high mortality rate (46 deaths/1,000 live
8 births) (8). In addition, 35% of mothers have a BMI below 18.5, which also significantly
9 contributes to the high mortality rate (9). Due to the absence of iodized salt, and the poor
10 iodine content of the soil, it has become a common deficiency (9).

11 Their overall food supply is quite limited, and is especially low in animal products
12 (8). Their staple food is local corn, rice and spices (8,10), which does not provide many
13 nutrients. Because of the minimal food supply, they have developed a habit of "earth eating"
14 which means that they eat whatever they can find in their environment such as nuts, roots,
15 and berries (8). It is evident that their environment significantly impacts their nutritional
16 status, since much of their diet is based on the food available around them. Not only is their
17 overall intake inadequate, but they also do not have access to many nutrient dense foods,
18 such as meats and fortified foods (e.g., cereals and milk), which would help to overcome
19 some of the major nutritional deficiencies they experience.

20 ***Somalia***

21 The next country to examine is Somalia. It is located in Eastern Africa, and has a
22 population of 8,863,338 people (2006 estimate) (3). Many of these people are nomads and
23 refugees due to the severe civil wars this country has experienced in past years (11). The

1 year of major conflict was 1990 (12). The fighting destroyed harvests, the militia looted
2 assets needed for crops, bandits closed trade routes, and their attacks discouraged food
3 growing (12). To make matters worse, the fighting paralyzed relief efforts (12). All of this
4 has lead to severe food insecurity. More recently, this country has also been plagued with
5 floods and famines, which has led to deplorable availability of food (13). Severe flooding
6 destroyed underground food supplies and assets which lead to the famine they are still
7 experiencing (13). The life expectancy in this country is only 48 years old, which is quite
8 low when compared to many other populations (3).

9 Overall, this country has a poor nutritional status due to several factors, such as
10 limited accessibility to food, low quality of diet, poor infant feeding practices, and inadequate
11 food safety (14). Specifically, the major nutritional deficiencies are Vitamin A, iron-
12 deficiency anemia, and iodine which not surprisingly are the same as East Timor (14).

13 The food supply is based on unfortified milk and cereals (15). Their supply of fruits
14 and vegetables is low, and most have an insufficient energy intake (17). Due to war and
15 famine, most of the food supply was provided by relief organizations. Studies have shown
16 that these types of food rations are designed to prevent starvation, but do not necessarily
17 inhibit nutritional deficiencies such as iron, Vitamin A, Vitamin C, and most B vitamins (16).

18 The most commonly consumed foods are lamb, goat, sweetened tea, and homemade
19 cakes (3). Frying is the most common method of cooking (17). This does not provide for the
20 most nutritious diet. The rate of exclusive breastfeeding is low (17). As a result of that and
21 the high incidence of maternal anemia, they too, like East Timor have a high infant and
22 maternal mortality rate (115 deaths/1,000 live births) (3).

1 For those that aren't killed in wars, infection related to nutritional deficiencies claims
2 many other lives (3). Hepatitis A and E are both highly prevalent (3). Since many are
3 nomads, they do not have fields to grow crops in, harvest food, or raise cattle. Many of the
4 villages have been completely destroyed either by the war or by floods (12, 13). Currently
5 people are concerned with more imminent factors than their nutritional health.

6 In Somalia, the environment is the major influence on their nutritional status. It
7 affects the types and quantity of foods that are available. People do not always know when
8 or where their next meal might come. If this trend continues, the situation will only worsen
9 and cause further problems.

10 Fortunately, conditions seem to be on the rise. In a report put out in January 2007 by
11 the Food Security Analysis Unit, the nutritional situation in Somalia is improving (18). In
12 July 2006, about 20% of the population was classified as having a very critical acute
13 malnutrition, and by January 2007, this number had significantly decreased (18). There is
14 still a large amount of the population that is classified as having a critical nutrition status, and
15 they reside mainly in the southernmost part of the country.

