Introduction
With increasing awareness about prostate health, there is renewed interest in the role of diet and nutrients in the prevention of prostate disorders and maintaining a healthy prostate. The normal prostate is a small gland that weighs about an ounce, the size of a walnut. It is located just below the bladder, behind the pubic bone and just in front of the rectum. It wraps around the urethra, the tube carrying urine from the bladder. It helps to control the flow of urine and during sexual activity a protein produced by the seminal vesicles is mixed with prostatic fluid forming the semen. The prostate plays an important role in reproduction, facilitating fertilization, sperm transit and survival. Proteins secreted by the prostate such as Prostate Specific Antigen (PSA) are used to help sperm reach the egg during intercourse. Other nutrients made by the seminal vesicles and prostate including zinc, citrate, and fructose provide energy to the sperm. The prostate typically grows during adolescence under the control of the male hormone testosterone and its byproduct dihydrotestosterone (DHT). A healthy and fully functional prostate, therefore, is essential for its role in overall health.

Disorders associated with prostate health are among the most important health problems in Western countries and increasingly around the globe. They include urinary disorders, inflammation of the prostate gland (prostatitis), enlargement of the prostate gland (benign prostatic hyperplasia – BPH) and prostate cancer (PC). There are multiple risk factors that influence prostate health outcomes including but not limited to age (the older the age, the greater the risk), race (African American men have the highest risk), family history and genetics, obesity, sedentary lifestyle, inflammation of the gland, infection, and vasectomy. Increasingly, diet is now recognized as an important risk factor for prostate health. Traditionally, high intake of caloric energy, saturated fat and excess intake of dairy products and red meat, as well as low intake of fruits and vegetables, dietary fiber and antioxidants have been implicated as risk factors of concern in the diet.1,2 Micronutrients are of recent interest in relation to prostate health. For the purpose of this article, the term micronutrients will be used not only to include traditional nutrients such as trace minerals and vitamins but also ‘phytonutrients’ and botanicals that influence the risk of prostate health. Some important micronutrients, phytochemicals and botanicals studied recently in relation to prostate health and cancer are shown in Table 1.

Role of botanicals, phytonutrients and micronutrients in prostate health
BOTANICALS
Although some of the botanicals have been used traditionally to treat many human diseases including urinary tract infections and prostate cancers, there is no good scientific evidence in support of their beneficial effects. Of all the botanicals, cranberries, cranberry juice and Saw Palmetto have been investigated the most3,4 and recommended anecdotally for the treatment of prostate cancer. Further studies including human clinical trials are required before beneficial effects on prostate health can be documented and recommended.

PHYTONUTRIENTS
Among the phytochemical micronutrients, carotenoids have been suggested as being beneficial for prostate health5,6. Several basic, epidemiological, experimental and clinical studies have been directed at lycopene, a carotenoid present in many foods, tomatoes being the major source for prostate health. Among the phytochemical micronutrients, carotenoids have been suggested as being beneficial for prostate health. For the purpose of this article, the term micronutrients will be used not only to include traditional nutrients such as trace minerals and vitamins but also ‘phytonutrients’ and botanicals that influence the risk of prostate health. Some important micronutrients, phytochemicals and botanicals studied recently in relation to prostate health and cancer are shown in Table 1.

VITAMIN A
Requirement of vitamin A for growth of cells is well recognized. Several studies have now reported the relationship between vitamin A and prostate cancer risk7,8. The outcomes have been mixed with some studies showing no significant association and others showing positive association9. A weak positive association was observed between the intake of retinol and the risk of cancer10. Similar positive association was also seen between total vitamin A intake and the risk of prostate cancer in both elderly and young men11. These observations suggest vitamin A to be a risk factor for prostate cancer. However, in another study, prostate cancer risk was reduced in the upper quartile of retinol intake12. Several mechanisms are proposed for the effect of vitamin A and related compounds on prostate cancer that include: antioxidant activity preventing DNA damage, increase the function and expression of a number of enzymes involved in detoxification and antioxidant, proapoptotic effect, effect cell differentiation and growth of prostate cancer cells, and inhibiting the growth of the prostate ductal and branching.

Overall, the role of vitamin A and retinol in the risk of prostate cancer is not clearly understood at present with results showing conflicting outcomes. Further studies in the future should help clarify the role of vitamin A in prostate health.

VITAMIN B
Several members of the vitamin B group serve as coenzymes in the folate mediated one-carbon pathway that plays an important role in DNA synthesis, repair and methylation14, thereby playing a role in cancer risk. Overall results from epidemiological and intervention studies are quite confusing. A survey conducted by the American Cancer Society to study the association between folate intake and prostate cancer risk in men did not find any association of dietary or total folate intake with overall prostate cancer risk15. However, in another study where acetylsalicylic acid and folic acid supplementation were investigated for cancer prevention, the baseline dietary folate showed an inverse relationship while folate supplementation indicated positive association with prostate cancer risk16. These observations indicate that the effects of supplements folate may be different from that of the dietary folate. The reasons for such differences are not yet clear. Overall the studies seem to indicate that dietary vitamin B may reduce the risk of prostate cancer while supplementation may enhance the risk.

