



NUTRITION AND IMMUNE HEALTH: CONSIDERATIONS FOR ATHLETES



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OVERVIEW

- Functions of the immune system
- Discuss dietary constituents needed for immune support
- Describe lifestyle factors associated with immune health
- Review key nutrition education concepts to best promote health and immune function



Support vs Boost

Physiological Support of Immunity

Dietary strategies
Energy & protein
Vitamins & minerals from food

Adequate sleep
Limit alcohol
Strategic supplementation



Immune Boosting

A marketing term for supplements

The immune system can only be “boosted” if there is a nutrient deficiency or lifestyle alternation leading to immunosuppression

IMMUNE FUNCTION & ATHLETES

Why infection is incompatible with success in elite sport.

- Medal winners suffer fewer and shorter URI
- Infection is the 2nd most common reason to present to a team medic, after injury
- Sickness correlates negatively with training volume
- Illness accounts for 1/3 of all lost training days
- 2/3 of illnesses result in “time loss” from training and competition; 1/3 of illnesses result in “performance restriction”
- Recent below-the-neck symptoms increases the likelihood of not finishing an endurance event
- Heavy exercise can extend an ongoing infection
- Heavy exercise during infection, or after incomplete recovery, can lead to medical emergencies ...
 - Rhabdomyolysis¹
 - Myopericarditis²
 - Exertional heat stroke

SSE#198



IMMUNE FUNCTION & ATHLETES

Ten risk factors for infection in athletes.

1. Autumn and winter — common cold and flu season
2. Poor hygiene and exposure to sick people
3. Recent symptoms
4. Air travel
5. Life stress, depression and anxiety
6. Low energy availability
7. Poor sleep
8. Increases in training load, e.g., training camp
9. National vs. International level
10. Low mucosal immunity (saliva/tear immunoglobulin-A)

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SEVERE CALORIE RESTRICTION

Protein Calorie Malnutrition

- Increases risk of infection

Severe Energy Restriction

- Increased stress hormones (cortisol)
- Impacts immunity

Most athletes don't have a severe restriction but may have low energy.

Paradoxically, athletes with frank anorexia nervosa do not have immunosuppression unless the condition is severe.



LOW ENERGY AVAILABILITY (LEA) & INFECTION



~50%

URI illness reported by athletes during training & competition

~40%

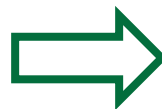
Elite female athletes experiencing LEA (via LEAF-Q)

4-8x

Risk of URI in female athletes with LEA



Identifying athletes at risk for LEA may be helpful to assess illness risk in team sports.



Restrictive eating, fasting and strict diets may be a risk factor for illness.



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**CARBOHYDRATE
INTAKE IS
RELATED TO THE
IMMUNE
FUNCTION OF
AN ATHLETE**

