

Zinc Deficiency Impact on Health and Preventive Strategies

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Current Science for Your Practice

This issue of Nutrition Perspective presents an overview of the current science on the far-reaching health consequences of mild zinc deficiency. Nutrition strategies to promote adequate zinc intakes among Canadians are highlighted.

See Inside for New Recommendations on Daily Zinc Intakes

News You Can Use on How Mild Zinc Deficiency Affects Health

Zinc is found in every living cell in the body. This trace mineral is essential for healthy growth and is required by enzymes involved in most major metabolic pathways.^{1,2} Zinc supports the body's immune system, influences the activity of many hormones and plays a key role in the synthesis of genetic material.^{1,2} The negative health consequences of mild zinc deficiency have been well documented by research in both industrialized and developing nations.^{1,2,3}

- Mild zinc deficiency can have adverse health effects on pregnancy outcomes, growth, cognition and immune function.^{1,2}

- Increasing intakes of zinc-rich foods, like lean beef, and understanding factors that affect bioavailability can help to improve zinc status.³
- Infants, young children, adolescent girls and older adults are particularly vulnerable to mild zinc deficiency.^{4,5}
- Vegetarians may need as much as 50% more zinc than people who consume meat, poultry and fish.¹

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ZINC STATUS OF CANADIANS

The *Food Habits of Canadians* study found that 23% of men and women (ages 18 to 65) had intakes below the Estimated Average Requirement for zinc.⁶ In the same study, 36% of men and 40% of women ages 18 to 65 did not meet the Recommended Daily Allowance for zinc.⁶ However, the ubiquitous nature of zinc and tight metabolic control have made it difficult to develop a test sensitive enough to diagnose mild zinc deficiency in practice. Supplementation trials have shown that mild zinc deficiency can negatively affect pregnancy outcomes, growth, cognition and immunity. Although research indicates that some Canadians

are vulnerable, mild zinc deficiency generally goes undiagnosed due to the lack of reliable clinical tests.

Nutrition Strategy to Increase Zinc Intakes

Meat and Alternatives are an important source of dietary zinc. Meat, poultry, fish and seafood are particularly rich in zinc and high quality protein that increases zinc absorption. A healthy eating plan that includes 2 to 3 servings of Meat and Alternatives and a variety of zinc-rich foods will promote adequate zinc intakes.

See page 6 for more on "Dietary Strategies to Increase Zinc Intakes"

Recommended Daily Intakes for Zinc¹

LIFE STAGE	AGE (Years)	ZINC (mg/day)	<i>Understanding Dietary Reference Intakes¹</i>
Infants	0-6 months	2*	<p>Recommended Dietary Allowance (RDA) – is set at a level that is expected to meet or exceed the needs of 97% of the population. While intakes below the RDA do not indicate inadequate intakes, they do suggest a greater risk of not meeting individual requirements.</p> <p>Adequate Intake (AI) – is provided instead of RDA when there is insufficient evidence to establish an Estimated Average Requirement (EAR). The AI is expected to meet or exceed the amount needed to maintain adequacy in all members of a specific healthy population.</p> <p>Estimated Average Requirement (EAR) – is the daily intake that is estimated to meet the requirements in half of apparently healthy individuals in a life stage or gender group. At this level of intake, half of those in the specified group would not have their needs met.</p> <p>Tolerable Upper Intake Level (UL) – is the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects for almost all individuals in a specified life stage and gender group. The general population should not routinely exceed the UL intake.</p>
	7 months-1 yr.	3	
Children	1-3	3	
	4-8	5	
	9-13	8	
Boys & Men	14 plus	11	
Girls	14-18	9	
Women	19 plus	8	
Pregnancy	14-18	13	
	19-50	11	
Breastfeeding	14-18	14	
	19-50	12	

**The figure for infants from zero to six month is an Adequate Intake (AI), all other figures are Recommended Dietary Allowances (RDA).*

Visit the National Academy Press website for the complete Dietary Reference Intake Reports:

www.national-academies.org/subjectindex/hea.html

PREGNANCY OUTCOMES

Healthy Fetal Development

Zinc plays a critical role in healthy fetal development. Research has shown that maternal zinc intake can impact fetal growth and birth weight.⁷ In women with low plasma zinc concentrations, zinc supplementation in early pregnancy has improved both birth weight and head circumference.⁸ Maternal consumption of zinc-rich foods from animal sources has also been associated with higher attention scores in

newborns.⁹ Zinc repletion during the first 8 weeks of life improved behavioural ratings in low-birth-weight infants when tested at one year.¹⁰