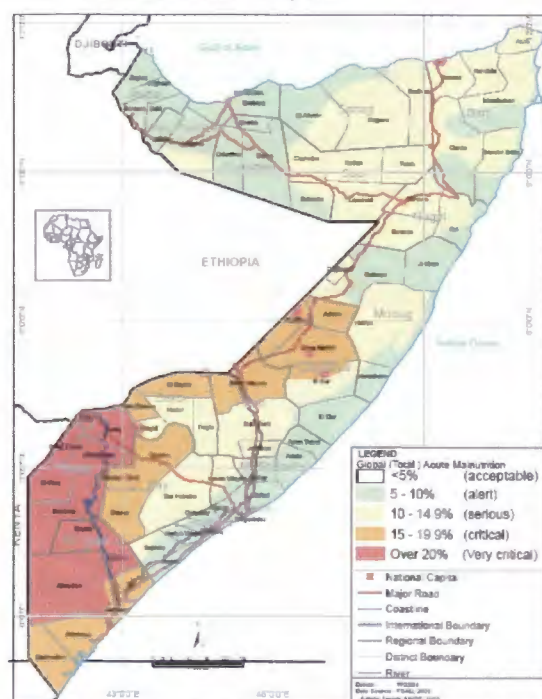
16 Figure 1 displays the nutritional status from July of 2006, as compared to January of
17 2007. It is evident that major improvements have been seen. They have mainly been due to
18 recent rainfall which has improved the environmental conditions for agriculture and livestock
19 (18).

20

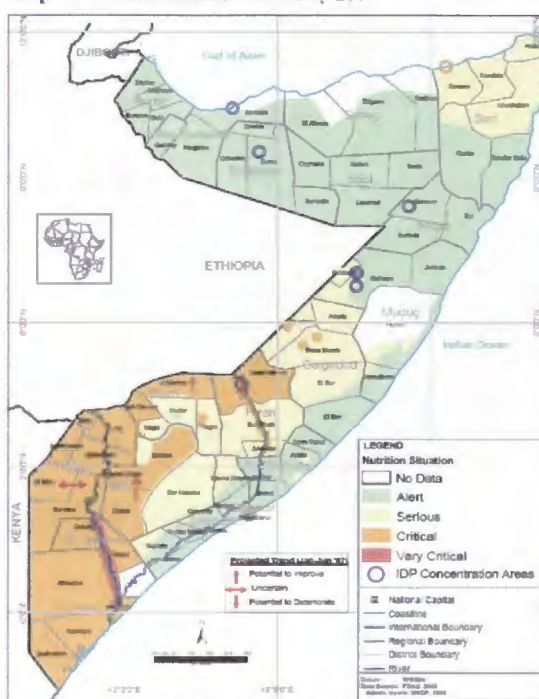
21 ***Sierra Leone***

22 The last of the economically impoverished countries is Sierra Leone. It is located in
23 Western Africa between Guinea and Liberia, and has a population of 6,005,250 (2006

Map 1: Nutrition Situation - July 2006



Map 2: Nutrition Situation - January 2007



1
2 **Figure 1a.** Nutrition Situation July 2006 **Figure 1b.** Nutrition Situation Jan 2007

3
4 estimate) (3). Like Somalia, it too has been racked by brutal civil wars (19). The life
5 expectancy is only 38 years (3).

6 Daily capita energy supply is about 1880 calories, and 44 grams of protein (19).
7 Considering that the life expectancy is so low, and the median age is about 17 years old, this
8 energy intake would be inadequate for most of the population (3). This could account for
9 why five percent are wasted, 23% percent are underweight, and 41% are stunted (19). Forty
10 six percent of child deaths, almost half, are due to malnutrition (21). Overall, 35% of the
11 population is undernourished (19). An astounding 86% of pregnant women are anemic (19).
12 Fish makes up eighty percent of their animal protein intake (20). Since they are on the coast,
13 it is the most easily accessible food source (3, 20).

