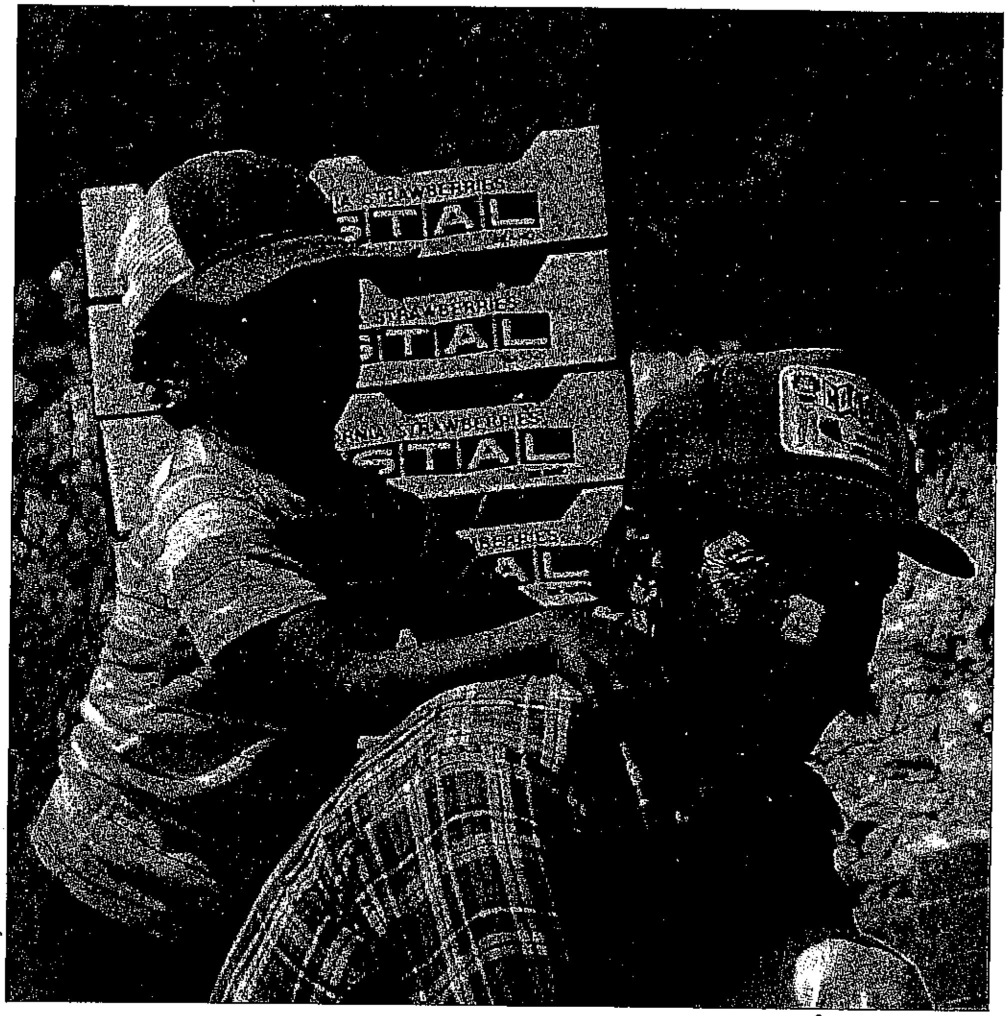
▶ Children, the elderly, low-income people and farmworker families, *right*, may be particularly vulnerable to environmental toxicants, such as pesticides.