COSMED
Pulmonary Function Equipment

T20

SUBOPTIMAL CARBOHYDRATE

Suboptimal carbohydrate may alter the immune response to exercise



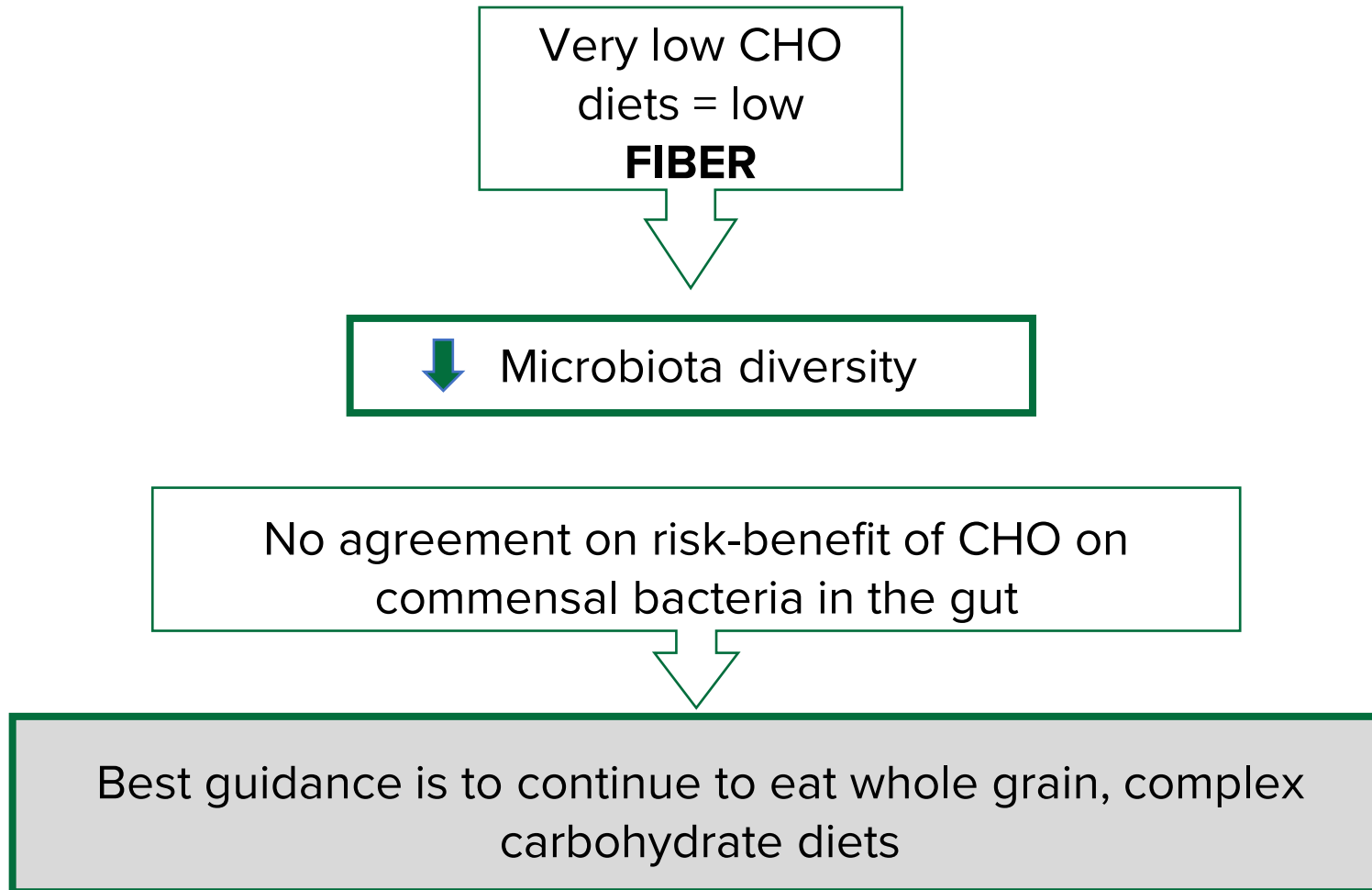
Exercising on a low CHO diet (<10% of calories) elevates stress hormones and may cause a fall in white blood cells.



Consuming 30-60 grams of CHO *during* exercise can prevent a decrease in T-lymphocytes as well as the reduction of stress hormones.

Adequate CHO is essential for proper immune function and levels of stress hormones.

SUBOPTIMAL CARBOHYDRATE



(High saturated fat diets can also alter gut bacteria ratios)

FIBER REQUIREMENTS



39 g/d



25 g/d

14 g per 1000 calories

Increase gradually!

The average American only eats 10 - 13 g/d!