1 Despite these horrifying statistics, conditions are changing. For example, in 1992,
2 97% of children ages six to fourteen had an iodine deficiency, which is the major preventable
3 cause for mental retardation (19). However, by 2003 only 37% percent had an iodine
4 deficiency (19). This is a *huge* improvement. Unfortunately, not all changes are for the
5 positive. New dietary habits have led to an increased incidence of diabetes mellitus,
6 hypertension, cardiovascular diseases, and mental disorders (19). This could be partly due to
7 the fact that the main agricultural products include palm kernels, palm oil, and pigs, which
8 are all quite high in saturated fats (3). Other agricultural products include rice, coffee, cocoa,
9 peanuts, poultry, cattle, sheep, and fish (3). Vitamin A, iodine, and iron are still the major
10 nutritional deficiencies, just like East Timor and Sierra Leone (19).

11

12 ***Luxembourg***

13 Now that we have examined the poorest countries, we can begin to compare them to
14 the wealthiest in the world. Luxembourg is located in Western Europe between France and
15 Germany. It is the richest country in the world and has a population of 484,413 (2006
16 estimate) (3). The life expectancy is 79 years, which is quite high compared to the countries
17 previously mentioned (3). They also have a low infant mortality rate of 5 deaths per 1,000
18 live births (3). These statistics are all quite favorable when compared to any of the poor
19 countries. The question is, are these encouraging circumstances due to economic stability
20 alone, or are there other factors playing a role? Luxembourg has not faced the environmental
21 or governmental issues that so greatly affect many poorer countries. They have a stable
22 government, economy, and living conditions (22).

23 Luxembourg has particularly high rates of cancers and cardiovascular disease (22).

1 This is not surprising considering that their diets are insufficient in fiber, polyunsaturated
2 fats, and carbohydrates (22). Their average fat intake is approximately 45% of total calories
3 (22). The main agricultural products include: wine, grapes, barley, oats, potatoes, wheat,
4 fruits, dairy products, and livestock (3). This is a much wider array of foods than is seen in
5 the poor countries that we examined. There are many people that do follow the
6 Mediterranean diet (22). Their style of cooking is very much influenced by France and
7 Germany (23). Most of their meals are simple and hearty, but when entertaining guests, it
8 becomes an all-out feast (23).

9 Unfortunately, there is not much data about micronutrient deficiencies in this country.
10 According to data compiled by UNICEF, Vitamin A and iodine are not issues in this region
11 (24, 25). However, it is estimated that almost 11% of the population have an inadequate zinc
12 intake (26). In Luxembourg, the problem is more of overnutrition than undernutrition, which
13 is seen by their high rates of chronic diseases such as cardiovascular disease (22).

14 While no studies could be found, a nutrient of concern in this country could be
15 Vitamin D due to their geographic location. People do not get enough ultraviolet exposure in
16 order to synthesize the Vitamin D they need year round, and since the food sources of
17 Vitamin D are limited, it is possible that they are not getting an adequate amount through
18 their diet either (27).

19

20 *Norway*

21 Norway is located in Northern Europe, and has a much larger population than
22 Luxembourg at 4,610,820 (2006 estimate) (3). Their infant mortality rate is even lower than
23 Luxembourg's, at 4 deaths/1,000 live births, and they have a high life expectancy of 80 years

1 (3). The main agricultural products are: barley, wheat, potatoes, pork, beef, veal, milk, and
2 fish (3).

3 Their diets are high in fat and salt because they consume large amounts of smoked
4 and salted foods (28). Fresh fruits and vegetables are only available for a few months of each
5 year (28). The staple foods include: potatoes, fish/seafood, mutton, cheese, cabbage, apples,
6 onions, berries, nuts, and bread (3). Dairy products are heavily consumed in this country
7 (28). Smorgasbords are common for lunch (28). They usually eat three meals per day plus a
8 coffee break (28).