Jack Kelly Clark

Young children and elderly people are at great risk of poor nutrition. In a study of low- and high-income young children, we found that a large percentage of both groups, between 24% and 13%, had low intakes of calcium, iron and copper. Interestingly, the high-income children had greater deficiencies of several nutrients than the low-income children. Another study showed that many senior citizens consume diets providing less than two-thirds of the recommended dietary intakes of some essential vitamins and minerals. Further, animal experiments and human studies indicate that nutritional status can influence an individual's susceptibility to environmental toxicants including air pollutants, food contaminants, heavy metals and pesticides. For example, dietary antioxidants are known to aid in the metabolism of organophosphate pesticides; but low-income farmworkers and their children, who are at greater risk of pesticide exposure, often do not consume enough fruits and vegetables with these important nutrients. Likewise, children and adults with iron-deficiency anemia absorb more lead from their environments than those with adequate iron stores. Conversely, good nutrition at all life stages can decrease susceptibility to adverse effects of toxicants. Additional studies on the interactions between diet and chemical exposure in humans will be needed in the future.

Nutrition may influence toxicant susceptibility of children and elderly

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During the past decade, awareness has increased of the critical role that nutrition plays in modulating an individual's susceptibility to environmental toxicants, including air pollutants, food contaminants such as aflatoxin, heavy metals and pesticides. This interest is based on results from both animal experiments and human studies (Sinclair 2000; Bannerjee 1999; Oteiza et al. 1999; Hackman and Hurley 1983).

This area of research has received particular attention from scientists as it relates to the influence of nutritional status on women's response to toxicants that can cause birth defects (Keen et al. 1997). Indeed, during the past few years, a consensus has been emerging that consuming essential nuwere less than two-thirds of the RDA in 76% of the high-income children, compared to 60% of the low-income children. This was due in part to lower intakes of meat among the high-income children, because their parents perceived meat-heavy diets as unhealthy and a source of excess dietary fat. Nutritionists and public-health professionals often encounter such difficulties as they try to define "optimal" diets. Specifically, a diet that is low in fat (presumably of value with respect to the prevention of cardiovascular disease) may also be low in important essential micronutrients.

Furthermore, 24%, 22% and 20% of the low-income children had intakes of calcium, iron and copper, respectively, that were less than two-thirds of the FNB's recommended levels. Similarly, for the high-income group, 19%, 13% and 16% of the children had low intakes of calcium, iron and copper, respectively. Therefore, a large proportion of children may be at risk for essential micronutrient deficiencies independent of their socioeconomic status.

Assuming that the FNB's recommended intake values are appropriate, essential nutrient intakes for many individuals are clearly inadequate. There is a remarkable dearth of information concerning how these marginal intakes influence an individual's ability to either respond to, or recover from, exposure to toxic xenobiotics (foreign chemicals) or other natural stressors such as ozone, pollutants and several medications. The need for such studies is particularly acute for young children, given their high risk for nutrient deficiencies and their vulnerability to environmental contaminants.

Biochemical assessments can determine if low intakes of certain micronutrients are associated with abnormal blood biochemistry. In the same study, mean hemoglobin, hematocrit and plasma ferritin values were similar among the high- and low-income children (table 1). However, 17% of the children had hemoglobin and hematocrit values that were below the U.S. Centers for Disease Control and Prevention (CDC) cutoffs. Using a cutoff of 10 micrograms per liter for ferritin, 8% of the children studied were classified as at risk for low iron stores. Mean plasma iron, zinc and copper concentrations were lower in the high-income group than in the low-income group. Hypozincemia — defined as a plasma zinc concentration less than 10.4 micromolars — was observed in 46% of the high-income and 13% of the low-income children. The data demonstrate that the marginal dietary intakes of zinc and iron observed in the children are functionally significant.

Blood lead concentrations, also determined for the children in this study, ranged from less than 5 to 14 micrograms per deciliter (Zidenberg-Cherr et al. 1996). Encouragingly, only 2% of the children in the high-income group had blood lead in excess of 5 μg/dL, but 25% of the children in the low-income group had values exceeding this level. While only two of the children studied had blood lead levels that exceeded the current CDC action level of 10 μg/dL, the fact that the larger proportion of children in the low-income group had blood lead levels between 5 and 10 μg/dL is of concern; it demonstrates that children in this group have a greater exposure to lead compared to higher socioeconomic groups.