FIBER CONTENT OF FOODS (G/SERVING)

**9-
14 g**

High fiber bran cereal

9.6 g

Navy beans

5-9 g

Shredded wheat

8.1 g

Chickpeas

7.8 g

Lentils, cooked

7.5 g

Black beans, cooked

**4.9 –
5.5 g**

Wheat bran flakes

5.5 g

Pear, medium

5.2 g

Pumpkin seeds

5.2 g

Edamame, shelled

5.0 g

Avocado

4.4 g

Apple, medium

4.1 g

Chia seeds

3.8 g

Sweet potato (w skin)

3.6 g

White potato (w skin)

2.6 g

Quinoa

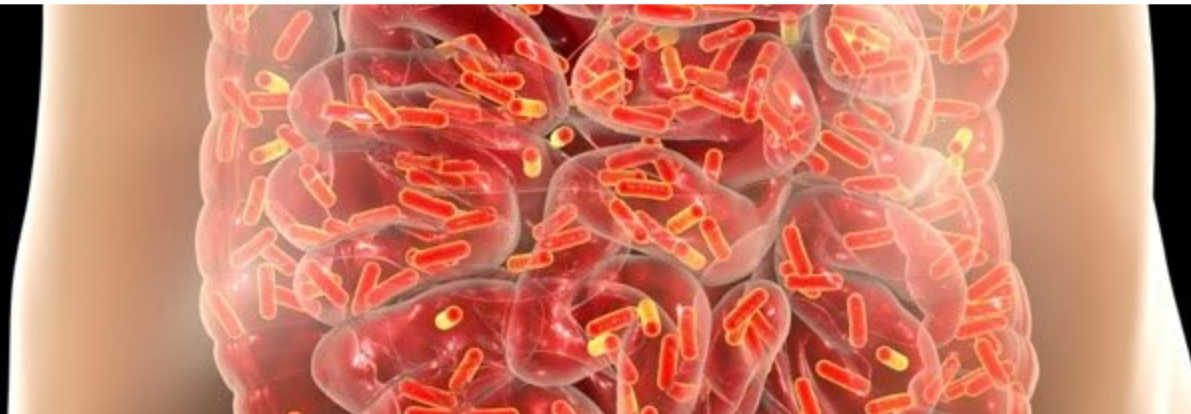
THE GUT MICROBIOME & IMMUNE HEALTH

Microorganisms on/within the body:

Short chain fatty acids (SCFA) result when gut bacteria work on undigested CHO.

SCFA from high fiber have been shown to reduce the inflammation in the colon and dampen allergic airway disease.

Diets should be rich in fiber and prebiotics; the food needed for probiotic survival.



PROBIOTIC & PREBIOTIC CONTAINING FOODS

Probiotic-Containing Foods

Yogurt

Kefir

Sauerkraut (refrigerated)

Pickles (refrigerated)

Kimchi

Tempeh

Miso

Prebiotic-Containing Foods

Asparagus

Banana

Barley

Beets

Chicory

Garlic

Honey

Onion

Tomato

Rye

Soybean

Wheat

Cow's Milk

Peas

Beans

Seaweed

Microalgae

Jerusalem Artichoke

PROBIOTICS

Probiotics can bolster the gut barrier and prevent bacterial migration.

May be able to reduce the time of inflammatory response.

Supplementation may reduce the incidence of upper respiratory illness by 50% and reduce the duration, if infected by approximately 2 days.

Associated with a decreased demand for antibiotics.

PROBIOTICS & ATHLETES

- In one study, four weeks of multi-species probiotic supplementation reduced markers of gut permeability and symptoms of GI discomfort during exercise-induced heat stress.
- May protect the intestinal barrier and crowd out the deleterious bacteria.
- Most studies use probiotics over an extended time for prevention.