9 These dietary habits have lead to a high incidence of hypertension, cardiovascular
10 disease, and stomach cancer (28). The high salt intake affects the incidence of both
11 hypertension and cardiovascular disease, as these two conditions are tightly intertwined.
12 High intakes of salted and smoked foods can increase risk for stomach cancer, which
13 explains why the prevalence is so high in this country (28).

14 A study done in Norway in 2005 revealed that 10-15% of women of childbearing age
15 were iron-deficient (29). The prevalence for the overall population is about nine percent
16 (29). The other main micronutrient of concern is Vitamin D, for the same reason that it could
17 be a problem in Luxembourg. Norway is so far north of the equator that people simply do
18 not get adequate sun exposure to meet the nutritional requirements.

19

20 ***United States***

21 The United States is the last of the countries to examine. The most current estimate
22 of the population is 298,444,215 from 2006 census data (3). This is higher than the other five
23 countries put together, therefore the percentages of deficiency are inclusive of a larger

1 number of people. Life expectancy in this county is about 78 years, and the infant mortality
2 rate is relatively low at 6 deaths/1,000 live births (2006) (3).

3 An important factor to consider is that the financial situation of the population is
4 much more variable in the United States, when compared to the other developed countries.
5 The United States is considered one of the richest countries: it is home to the richest man in
6 the world, as well as many other money moguls who hold a large percentage of the wealth in
7 the country (4). So while the GDP per capita is high, that does not necessarily mean that
8 most of the people in the country are well off. There are still millions of people in the United
9 States that are starving and/or are malnourished (30). It is important to consider that some
10 are malnourished not due to lack of food, but personal choice. The idealized perception that
11 women should be skinny as possible leads many to choose to deprive themselves of many
12 essential nutrients. The popularity of competitive sports in the United States, and the
13 pressure athletes feel to succeed can cause them to purposely restrict food intake in order to
14 obtain the weight or body shape that is expected for their sport. There are also many who
15 display the over-nourished/malnourished paradox, where energy intake is high, but
16 micronutrient intake is low. So while they may be consuming more-than-adequate calories,
17 they are still considered malnourished because they are not getting all the nutrients they need.
18 There is also a high rate of immigrants from underdeveloped countries that bring
19 micronutrient deficiencies with them. All of these circumstances have led to major
20 micronutrient deficits in one of the richest countries in the world, which mimic those of the
21 poor countries.

22 According to data collected in 1994 to 1996, 56% of the population was not meeting
23 the RDA for Vitamin A, 39% was not meeting the RDA for iron and 73% was not meeting

1 the RDA for zinc (31). These percentages translate into 167,128,760; 116,393,243; and
2 217,864,277 people respectively. These numbers have likely changed since then, but it still
3 shows that these nutrients are of major concern. Other common deficiencies included
4 calcium, magnesium, and Vitamin B6 (31).

5 In the United States, as the pace of society has picked up, convenience foods have
6 become the trend. This includes fast foods, frozen dinners, condensed soups, and other
7 ready-made foods. Many of these foods are high in macronutrients such as fat and sugar, and
8 low in micronutrients. This has led to the over-nourished/malnourished paradox. So, while
9 the food supply is adequate, people are not choosing foods that contain the nutrients they
10 need. This raises a new question: what are the major food sources of these nutrients, and are
11 they actually available to the general population in not only the United States, but also the
12 other countries that have been discussed?

13

14 **SPECIFIC NUTRIENTS**

15 *Vitamin A*

16 The major food sources of Vitamin A include liver, fortified milk, dark green leafy
17 and yellow orange vegetables, and fruit (i.e. carrots, spinach, greens, OJ, and sweet potatoes)
18 (27.) In the impoverished countries, these foods are often not available. While many of
19 these foods could be grown, the environment in many countries does not allow for it either
20 due to wars or famine. In developed countries such as the United States, there are so many
21 other foods to choose from, many people simply do not consume them. Not all countries
22 have fortified milk. In some countries, they only have access to these fruits and vegetables
23 during a few months of the year when they are in season. The United States has a unique

1 situation, in that it has access to most foods year round; however when these foods are not in
2 season, they are often times expensive, and do not taste the same. For this reason, many
3 people do not consume them year-round even if they are available. A tree-ripened orange is
4 not the same as one that has been picked early for shipping purposes.