Pre - and Postnatal Immune Function

Insufficient zinc during pregnancy may be especially harmful for the development of the immune system.¹¹ Immune defects caused by prenatal zinc deficiency, such as depressed antibody production and lymphocyte proliferation, are not reversible by postnatal zinc administration and may even persist in subsequent generations.¹¹

Adequate zinc intakes during infancy may also be beneficial in preventing certain infectious diseases throughout childhood and into adulthood.¹²

Nutrition Strategy for Women and Healthy Pregnancy

Gestational zinc deficiency is a common problem throughout all cultures and socioeconomic levels.¹¹ Factors that can interfere with zinc absorption during pregnancy include supplemental iron, high phytate intakes from whole grains and legumes as well as gastrointestinal diseases.¹³ Women should be encouraged to eat plenty of zinc-rich foods during pregnancy, especially if they eat a lot of whole grains and legumes, restrict foods with high quality animal protein, such as meat, poultry, fish and seafood, or take an iron supplement.

GROWTH AND DEVELOPMENT

Achieving Adequate Zinc Intakes in Infancy

A review of common feeding practices indicates that early complementary foods are typically iron-fortified but low in zinc.¹⁴ Several studies have investigated the effects on iron and zinc status of including meat, poultry and fish as an earlier complementary food after 6 months. Results suggest that increased intake of meat, poultry and fish by breastfed infants older than 6 months would help to meet both iron and zinc requirements.¹⁴

Nutrition Strategy for Infants

The introduction of meat, fish and poultry as an early complementary food may help reduce the risk of both zinc and iron deficiencies in the second half of the first year. Infant feeding guidelines should highlight the inclusion of both iron- and zinc-rich foods, such as meat, as early as possible between 6 to 9 months following the introduction of iron-fortified infant cereal, vegetables and fruit.

Growth-Limiting Zinc Deficiencies

Marginal zinc status limits normal bone formation and growth in infants, children and adolescents.¹⁵ Researchers have found growth-limiting mild zinc deficiency in apparently healthy children in Canada

and the United States. In a Canadian study of short, but otherwise healthy boys, ages 5 to 7 years, zinc supplementation resulted in a significant improvement in growth.¹⁶ However, in practice, mild zinc deficiency usually goes undiagnosed due to the lack of reliable clinical tests.

Nutrition Strategy for Young Canadians

Young Canadians should be encouraged to eat 2 to 3 servings from the Meat and Alternatives group, especially zinc-rich foods. Those who restrict their intakes of red meat, fish and poultry are at higher risk of both zinc and iron deficiency, according to a Canadian study of adolescent girls ages 14 to 19.¹⁷

COGNITIVE FUNCTION

Children's Learning Ability

Zinc is essential for optimal cognitive development and functioning.¹⁸ Improved motor development, activity, attention and responsiveness have been observed in zinc supplementation trials conducted with infants.¹⁹ In a study of school age children (6 to 9 years old), zinc repletion was found to improve attention, reasoning, memory and psychomotor function.²⁰ In a similar study, school age children who received supplemental zinc demonstrated improved cognitive reasoning and took fewer trials to learn simple concepts.²¹ Since nutrients like iron also influence cognition, the correction of other micronutrient deficiencies may be required before the benefits of zinc repletion can be observed.²⁰

Adult Cognitive Performance

There is some evidence that mild zinc deficiency may also impair cognitive function in adults. Attention and performance on perceptual, memory and spatial tasks were impaired in healthy adult men as a result of mild zinc deficiency induced experimentally by feeding a low zinc diet for 35 days.²² Short-term visual memory improved in iron-deficient women taking 30 mg of zinc per day (either alone or with iron) in addition to a vitamin-mineral supplement.²³ No such improvement was seen with the vitamin-mineral supplement alone.²³ A positive correlation

between dietary zinc intake and cognitive function has also been observed in older adults aged 65 to 90 years.²⁴

