TECHNICAL BULLETIN

Zinc Deficiency in Men Over 50: Implications for Prostate Health

Introduction

Prostate disorders, including benign prostatic hyperplasia (BPH) and prostate cancer (PCa), represent a major health concern for aging men, with prevalence increasing sharply after 50 years of age. While endocrine and genetic factors have long been associated with prostate disease progression, accumulating evidence indicates that zinc (Zn) deficiency is a consistent and defining characteristic of both benign and malignant prostate conditions.

Zinc plays a unique and essential role in prostate physiology, influencing cellular metabolism, apoptosis, immune regulation and tissue homeostasis. This technical bulletin reviews current peer-reviewed medical literature on Zn biology in the prostate, with emphasis on age-related Zn deficiency and its potential implications for prostate health. Findings are derived from human observational studies, mechanistic research and cellular models.

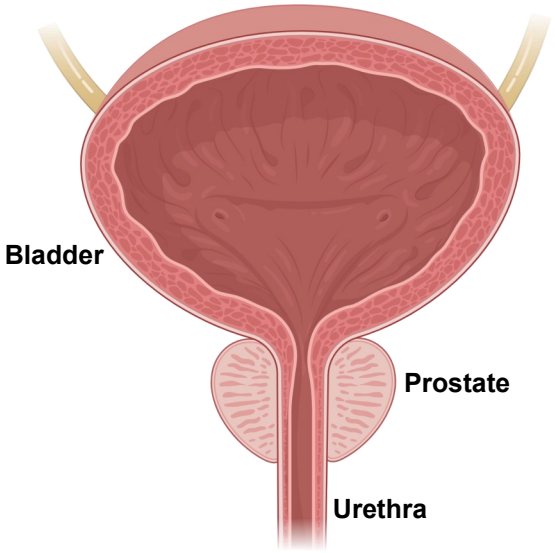

Figure 1: Position of the prostate within the male lower urinary tract

Zinc Deficiency as a Hallmark of Prostate Disorders

A substantial body of literature demonstrates that Zn depletion is a defining feature of prostate disease.

- Prostate cancer tissue exhibits a 60 to 80% reduction in Zn concentration compared with normal prostate tissue (Costello et al., 2016).
- Zinc levels in BPH tissue are reduced by more than 50% relative to healthy controls.
- No published studies to date have reported prostate cancer tissue without a corresponding reduction in Zn concentration.
- Evidence suggests that Zn depletion occurs early in disease development, preceding malignant transformation rather than resulting from it.

These findings indicate that Zn deficiency is not merely associated with prostate disease, but may play a contributory role in disease progression.

Age-related Risk Factors for Low Zn Status in Men Over 50

Men over 50 years of age are at increased risk of developing Zn deficiency, even when dietary intake appears adequate. Risk factors contributing to Zn deficiency include:

- Increased urinary Zn excretion observed in BPH and PCa.
- Common medication use (e.g., proton-pump inhibitors, diuretics, chelating agents).
- Dietary antagonists such as phytates, which reduce Zn bioavailability.
- Limited dietary variety in older adults.

Population studies indicate that 35 to 45% of older adults may fail to meet Zn requirements through diet along, placing this demographic at heightened risk for subclinical Zn deficiency.

Relationship Between Zn and Normal Prostate Function Versus Deficiency

The prostate accumulates higher concentrations of Zn than any other soft tissue in the male body. This accumulation is not incidental, but rather central to normal prostate metabolism and function. Zinc inhibits mitochondrial aconitase, resulting in citrate accumulation, which is a hallmark of healthy prostate cells. Elevated intracellular Zn disrupts the Krebs cycle, limiting energy production and maintaining normal secretory function. Zinc accumulation promotes mitochondria-mediated apoptosis, serving as a regulatory mechanism to prevent excessive cell proliferation. Specialized Zn transporters (e.g., ZIP1) facilitate Zn uptake into prostate epithelial cells, enabling these metabolic and regulatory processes. Loss of Zn accumulation disrupts these pathways and alters prostate cell behavior.

