DNA damage from micronutrient deficiencies is likely to be a major cause of cancer.

"Mutation Research / Fundamental and Molecular Mechanisms of Mutagenesis"

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FROM ABSTRACT

A deficiency of any of the micronutrients: folic acid, Vitamin B12, Vitamin B6, niacin, Vitamin C, Vitamin E, iron, or zinc, **mimics radiation** in damaging DNA by causing single and double-strand breaks, oxidative lesions, or both. For example, the percentage of the US population that has a low intake (<50% of the RDA) for each of these eight micronutrients ranges from 2 to >20%. A level of folate deficiency causing chromosome breaks was present in approximately 10% of the US population, and in a much higher percentage of the poor. Folate deficiency causes extensive incorporation of uracil into human DNA (4 million/cell), leading to chromosomal breaks. This mechanism is the likely cause of the increased colon cancer risk associated with low folate intake. Some evidence, and mechanistic considerations, suggest that Vitamin B12 (14% US elderly) and B6 (10% of US) deficiencies also cause high uracil and chromosome breaks.

Micronutrient deficiency may explain, in good part, why the quarter of the population that eats the fewest fruits and vegetables (five portions a day is advised) has about double the cancer rate for most types of cancer when compared to the quarter with the highest intake. For example, 80% of American children and adolescents and 68% of adults do not eat five portions a day. Common micronutrient deficiencies are likely to damage DNA by the same mechanisms as radiation and chemicals. **This damage appears to be many times more important than the damage from radiation and chemicals**. Remedying micronutrient deficiencies should lead to a major improvement in health and an increase in longevity at low cost.

THE AUTHOR ALSO NOTES:

"Approximately 40 micronutrients (the vitamins, essential minerals and other compounds required in small amounts for normal metabolism) **are required** in the human diet."

"For each micronutrient, metabolic harmony requires an optimal intake (i.e. to give maximal life span); deficiency distorts metabolism in numerous and complicated ways, many of which may lead to DNA damage."

The recommended dietary allowance (RDA) of a micronutrient is based on acute effects because the optimum amount for long-term health is not known.

"For many micronutrients, a sizable percentage of the population is deficient relative to the current RDA."

The optimum intake of a micronutrient varies with age and genetic constitution, state of well being, and is influenced by diet.

"Micronutrient deficiency can mimic radiation (or chemicals) in damaging DNA by causing single and double-strand breaks, or oxidative lesions, or both."

"Chromosomal aberrations such as double strand breaks are a strong predictive factor for human cancer."

Micronutrient deficiencies that mimic radiation exposure are folic acid, B12, B6, niacin, C, E, iron, and zinc.

"The level of each micronutrient that minimizes DNA damage remains to be determined."

"Micronutrient deficiency is a plausible explanation for the strong epidemiological evidence that shows an association between low consumption of fruits and vegetables and cancer at most sites."

DIETARY FRUITS AND VEGETABLES AND CANCER PREVENTION

“Greater consumption of fruits and vegetables is associated with a lower risk of degenerative diseases including cancer, cardiovascular disease, cataracts, and brain dysfunction”. More than 200 studies show an association between low consumption of fruits and vegetables and the incidence of cancer.

“The quarter of the population with the lowest dietary intake of fruits and vegetables has roughly twice the cancer rate for most types of cancer (lung, larynx, oral cavity, esophagus, stomach, colon and rectum, bladder, pancreas, cervix, and ovary when compared to the quarter with the highest intake.”

“About 80% of American children and adolescents and 68% of adults do not meet the intake recommended by the National Cancer Institute and the National Research Council: five servings of fruits and vegetables per day.”

“Many components of fruits and vegetables may be responsible for their protective effect; such as micronutrients, plant phenolics, and fiber.”

Inadequate intake of micronutrients contributes to DNA damage, cancer, and degenerative disease.

“A major part of the protective effect of fruits and vegetables may be due to their micronutrient content.”

“Dietary deficiencies of micronutrients whose sources are not primarily fruits and vegetables, such as zinc, iron, niacin, Vitamin E, and Vitamin B12, also appear to contribute to DNA damage and are also common in the US population.”