IMMUNE FUNCTION

Zinc is Critical for Healthy Immune Systems

Zinc plays a critical role in the development and maintenance of healthy immune systems.²⁵ Zinc deficiency leads to impaired immune function and increased susceptibility to bacterial, viral and fungal infections.²⁵ Even mild zinc deficiency can result in immunological defects.²⁵ Zinc affects multiple aspects of the immune system, from the barrier of the skin to the regulation of genes within lymphocytes.²⁵ Antibody production, lymphocyte development and macrophage function are all compromised by zinc deficiency. Zinc is essential for the normal development and function of neutrophils and natural killer cells.²⁵ Zinc also functions as an antioxidant and helps to stabilize membranes.²⁵

Zinc Promotes Resistance to Infection

Research indicates that zinc promotes resistance to infection in children. A recent zinc supplementation trial in infants born small for gestational age concluded that zinc can result in a substantial reduction in infectious disease mortality.²⁶ Other studies in zinc-deficient children in developing countries have demonstrated that zinc supplementation reduces the incidence, duration and severity of diarrhea and acute lower respiratory infection.²⁷

Nutrition Strategy for a Healthy Immune System:

Enjoying zinc-rich foods as part of a balanced diet helps maintain a healthy immune system.

OLDER ADULTS

Adequate Zinc Benefits Older Adults

Zinc deficiency in the elderly may contribute to reduced resistance to infection, depressed taste acuity, poor appetite, anorexia and slow wound healing. Zinc supplementation in the elderly, for a period of one to two months, may decrease the

incidence of infection and improve survival rates following infection.²⁸ This highlights the importance of adequate zinc intakes to maintain health in older adults.

Marginal Zinc Status in Older Adults

One quarter of older Canadians participating in recent provincial nutrition surveys had zinc intakes below their Estimated Average Requirements.^{1,29,30,31} Older adults may be at increased risk of zinc deficiency due to medical conditions or due to food choices resulting in low dietary intakes. For example, the Ontario Health Survey found that 61% of adults 65 years and over ate less than the minimum recommendation of 2 servings of Meat and Alternatives daily.³² Similarly, the Quebec Nutrition survey found that more than half of the elderly women (aged 65 to 74) surveyed ate less than 2 servings of Meat and Alternatives daily.^{8,33}

Nutrition Strategy for Older Adults

It may be challenging for older adults eating fewer calories to meet zinc requirements. Adequate zinc intakes can be achieved by focusing on a healthy balance of nutrient-dense foods from Canada's Food Guide to Healthy Eating, such as, including 2 to 3 servings of Meat & Alternatives, particularly zinc-rich foods like lean red meats.

HOW DIETARY PATTERNS INFLUENCE ZINC STATUS

Dietary Factors that Enhance Zinc Absorption

Zinc is found in a wide range of foods including meat, poultry, fish, seafood, legumes and grain products. Red meats are particularly rich in zinc.³⁴ The amount and quality of protein in the diet influences the bioavailability of zinc. Zinc absorption from diets rich in high quality animal protein is generally greater than from diets rich in plant proteins such as soy.³⁴ Increasing the amount of meat in the diet improves the overall bioavailability of zinc.³⁵

Dietary Factors that Limit Zinc Absorption

Zinc absorption is inhibited primarily by phytates found in plant foods such as legumes, soy protein

and whole grains.^{1,3,36} Plant foods are an important part of healthy eating, but balancing them with high quality animal protein helps increase zinc absorption. High phytate-to-zinc ratios, found in plant-based diets high in unrefined whole grains and low in animal protein, are considered the major factor contributing to zinc deficiency around the world.³⁷ High intakes of iron at levels found in some supplements may also decrease zinc absorption.¹ Studies on calcium supplements show that some forms, such as calcium phosphate, may decrease zinc absorption, while others may not.¹

Red Meat Intake and Zinc Status

Recent research on how dietary patterns influence zinc status found that the mean serum zinc of red meat eaters was significantly higher than that of non-red-meat eaters.³⁸ A significant negative correlation between serum zinc and dietary phytate was also observed.³⁸ An analysis of the Quebec Nutrition Survey data found that zinc intake was highly correlated with beef consumption.³³

Vegetarian Diets and Zinc Status

Achieving adequate zinc intakes can be a particular challenge for those who restrict foods of animal origin.^{1,39} Children and adolescents consuming strict vegetarian diets may be especially vulnerable to zinc deficiency. A Canadian study of adolescent girls found suboptimal zinc status in