Zinc deficiency alters multiple cellular pathways involved in prostate health. Reduced Zn levels allow continued Krebs cycle activity, increasing ATP availability and supporting uncontrolled cell growth. Loss of Zn-induced apoptosis removes a key regulatory mechanism that limits hyperplasia and malignancy. Downregulation of Zn transporters such as ZIP1 is observed early in PCa development. Zinc deficiency may activate Zn-sensing receptors (ZnR/GPR39), promoting signaling pathways (PI3K-AKT/ERK) associated with tumor growth and survival. Collectively, these mechanisms suggest that adequate Zn status is critical for maintaining normal prostate cell metabolism and growth control.

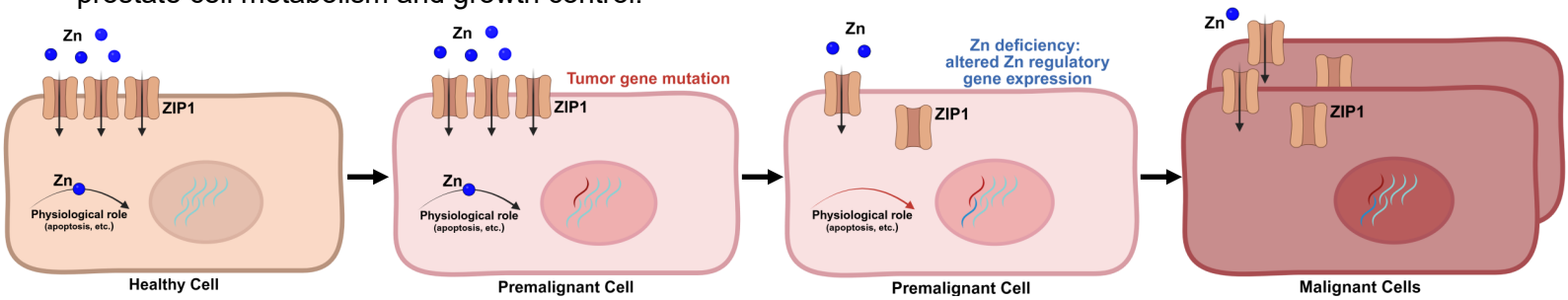

Figure 2: Proposed effects of zinc deficiency on prostate cell metabolism

Bioavailability Considerations: Not All Zn Sources Are Alike

The effectiveness of Zn in supporting biological function is influenced by its chemical form and bioavailability.

- Inorganic Zn sources (e.g., sulfates, oxides) are absorbed via divalent cation transporters and are susceptible to antagonism from other dietary minerals and compounds.
- Zinc lysine glutamate uses amino acid transport pathways, reducing competitive inhibition during absorption.
- Zinc amino acid complexes have demonstrated:
  - Reduced interaction with Zn uptake antagonists, including calcium, copper, phytate, and folic acid
  - Improved cellular uptake and trans-epithelial transport in experimental models
  - Preserved Zn absorption under conditions where classical Zn transport function is impaired

These characteristics may be particularly relevant for aging populations with compromised absorption or medication-induced Zn losses.

Implications for Nutritional Strategies

Current literature underscores the importance of maintaining adequate Zn status for prostate health, particularly in men over 50 years of age. Nutritional strategies should account for age-related changes in Zn absorption and utilization, medication-associated Zn losses, and the influence of Zn source and bioavailability. Population studies indicate that 35 to 45% of older adults may fail to meet Zn requirements through diet alone, placing this demographic at heightened risk for subclinical Zn deficiency. While additional clinical research is needed to define optimal Zn strategies for prostate health, existing evidence supports the biological importance of Zn in maintaining normal prostate structure and function.

Source: Sauer et al., 2020. Front. Oncol. 10:553161; Costello et al., 2016. Arch. Biochem. Biophys. 611:100-112