The strength of evidence for the use of probiotics to support immune function is moderate/strong





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VITAMINS & MINERALS FOR IMMUNE HEALTH

VITAMINS IMPORTANT FOR IMMUNE FUNCTION

Vitamin A

(beta carotene)

Sweet potato
Carrots
Peppers
Broccoli
Butternut Squash

Vitamin C

Citrus fruits
Potatoes
Broccoli
Strawberries
Kiwi

Vitamin D

Salmon
Trout
Milk
Fortified cereal
Mushrooms

Folic Acid

Green leafy veg
Fortified cereal
Liver
Black-eyed peas
Asparagus

Niacin

Turkey
Salmon
Chicken
Pork
Brown rice
Fortified cereals

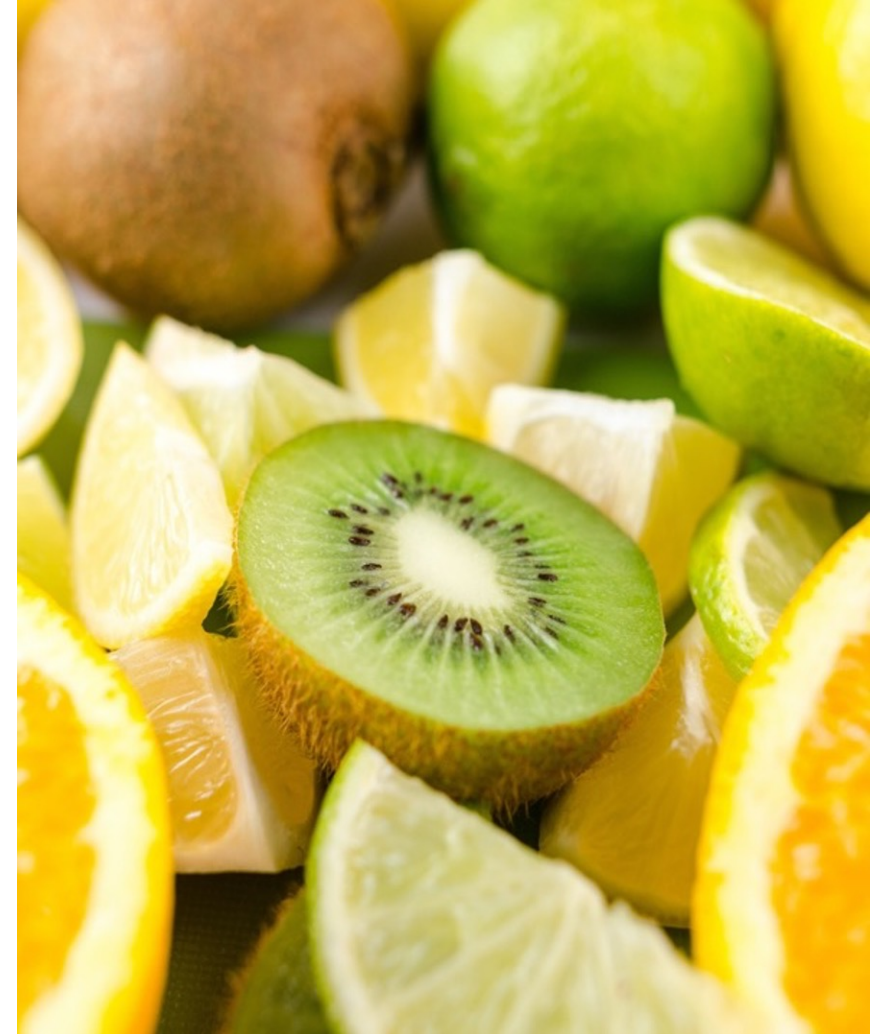
Vitamin B6

Chickpeas
Tuna
Salmon
Potatoes

Vitamin B12

B12-animal foods
Nutritional yeast

- Supports epithelial barrier function against pathogens and promotes the oxidant scavenging activity of the skin
- Needed for the development of immune cells
- Found in high concentrations in white blood cells
- Levels fall significantly during a common cold
- Saturating tissues requires 100-200 mg per day
- During an active infection, ~1g/d may be needed with some indication for higher doses