Regrettably, marginal nutritional deficiencies still occur in wide segments of our society. Based on extensive experimental data, we know that deficiencies can result in an increased risk for a number of toxicants.

TABLE 1. Mean levels of biochemical status indicators for iron, zinc and copper, and percentage of children falling below standard cutoffs, by income level

Status measure	Lower income	Higher income
	mean ± sd	
Ferritin (μg/L)	27.7 ± 16.7	24.3 ± 15.0
Hemoglobin (g/L)	117.1 ± 8.3	119.4 ± 7.4
Hematocrit (%)	34.6 ± 2.3	34.9 ± 2.2
Plasma iron (μM)	20.0 ± 7.6	16.5 ± 6.6
Plasma zinc (μM)	12.7 ± 2.1	10.5 ± 2.4†
Plasma copper (μM)	21.0 ± 3.1	19.3 ± 3.0‡
	% falling below cutoffs	
Low hemoglobin/hematocrit§	18.9	13.6
Low ferritin¶	8.9	6.5
Low plasma zinc#	12.8	45.7†

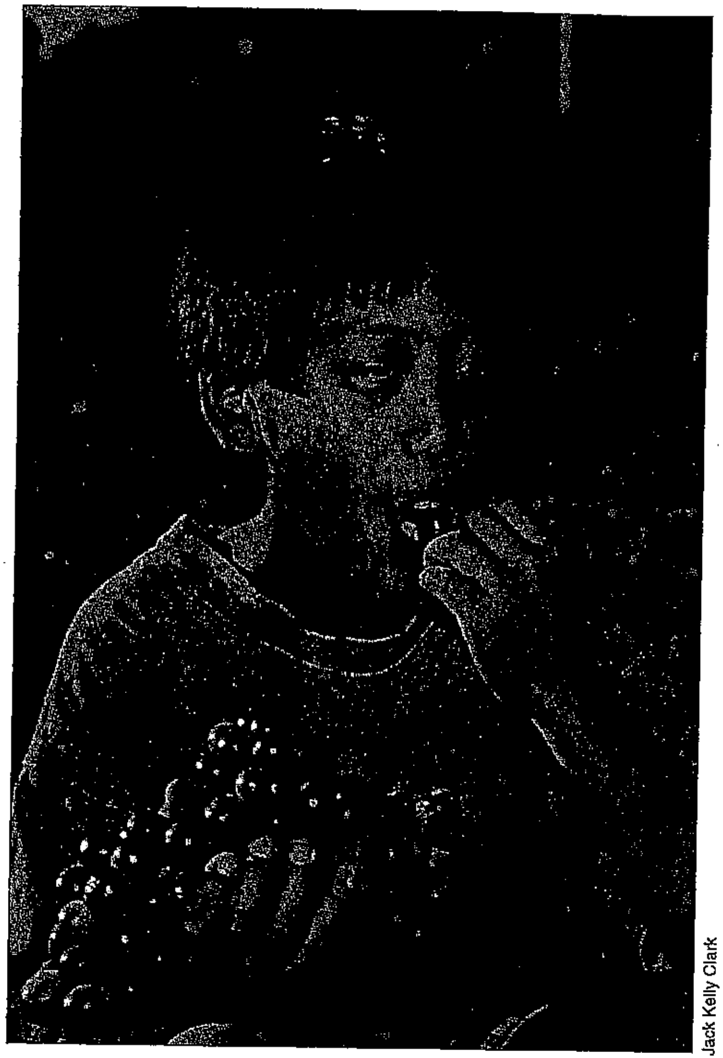
*Mean or proportion is significantly different by income ($P < 0.05$)
†Mean or proportion is significantly different by income ($P < 0.001$)
‡Mean or proportion is significantly different by income ($P < 0.01$)
§Hemoglobin less than 110 g/L for age 1 year and less than 112 g/L for age 2–4 years; hematocrit less than 33% for age 1 year and less than 34% for age 2–4 years.
¶Ferritin less than 10 μg/L.
#Plasma zinc less than 10.4 μM.