VITAMIN C
Vitamin C is both an antioxidant and an essential nutrient for humans in collagen, carnitine and neurotransmitter biosynthesis. Most of the studies done to evaluate its role in prostate cancer...
used a mixture of micronutrients, making it difficult to indicate the effect of vitamin C alone. A few observational studies showed an inverse association of vitamin C intake with the risk of prostate cancer. On the other hand, some recent studies did not show such an association.

**VITAMIN D**

Although very few human intervention studies have been done evaluating the role of vitamin D in prostate health, there are studies that show the beneficial effect of proper exposure to sunlight on the prevention of prostate cancer. This protective effect may be due to the effect of sunlight on vitamin D production. Some studies suggest vitamin D as a therapeutic agent against prostate cancer. However, therapeutic doses of vitamin D are also associated with hypercalciemia and hypercalciumia. Newer vitamin D analogues are now being investigated having none or minimal harmful effects associated with vitamin D. However, the adverse effect of vitamin D in the prevention of prostate cancer has prevented its clinical use. In vitro studies have suggested that the use of vitamin D in combination with other anticancer agents can be an effective strategy in reducing the risk of prostate cancer. Mechanism of the anticancer activities of vitamin D may be through its nuclear receptor or vitamin D receptor activity. Vitamin D has been shown to cause prostate cancer cellular dysfunctions and altered gene expression, including inhibition of cell proliferation, cell invasiveness, angiogenesis, telomerase expression, induction of cell differentiation, and apoptosis.

**VITAMIN E**

Several isomers of vitamin E, tocopherol, are naturally present in foods. α-tocopherol is the most abundant form followed by γ-tocopherol. They have been studied to relate the most protection to their protection against prostate cancer. Supplementation with α-tocopherol, for a period of 5 years on average, was shown to substantially reduce the incidence of prostate cancer in male smokers. Other studies also showed that the risk of prostate cancer in men receiving vitamin E supplementation was reduced significantly compared to the placebo group. However, other large intervention studies did not show any effect of vitamin E supplementation alone or in combination with selenium on prostate cancer risk. Overall, there is evidence in support of the role of vitamin E in reducing the risk of prostate cancer.

**SELENIUM**

Selenium is an essential nutrient that acts in combination with vitamin E and participates in several important biochemical functions. It is required in the synthesis of several selenoproteins such as glutathione peroxidase, having antioxidant properties. Several reports document the antimutogenic properties of selenium compounds. Animal studies have also shown the ability of selenium compounds to reduce the risk of prostate cancer. Low serum selenium levels have been shown to be associated with increased incidence of prostate cancer. Based on epidemiological and experimental study results, it has been suggested that selenium supplementation can be used as a chemopreventive agent in the management of prostate cancer. Final recommendation pertaining to the use of selenium supplements will have to wait for the results of several intervention studies that are currently being investigated.

**ZINC**

Interest in zinc and prostate health is based on the fact that mammalian prostate gland contains much higher levels of zinc than other tissues. There is some evidence to indicate that zinc levels may be decreased in prostate carcinoma. Although the mechanisms by which zinc may influence prostate cancer are not fully understood, it has been suggested that it may inhibit progression of malignancy. Definitive evidence supporting the role of zinc in prostate health requires further experimental and clinical studies.

**Conclusion**

The prostate is an important organ playing a significant role in human reproduction. Disorders of the prostate gland are common and are influenced by many factors. Although, age is a significant contributing factor, diet and nutrients are being recognized as playing a key role in maintaining a healthy prostate gland. Several micronutrients have been shown in epidemiological, experimental and human intervention studies to be effective in reducing the risk of prostate cancer. More recently there has been interest in the use of phytornutrients and botanicals in the management of prostate health. Although the results seem very encouraging and exciting, we do need more information on specific micronutrients and the mechanisms of their action before definitive recommendations can be made for their role in prostate health.

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### Table 1.

Some important micronutrients, phytochemicals and botanicals in relation to prostate health.

<table>
<thead>
<tr>
<th>Micronutrients</th>
<th>Phytochemicals</th>
<th>Botanicals</th>
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</thead>
<tbody>
<tr>
<td>• Vitamin A</td>
<td>• Carotenoids</td>
<td>• Cranberries</td>
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<tr>
<td>• Vitamin B (Folate, Riboflavin, B6 and B12)</td>
<td>• β-carotene Lutein</td>
<td>• Flax seed oil (cold pressed)</td>
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<tr>
<td>• Vitamin C</td>
<td>• Zeaxanthin</td>
<td>• Green tea</td>
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<tr>
<td>• Vitamin D</td>
<td>• Β-Cryptoxanthin</td>
<td>• Nettle root</td>
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<tr>
<td>• Vitamin E</td>
<td>• Isoflavones</td>
<td>• Pygeum</td>
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<tr>
<td>• Selenium</td>
<td>• Phytoestrols</td>
<td>• Red clover</td>
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<tr>
<td>• Zinc</td>
<td>• β-Stioesterol</td>
<td>• Saw Palmetto</td>
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