FOOD SOURCES OF VITAMIN C

| | | | | |
|------------------|---|-------|---|-------|
| Sweet Red Pepper | — | 1/2 c | — | 95 mg |
| Orange Juice | — | 3/4 c | — | 93 mg |
| Orange | — | 1 med | — | 70 mg |
| Broccoli | — | 1/2 c | — | 51 mg |
| Cabbage (cooked) | — | 1/2 c | — | 28 mg |
| Cauliflower | — | 1/2 c | — | 26 mg |
| Potato (baked) | — | 1 med | — | 17 mg |
| Tomato (raw) | — | 1 med | — | 17 mg |
| Spinach (cooked) | — | 1/2 c | — | 9 mg |



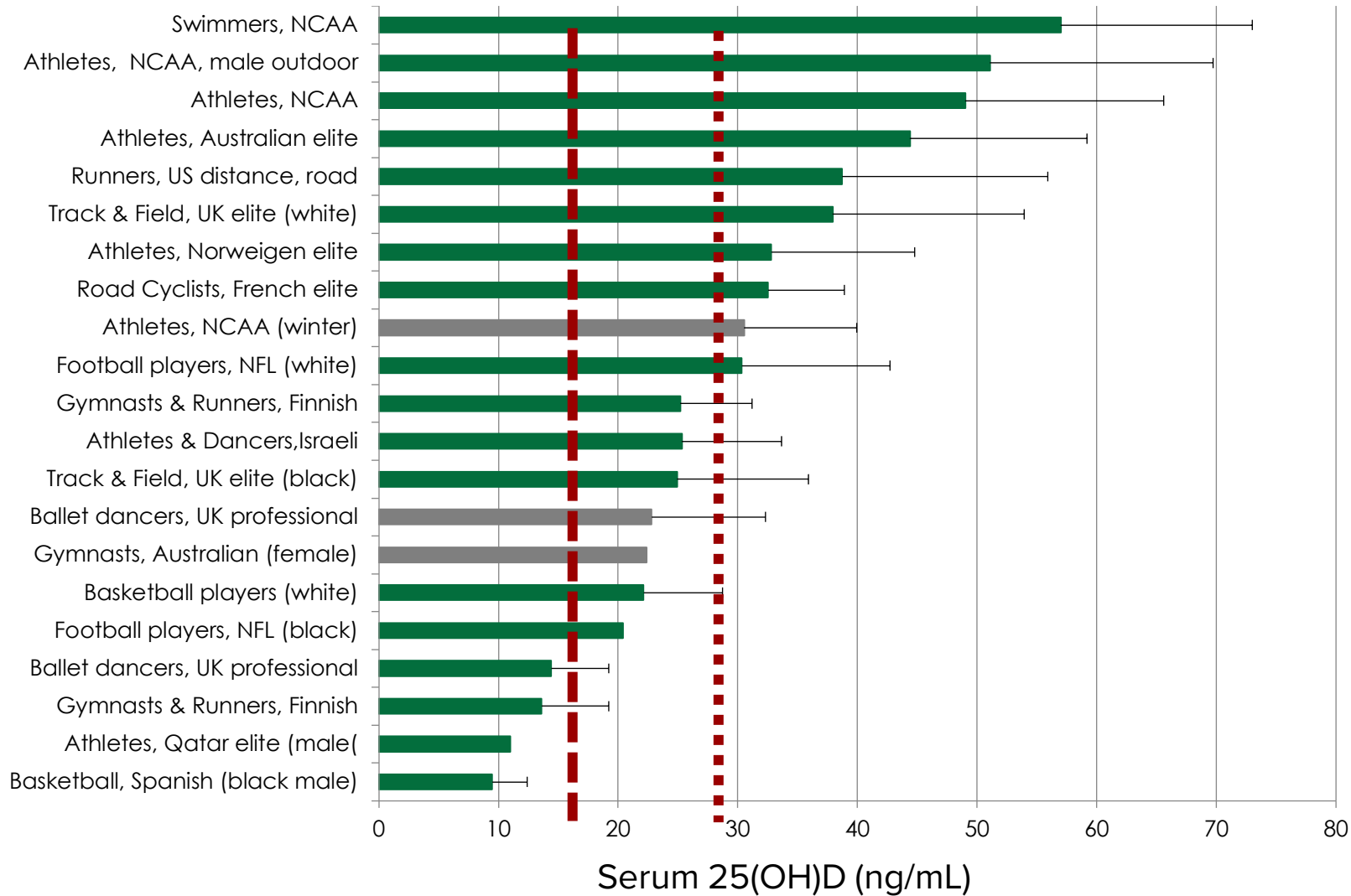
- ☀ Vitamin D deficiency can have a negative impact on immune health
- ☀ Moderate to strong evidence that adequate levels of vitamin D supports the immune health of athletes
- ☀ Decreased inflammatory cytokines, preserved epithelial function, increased antimicrobial peptides