5 Another issue with Vitamin A is that it is a fat soluble vitamin (32). Therefore if fat
6 intake is inadequate, the consumed vitamin A will not be absorbed because it requires a
7 certain amount of fat to trigger the process. This becomes especially important in poor
8 countries, where many of them are not even getting enough calories as a whole, and fat
9 intake is often inadequate. This is a dual-problem: the food-sources of this vitamin are both
10 frequently unavailable, and also often impossible to absorb due to the lack of fat. This helps
11 to explain the high level of Vitamin A deficiency in underdeveloped countries.

12

13 *Iron*

14 The next major nutrient of concern is iron. The main food sources are: liver, oysters,
15 seafood, kidney, heart, lean meat, poultry, dried beans, vegetables, egg yolks, dark molasses,
16 whole grain, and enriched breads and cereals (27). Many of the rich sources of iron are the
17 organ meats, which are not commonly consumed in most cultures or are simply not available.
18 Many of the impoverished countries do not have access to animal products at all, other than
19 maybe fish or seafood if the country is located on a coastline. Most of the populations that
20 are iron-deficient are women (32). Due to significant monthly menstrual blood loss in
21 women, it is constantly a challenge to keep up with the iron requirement, even if iron-rich
22 foods are available. Also, iron is not the most bioavailable nutrient, which means that even if
23 these foods are consumed, the iron may not be absorbed (32). Iron is most readily absorbed

1 from meat products, which are not always available in underdeveloped countries (32). In
2 other parts of the world, vegetarianism is commonplace, and therefore there are many that
3 choose not to consume animal products. Fortunately, many of these people have higher
4 levels of fruit and vegetable consumption, which can compensate for the unavailability of
5 iron in plant sources. However, if the person is not adequately informed about following a
6 balanced, healthy vegetarian diet, it may be a problem if they simply start eliminating animal
7 products from their diet.

8

9 *Zinc*

10 Zinc is the next nutrient of concern. The main food sources are: meat, fish, poultry,
11 milk, shellfish, cheese, whole grain cereals, dry beans, nuts, and soy (27). Most come from
12 animal products, which are unavailable in impoverished countries. Oysters have the highest
13 zinc content of any food (33), but how many cultures eat them on a regular basis? But the
14 under-consumption of zinc-containing foods is not the only cause for deficiency. There are
15 nutrients like iron, calcium, Vitamin D, fiber, and phytates in cereal that can bind zinc,
16 causing it to be less available (33). So, even though the United States consumes plenty of
17 meat products that would contain zinc, it competes with these other nutrients that prevent
18 absorption. While foods like meat and oysters contain zinc, they also contain a significant
19 amount of iron (27).

20

21 *Iodine*

22 The main source of iodine is iodized salt. However seafood does contain some (27).
23 The iodine content is somewhat variable in milk and eggs (27). Unfortunately, iodized salt is

1 not available in all parts of the world (25). Many of the underdeveloped countries do not
2 have access to it, and other foods do not contain enough to prevent goiters and cretinism.
3 Iodine is a unique nutrient in that it is a major problem worldwide, but only in
4 underdeveloped countries, unlike Vitamin A or iron, which are problems in many countries,
5 independent of economic status. The development of iodized salt has greatly decreased the
6 incidence of iodine deficiency; (25) and the expectation is that it will continue to do so due to
7 fortification programs that have been put in place (25). In the meantime, however, it is still a
8 significant problem.