33% of those following a semi-vegetarian diet (eating red meat less than once a month, and eating only small amounts of poultry and fish), compared to 18% of those who ate red meat more regularly.¹⁷ In young women consuming a lacto-ovo vegetarian diet, zinc absorption was 35% less compared to non-vegetarian controls.⁴⁰ This was attributed to both a decrease in zinc intake as well as reduced absorption efficiency associated with the vegetarian diet.⁴⁰

Nutrition Considerations for Vegetarians

Vegetarians who limit high quality animal protein zinc-rich foods like meat, fish and poultry may need up to 50% more zinc.¹ Strict vegetarians, especially parents of vegan infants, should consult a registered dietitian regarding menu planning. Older vegan infants may need zinc supplements as well as reliable sources of iron and vitamins D and B₁₂.⁴¹

Other Conditions that Affect Zinc Status

Body stores of zinc can also affect the efficiency of zinc absorption. More zinc is absorbed when body stores are low.¹ Other conditions that can influence zinc absorption include malabsorption syndromes and gastrointestinal diseases such as Crohn's disease and short bowel syndrome.¹ Increased zinc excretion has been reported in patients with diabetes and alcoholism.⁴²

Foods with Zinc

More than 5.0 mg per serving	3.1 to 4.0 mg per serving	1.1 to 3.0 mg per serving	1.0 mg per serving or less
Oysters Most beef cuts Ground beef Liver (beef, lamb, veal) 	Most pork cuts Baked beans 	Lentils Kidney beans Mussels Shrimp Chicken, light and dark meat Cheddar cheese Yoghurt, plain Eggs Bran flakes Tofu 	Milk Peanut butter Tuna, canned Sole fillet Salmon Oatmeal, quick Rice, white and brown Corn flakes Spaghetti/macaroni Bread, whole wheat and white Most fruits and vegetables 

Based on serving sizes recommended by Canada's Food Guide to Healthy Eating, at: www.hc-sc.gc.ca/hppb/nutrition
 For Meats and Alternatives - 100 g cooked meat, poultry, fish, tofu; 250 mL legumes; 2 eggs.

Source: Canadian Nutrient File, 2001.

DIETARY STRATEGIES TO INCREASE ZINC INTAKES

1 Eat 2 to 3 servings of Meat and Alternatives daily — Follow *Canada's Food Guide to Healthy Eating*: www.hc-sc.gc.ca/hppb/nutrition

2 Choose Nature's Best Sources of Zinc More Often — Select plenty of foods that are naturally rich in zinc like lean red meats such as beef.

3 Increase Zinc Absorption with High Quality Protein — Include high quality animal protein with meals to increase overall zinc absorption. Add lean meat, poultry, fish and seafood to pasta dishes, stir fries, chilli, soups, sandwiches, wraps, and salads.

For your client, "Zinc & Your Health" fact sheet is available at 1-888-248-2333. To download copies visit the order centre at www.beefinfo.org.

ZINC SUPPLEMENTATION

Zinc Supplementation Is Seldom Recommended

Most people can meet their daily zinc requirements by choosing a variety of zinc-rich foods as part of a balanced diet. In cases of zinc deficiency, supplementation may be required on a short-term basis in addition to increasing intakes from zinc-rich foods. A recent meta-analysis concluded that despite numerous randomized trials, evidence is still lacking for the effectiveness of zinc lozenges in reducing the duration of common colds.^{1,43} Unnecessary supplementation can contribute to nutrient imbalances by interfering with the absorption of other nutrients from foods.¹ For example, zinc supplementation may interfere with copper status.¹ Adverse effects associated with chronic use of supplemental zinc include suppression of immune responses and decreases in HDL (high density lipoprotein) cholesterol.¹ Zinc toxicity, although very uncommon, may occur with prolonged use of zinc supplements.¹ The Tolerable Upper Intake Level for adults is 40 mg of zinc per day.¹



Questions about beef? Visit www.beefinfo.org or call 1-888-248-BEEF or contact your local Beef Information Centre in Vancouver, Calgary, Regina, Winnipeg, Mississauga, St. Laurent or Bedford.

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ZINC & Your Health

Consumer Fact Sheet

Zinc is essential for growth, strong immune systems and healthy pregnancies. Enjoying zinc-rich foods can help you get the zinc you need for good health.