VITAMIN D SUPPLEMENTATION



- ☀️ Vitamin D3 supplement 87% more effective than prescription vitamin D2
- ☀️ Food is a generally a poor source but better absorbed in a meal with moderate fat
- ☀️ No adverse effects of vitamin D supplementation reported for daily doses <10,000 IU/d
- ☀️ Mega doses (70,000 IU/week) have been found to increase status in athletes, but inhibit activity of the active form
- ☀️ Consider 10,000 IU/day for the first week then 5000 IU/day to maintain blood level between 40-60 ng/ml

VITAMIN D STATUS OF ATHLETES



Many would
require
supplementation
to reach
40-60 ng/ml

FOOD SOURCES OF VITAMIN D



| | | | | |
|---|---|-------|---|--------|
| Sockeye salmon (canned) | — | 3 oz | — | 716 IU |
| Rainbow Trout, farmed | — | 3 oz | — | 648 IU |
| Pink Salmon, canned | — | 3 oz | — | 492 IU |
| Sockeye salmon (cooked) | — | 3 oz | — | 444 IU |
| Portobello Mushrooms (exposed to UV light, grilled) | — | 1/2 c | — | 316 IU |
| Tuna (light, in oil) | — | 3 oz | — | 228 IU |
| Whole Milk | — | 8 oz | — | 128 IU |
| Tilapia | — | 3 oz | — | 124 IU |
| 2%, 1%, Nonfat Milk | — | 8 oz | — | 116 IU |

MINERALS IMPORTANT FOR IMMUNE FUNCTION

Iron

Beef
Lamb
Pork
Goat
Fortified cereals
Oysters
White Beans

Zinc

Oysters
Baked beans
Beef
Chickpeas
Fortified cereals

A NOTE ON ZINC

No Scientific Support

To **prevent** URI

Regular high dose zinc supplementation should be avoided.

Strong Scientific Support

To **treat** URI

Zinc lozenges (75 mg elemental zinc/day) may reduce the duration of an URI by 3 days when taken within the first 24 hours of symptoms.

Optimal composition of zinc lozenges is yet to be determined.





OMEGA-3 FATTY ACIDS

OMEGA-3 FATTY ACIDS

Direct Immune Support from Omega-3 Fatty Acids

- Evidence for a direct role on immune function is not strong.
- May play a role in the membrane integrity of lymphocytes.
- May help maintain integrity of the intestinal barrier, rather than direct effect on immune response.



LIFESTYLE CONSIDERATIONS

Sleep
Alcohol





SLEEP & IMMUNE FUNCTION

- ZZZ Cross talk between the immune system and sleep patterning.
- ZZZ Fever, sickness and the mediators involved can alter patterns of sleep.
- ZZZ Athletes who are ill report an increase in sleepiness and fatigue that may be caused by inflammation. Restoration of energy in part is driven by a decrease in inflammation.
- ZZZ Conversely, sleep deprivation has been shown in most studies, but not all, to have a negative impact on immune health.
- ZZZ Sleep deprivation can reduce the effectiveness of vaccines indicating some suppression of the immune response.