FOLIC ACID

“Folate deficiency, a common vitamin deficiency in people who eat few fruits and vegetables, causes chromosome breaks in human genes.”

“Approximately, 10% of the US population are deficient at the level causing chromosome breaks in humans.”

“The mechanism of chromosome breaks has now been shown to be deficient methylation of uracil to thymine, and subsequent incorporation of uracil into human DNA (4 million/cell).”

“Both high DNA uracil levels and chromosome breaks in humans are reversed by folate administration.”

Folate supplementation above the RDA minimizes chromosome breakage.

“Folate deficiency has been associated with increased risk of colon cancer, and the 15 year use of a multivitamin supplement containing folate lowered colon cancer risk by about 75%.”

Folate and B12 deficiencies are associated with cognitive defects in humans and neurotoxicity in children.

Folate deficiency causes increased homocysteine accumulation, which has been associated with neural tube defects in the fetus and in heart disease, both of which could be eliminated by folate supplements or better diets.

Folate deficiency may be a major cause acute lymphocytic leukemia.

Folate is very important for male reproductive function.

VITAMIN B12

“The main dietary source of B12 is meat.”

“About 4% of the US population consumes below half of the RDA of Vitamin B12.”

“B12 would be expected to cause chromosome breaks by the same mechanism as folate deficiency.”

“If either folate or B12 is deficient, then homocysteine, a major risk factor for heart disease, accumulates.”

“The B12 deficiency is known to cause neuropathy due to demyelination and loss of peripheral neurons.”

VITAMIN B6

“About 10% of the US population consumes less than half of the RDA (1.6 mg/day) of Vitamin B6.”

Vitamin B6 intake is inversely associated with prostate cancer.

Vitamin B6 deficiency contributes to heart disease and supplementation reduces risk and levels above the RDA may be necessary to minimize risk.

Reduced Vitamin B6 is a risk factor for stroke and atherosclerosis.

“Diets low in Vitamin B6 are associated with brain dysfunction in children and adults.”

“Good sources of Vitamin B6 are whole grain bread and cereal, liver, bananas and green beans.”

“A major source in the US is fortified breakfast cereal and multivitamins.”

VITAMIN C

“About 15% of the population consumes less than half the RDA (60 mg/day) of ascorbate which comes from dietary fruits and vegetables.”

The new RDAs for Vitamin C is 90 mg/day for men, 75 mg/day for women and 35 mg more for smokers.

Supplementation with Vitamin C reduces oxidative damage to DNA, lipids, and proteins.

The blood cell saturation for Vitamin C is 100 mg/day, and this level minimizes DNA damage.

Cataracts are due to oxidation of lens protein, and antioxidants, such as Vitamin C, E and carotenoids, appear to protect against cataracts and macular degeneration of the eye.

Vitamin C supplements for 10 years or more reduces lens opacities by about 80%.

“Some studies suggest that Vitamin C protects against cancer, which would be plausible based on the mechanistic data.”

Vitamin C protects against oral cancer, stomach cancer, renal cancer, and pancreatic cancer.

Vitamin C supplementation reduces overall mortality in cardiovascular disease.
Smoking significantly depletes Vitamin C.

“Smoking is a severe oxidative stress, and the nitrogen oxides in cigarette smoke depletes antioxidants.”

Smokers must ingest much more Vitamin C than non-smokers.

“Smokers also have more chromosomal abnormalities in their sperm than nonsmokers.”

“Smoking by fathers may plausibly increase the risk of childhood cancer and birth defects.”

Acute lymphocytic leukemia, lymphoma, and brain cancer are each increased three to four-fold in offspring of male smokers.

“Maternal use of multivitamins lowers the risk of childhood cancer in offspring. In one study, the maternal use of vitamins throughout the pregnancy lowered the risk of brain tumors in the offspring by about half.”

“A multivitamin supplement (or a better diet) for both parents might markedly lower childhood cancer.”

The higher cancer rates associated with diets deficient in fruits and vegetables is due to increased DNA damage.