GOOD FOR GROWTH

Infants, children and teens rely on zinc for healthy growth.



STRONG IMMUNE SYSTEMS

Your immune system depends on zinc to help fight infections.



FOOD FOR THOUGHT

Zinc may affect children's learning and adult mental performance.



HEALTHY PREGNANCIES

Moms-to-be need more zinc to meet baby's needs plus their own.

It's a good idea to always consult a registered dietitian or doctor before taking any supplements. Visit the Dietitians of Canada website to "Find a Dietitian" in your area for more individual advice on healthy eating: www.dietitians.ca

See How Much Zinc You Need Recommended Dietary Allowances

LIFE STAGE	AGE (Years)	Zinc (mg/day)
Infants	7 months-1 yr.	3
Children	1-3	3
	4-8	5
	9-13	8
Boys & Men	14 plus	11
Girls	14-18	9
Women	19 plus	8
Pregnancy	14-18	13
	19-50	11
Breastfeeding	14-18	14
	19-50	12

Extra Special Attention!

Everyone needs zinc, but young children, teen girls and older adults are especially vulnerable to mild zinc deficiency. Vegetarians who limit zinc-rich foods, like meat, poultry, fish and seafood, may need up to 50% more zinc.

Easy Ways to Get the Zinc You Need!

1 FOLLOW CANADA'S FOOD GUIDE TO HEALTHY EATING:

Enjoy a variety of foods each day. For a copy of *Canada's Food Guide to Healthy Eating*, contact your local health department or visit Health Canada at: www.hc-sc.gc.ca/hppb/nutrition

2 EAT 2 TO 3 SERVINGS OF MEAT & ALTERNATIVES EACH DAY

The Meat & Alternatives group includes some of the best sources of zinc. Keep in mind that a serving of meat is about the size of a deck of cards.

3 CHOOSE NATURE'S BEST SOURCES OF ZINC MORE OFTEN

Select plenty of foods that are naturally rich in zinc like lean red meats such as

beef. Use the *Foods with Zinc* list to help you choose zinc-rich foods.

4 INCREASE ZINC ABSORPTION WITH HIGH QUALITY PROTEIN

High quality protein from animal sources helps your body absorb more zinc. Add lean meat, poultry and fish to pasta dishes, stir fries, chili, soups, sandwiches, wraps, and salads to increase your overall zinc absorption.

5 BE AWARE THAT PLANT FOODS CAN LIMIT ZINC ABSORPTION

Plant foods are important for healthy eating, but phytates found in whole grains, soy products, lentils, dried peas and beans and other plant foods limit zinc absorption. Balance plant foods with animal protein to get more zinc.

Foods with Zinc

More than 5.0 mg per serving	3.1 to 4.0 mg per serving	1.1 to 3.0 mg per serving	1.0 mg per serving or less
Oysters Most beef cuts Ground beef Liver (beef, lamb, veal) 	Most pork cuts Baked beans 	Lentils Kidney beans Mussels Shrimp Chicken, light & dark meat Cheddar cheese Yoghurt, plain Eggs Bran flakes Tofu 	Milk Peanut butter Tuna, canned Sole fillet Salmon Oatmeal, quick Rice, white and brown Corn flakes Spaghetti/macaroni Bread, whole wheat and white Most fruits and vegetables 

Based on serving sizes recommended by *Canada's Food Guide to Healthy Eating*, at:

www.hc-sc.gc.ca/hppb/nutrition

For Meats and Alternatives - 100 g cooked meat, poultry, fish, tofu; 250 mL legumes; 2 eggs.

Source: Canadian Nutrient File, 2001.

Zinc Supplements are Seldom Recommended

Most people can get enough zinc by enjoying a variety of zinc-rich foods as part of a balanced diet. The effect of zinc lozenges on the length of the common cold is still not clear. However, long-term use of zinc pills may weaken your immune system, lower HDL (good) cholesterol and interfere with iron absorption.



This nutrition resource is brought to you by the registered dietitians at the Beef Information Centre.

Questions about beef? Visit www.beefinfo.org or call 1-888-248-BEEF or contact your local Beef Information Centre in Vancouver, Calgary, Regina, Winnipeg, Mississauga, St. Laurent or Bedford.

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