Nutritional status of elderly

In addition to children, other age groups such as the elderly can also be characterized by inadequate diets (Roe 1992; Cohen and Ralston 1993; Dickenson et al. 1993; Koughan and Atkinson 1993; Neyman et al. 1998). Using multiple 24-hour recalls and a culturally sensitive food-frequency questionnaire, we examined the dietary intakes of Hispanic senior citizens. We recruited 80 Hispanic men and women ages 60 to 93 years who were either participating or not participating in congregate-site meal programs from senior centers and other senior organizations in Kern and Fresno counties. The results showed that a large proportion of seniors consume diets that provide less than two-thirds of the FNB's recommended in-

TABLE 2. Percent of Hispanic seniors with intakes less than 2/3 of NAS Food and Nutrition Board's recommended levels

Nutrient	%
Folate (μg)	19
B6 (mg)	36
B12 (μg)	11
Vitamin A (μg RE)	28
C (mg)	24
E (mg TE)	55
Calcium (mg)	38
Iron (mg)	9
Magnesium (mg)	38
Zinc (mg)	60



Jack Kelly Clark

Even children of parents who believe they are providing a healthy diet may not attain optimal nutrition. The authors found that children of higher socioeconomic status did not necessarily have better diets than low-income children.

is true for university researchers as well as for government agencies such as the U.S. Environmental Protection Agency, CDC and NIH. It is reasonable to speculate that in the near future, committees will likely be asked to construct dietary recommendations that are applicable to specific at-risk populations. For example, if high intakes of dietary antioxidants reduce an individual's risk for heavy metal or pesticide poisoning, it might be prudent to suggest an increased vitamin E or vitamin C requirement for exposed populations. This type of logic has already been advanced for vitamin C in that the recommended intake for this nutrient is increased for individuals who smoke.

In a similar vein, if subtle differences in the dietary intake of a nutrient markedly modulates the risk for some disease (or the susceptibility to various toxicants), it suggests that there should be an increased emphasis on the study of the nutritional status of high-risk populations. If such studies in turn demonstrate that certain populations have a higher than normal risk for suboptimal diets, new intervention plans aimed at correcting these deficits will be needed. For example, if it is demonstrated that children in migrant farmworker families are at greater risk of deficiencies of antioxidants such as vitamin E, special efforts could be made to increase vitamin E intake of those children. However, without adequate funds to conduct controlled studies, we will not have the answers necessary to make such recommendations. Such efforts could include more focused intervention programs that incorporate supplementation with vitamin E and comprehensive nutrition education programs to ensure optimal intake of the nutrients at risk.

Complicating matters is the growing awareness of the critical role that genetics can play in modulating an individual's response to toxicants, as well as to nutritional deficiencies. It will be difficult in the future to make broad recommendations for entire population groups. In place of general recommendations, there will be an increasing demand by the public for individualized dietary recommendations. The consideration of the work and living environment of the individual is bound to play an increasing role in the determination of an individual's "recommendations."

The University has an obligation to its constituency to make them aware of ongoing research in this area. An efficient and effective way of reaching the greatest number of people is through the delivery of information through educators who are trained in and understand, the scientific method. A few years ago nutrition professionals often stated that "you can get all the nutrients you need from food," but now scientists must accept newly acquired knowledge that in some cases, diets can be optimized through food fortification and/or supplementation. Finally, we must begin dealing with the reality that people's requirements can differ significantly for certain nutrients, and we will have to develop new education and intervention programs that address this reality.

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Suzanne Paisley

While nutrition professionals have often said "you can get all the nutrients you need from food," new research is showing that this may not always be true. In the future, individualized dietary recommendations may be necessary, as well as greater reliance on food fortification, *above*, and dietary supplements for certain populations.

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