SLEEP & IMMUNE FUNCTION

Consequences of Short Sleep and Solutions

Disruptions in immune function.

Short sleep (< 7 hours) reduces natural killer cells by 30%.

Increasing sleep duration to 8-10 hours restores white blood cell levels.

Napping 30 minutes after sleep deprivation can also restore white blood cell levels.

Salivary cortisol, a marker of stress, is also reduced after a nap.



ALCOHOL & IMMUNE FUNCTION



- 🗑️ Studies of college student athletes consistently reveal that students involved in sports not only drink alcohol more often than non athletes, but they are also more likely to drink to excess.
- 🗑️ Alcohol alters the normal and desirable response of the immune system to infection via altering white blood cell function.
- 🗑️ Increased susceptibility to illness and infection.
- 🗑️ Decrease in anabolic hormones may alter protein synthesis, post-exercise recovery and healing.



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PRACTICAL RECOMMENDATIONS REGARDING FOOD & IMMUNE HEALTH

PRACTICAL RECOMMENDATIONS

A variety of foods is needed to increase nutrient diversity.

✚ 1/2 of the plate should contain a wide variety of fruits and vegetables.

✚ Fiber and prebiotics for gut and immune health.

✚ Polyphenols and colors to reduce inflammation and promote good health.



✚ 1/4 of the plate should contain whole grains and/or complex carbohydrates such as potatoes, sweet potatoes, brown rice, whole wheat or higher fiber pasta.

✚ 1/3 to 1/4 of the plate should be a lean protein to include eggs, fish, chicken, beef, tofu, tempeh or beans.

Nutrients for Immune Health: Summary

| Nutrient | Amount needed | Best food sources | Mode of action |
|------------|--|---|--|
| CHO | 40-60% of total calories 30-60 g per hour during sport | Whole grain, fruit, cereals, oatmeal, yogurt milk During sport- sport drinks- gels | Reduces stress hormones, supports gut microbiome |
| Protein | 0.54-0.9 grams per/lb | Lean meat, dairy, whey protein, beans, peas, nuts | Supports white blood cell formation |
| Vitamin D | 2000 IU per day | Sunlight, salmon, trout, mushrooms, fortified cereals | Gene expression, upregulation of B and T lymphocytes |
| Vitamin C | 200 mg for tissue saturation 1 gram + during illness | Oranges, peppers, broccoli, | Antioxidant, high concentration in WBC, scavenger of reactive oxygen species |
| Zinc | 8-11 mg DRI- 75 mg elemental zinc during infection within first 24 hours | Oysters, red meat, breakfast cereal | Anti-oxidant, protein synthesis, DNA,RNA synthesis |
| Probiotics | Daily intake- supplemental during season | Yogurt, kimchee, refrigerated pickles, sauerkraut, supplements | Preservation of gut integrity, blocking pathogens |
| Omega 3 | 500 mg EPA/DHA minimum up to 2 grams | Cold water fish, nuts, chia, | Primarily anti-inflammatory |

SUPPLEMENT RECOMMENDATIONS

Vitamin C

Needed during active infection at 1 gram/d.

Tissue saturation occurs at ~ 200 mg/d and can be done with food.

Vitamin D

Ideally blood values would be known, should be between 40-60 ng/ml.