VITAMIN E

“Vitamin E, the major fat-soluble antioxidant, is consumed primarily from dietary vegetable oils and nuts.”

The RDA is 10 mg/day for men and 8 mg/day for women.”

“About 20% of the population consumes less than half of the RDA.”

Alpha-tocopherol and gamma-tocopherol have very different functions, and they complement each other.

Alpha-tocopherol is a powerful antioxidant, and protects the lipids in the cell membrane.

Gamma-tocopherol protects the DNA.

Gamma-tocopherol is also an anti-inflammatory agent.

Taking 200 IU/day of Vitamin E supplements lowers their risk for colon cancer.

Taking 50 IU/day of Vitamin E has marked protective effect on prostate cancer.

Vitamin E protects against brain dysfunction and deficiency leads to neuropathologies.

Vitamin E supplements of 100-400 IU reduce the risk of coronary heart disease by about 40%, as well as mortality from all causes.

“Vitamin E is regenerated by Vitamin C.”

Vitamin E from 70 to 560 IU lowered lipid peroxidation while a very high dose appeared to increase it.

“Both Vitamin E and selenium enhance the immune system”.

“Vitamin E supplementation of 200-400 units/day enhances human immunity.”

SELENIUM

“Selenium is important in enzymatic defenses against oxidants, and deficiency would be expected to lead to oxidative DNA damage.”

An RDA of 70 microg/day of selenium and an upper limit of 350 microg/day.

Selenium plays an important role in the prevention of cancer.

Prostate cancer incidence was reduced by two/thirds in the selenium-supplemented group (200 g/day).

NIACIN

“The main dietary sources of niacin include meat and beans.”

“About 2.3% of the US population consumes less than half the RDA of niacin.”

Tryptophan from protein can also provide niacin equivalents.

Niacin contributes to the repair of DNA-breaks.

IRON

“A major dietary source of iron is meat.”

The world has about two billion people who are iron deficient, mainly women and children.

“In the US, about 19% of women, aged 12-50, and about 7% of the population, ingest below 50% of the RDA; about nine million people have been estimated to be clinically deficient.”

“Iron deficiency, or iron excess, leads to oxidative DNA damage.”

“Iron deficiency in children is associated with cognitive dysfunction.”

“Low iron intake results in anemia, immune dysfunction, and adverse pregnancy outcomes such as prematurity.”

ZINC

“Major sources of zinc are meat, eggs, nuts, and whole grains.”

“About 18% of the US population consumes less than half the RDA for zinc (12 mg women, 15 mg men).” Mean daily vegetarians intake of 6.4 mg is insufficient.

“Zinc is a component of over 300 proteins, over 100 DNA-binding proteins with zinc fingers, Cu/Zn superoxide dismutase, the estrogen receptor, and synaptic transmission protein.”

Chromosome breaks are reported with a zinc deficient diet.

The offspring of zinc deficient mothers have increased chromosome breaks.

Zinc deficiency is a contributor to esophageal cancer in humans.

“Zinc is known to be an essential trace element for testicular development and spermatogenesis.”

Lower zinc concentrations are found in infertile men.

Zinc deficiency slows growth and development of the neonate.

“Zinc deficiency leads to alterations in brain development and growth.”

Maternal zinc deficiency leads to learning and behavioral disabilities in offspring.

Zinc deficiency leads to cognitive defects.

Mild zinc deficiency impairs the immune system.

“The incidence of respiratory infections in a group of institutionalized elderly was decreased by over two-fold when they were given a supplement of zinc (20 mg) plus selenium (100 mg).”

Very high doses of zinc (100-150 mg/day) had an adverse effect on the immune system.

KEY POINTS FROM Dr. DANIEL MURPHY’s REVIEW

(1) Deficiency of micronutrient can do more damage to our DNA as exposure to radiation or chemicals.

(2) The best source for most micronutrients is fruits and vegetables.

(3) Much of the population is deficient in micronutrients, relative to the current RDA.

(4) Magnitudes of greater than RDA levels of micronutrients are required to optimize metabolic harmony, to promote long-term health, and to give maximal life span.