9

10 SOLUTIONS

11 By examining these six countries it has become evident what major nutritional
12 deficiencies exist. Apparently, these deficits can exist not only in underprivileged countries,
13 but also in wealthy countries even if for different reasons. By looking at each nutrient found
14 to be deficient, it was possible to explain potential causes for deficiency. So now that we
15 know what nutritional deficiencies exist, and what is causing them, it is crucial to ask
16 ourselves: *what can we do about it?* Unfortunately this is a question without any easy
17 answer, because the problem is multifactorial.

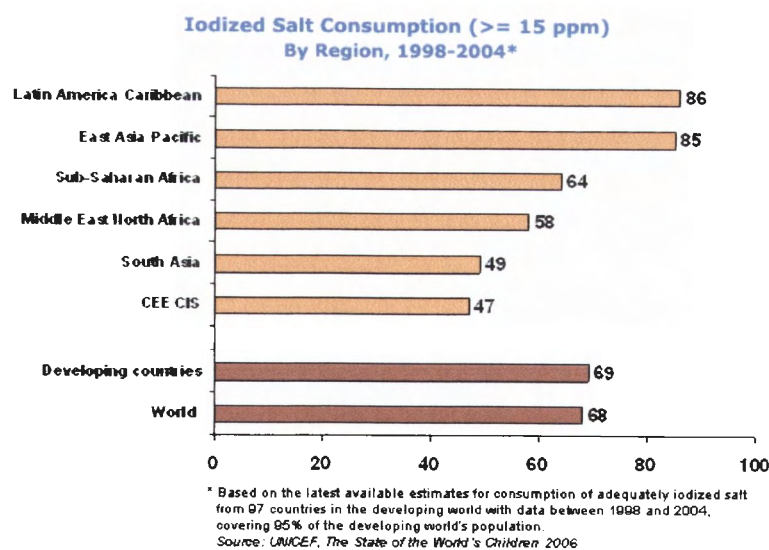
18 For Vitamin A there are some feasible solutions. One that has already been started is
19 large doses of Vitamin A supplementation in developing countries (24). Since Vitamin A is
20 a fat-soluble vitamin, large doses can be stored, making it available even during periods of
21 inadequacy. Another solution is to fortify the available food supply (24). Golden rice has
22 been genetically modified to contain Vitamin A; other foods that could be fortified include
23 sugar, milk, margarine, infant foods, and various types of flour (24). Lastly, providing

1 developing countries with a Vitamin A rich food supply could help to improve matters (24).

2 Some interventions have already been started.

3 For Iodine, the main solution is to make iodized salt more widely distributed and
 4 accessible (25). Great progress has been made in this area, but more is needed (25). For
 5 example, in Sierra Leone Iodine deficiency was reduced from 97% in 1992 to 37% in 2003.
 6 While there are other types of foods that could be iodized, salt is relatively inexpensive and
 7 widely consumed (25). There are still areas like Southeast Asia, where less than half the
 8 population are consuming an adequate amount of iodized salt. Figure 2 shows iodized salt
 9 consumption sorted by regions of the world. According to this UNICEF report, only 69% of
 10 developing countries consumed an adequate amount of iodized salt, which means we still
 11 have a long way to go (25).

12



13

14 **Figure 2.** Iodized Salt Consumption by Region

15

1 Zinc and iron deficiencies are more difficult to solve. For some, iron
2 supplementation may be required in order to improve conditions. For others, it may simply
3 be enough to educate the population on what foods are high in iron. However, it is important
4 to make sure that iron supplements and/or high-iron foods are not consumed in the same
5 meal containing high amount of zinc. This is because these two minerals have a negative
6 interaction (27). Zinc supplementation may also be required in some populations.

7

8 **CONCLUSION**

9 Despite economic differences, there is work to be done worldwide in the area of
10 nutrition intervention. Many people suffer needlessly each day because they do not have the
11 basics for life. Many lives could be improved, or saved, by a little creativity and effort on the
12 part of nutrition professionals and other concerned experts. So the most important question
13 we can ask ourselves is: what are we willing to do to make a difference?

14

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