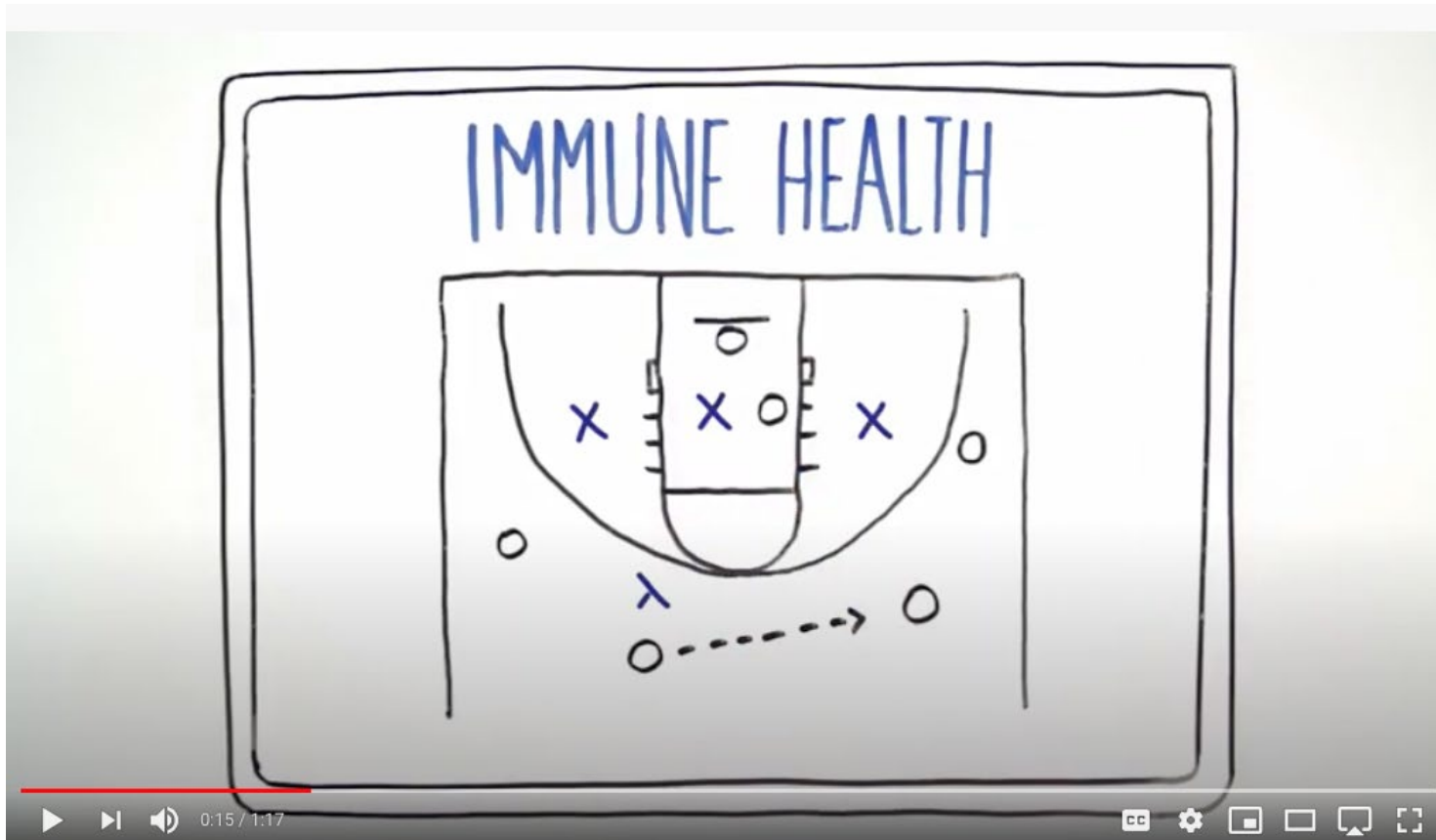
If the athlete is not supplementing, consider 10,000 IU for first week, followed by maintenance of 5000 IU/day.

Omega-3 Fatty Acids

2 grams of EPA +DHA per day.



SUMMARY VIDEO



[Link to video](#)

KEY TAKEAWAYS

- ✓ Maintaining a healthy immune system is important to for high level athletic performance
- ✓ The lifestyle of an athlete may increase their risk of infection. This includes, but is not limited to, low energy availability and poor sleep.
- ✓ Nutrients related to immune health include: carbohydrate, protein, Vitamins C & D, zinc and probiotics.



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