Spotlight
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on nutrition issues

What's Inside

Author

Kathy Furgala is a Registered Dietitian and nutrition consultant. She has assisted non-profit organizations, the food industry and corporate clients with strategic planning, resource and program development, nutrition education, communications and training. Prior to establishing a nutrition consulting practice, she was a Nutrition Educator and Media Relations Manager with Dairy Farmers of Canada (Ontario).

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Dietary Factors in the Prevention and Management of Hypertension:

Best Course for a Canadian Success Story

Synopsis

Hypertension, or high blood pressure, is a major risk factor for cardiovascular and renal disease; its prevalence is a major health concern. In Canada, hypertension affects almost one in five people, and is an important – but modifiable – factor in disease and early death. Lifestyle factors such as body weight, physical activity and diet play important roles in the prevention and management of hypertension, with weight reduction and the DASH diet (high in fruit, vegetables and milk products) having the greatest potential for lowering blood pressure. While reducing dietary salt can lower blood pressure, particularly as we age, the potential decrease is modest. Given the high incidence of hypertension with aging, even small reductions in hypertension can have a significant public health impact; therefore, national strategies to reduce salt intake are underway. On an individual basis, however, dietary salt reductions alone may not be enough if overall diet quality is poor. Consequently, nutrition education strategies should focus on lifestyle modifications known to improve blood pressure, particularly weight management and the DASH diet.

Introduction

The relationship between hypertension, or high blood pressure, and increased risk for cardiovascular and renal disease is well established. In fact, improving high blood pressure – a modifiable risk factor – may be one of the most important ways to prevent cardiovascular disease and death.[1,2]

There does not appear to be a blood pressure threshold, suggesting risk increases with progressive elevations in blood pressure, even within the prehypertensive range.[3,4] The relatively new classification of "prehypertension" (120–139 mm Hg systolic and/or 80–89 mm Hg diastolic) has resulted from new data on lifetime risk of hypertension (defined as blood pressure of 140 mm Hg systolic or 90 mm Hg diastolic or above) and the increased risk of complications associated with levels previously considered normal.[3] This new classification is meant to identify individuals who would benefit from early intervention with healthy lifestyle modifications,

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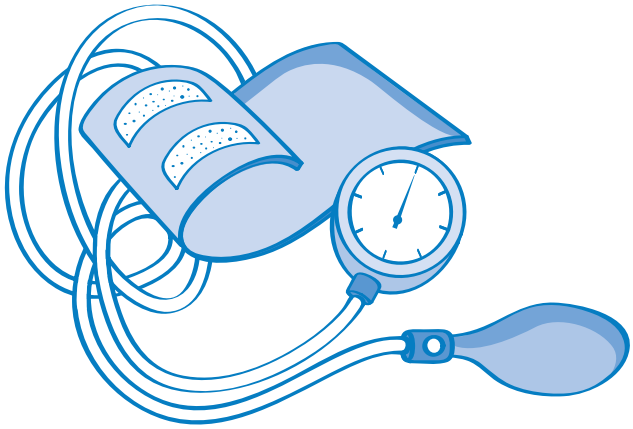
and thereby decrease or prevent the risk of progression to hypertension with age.[3]

This issue of *Spotlight* will provide an overview of hypertension as a factor in chronic disease, and an update on lifestyle risk factors and current interventions, particularly diet-related interventions, in the prevention and management of hypertension.



Hypertension

Prevalence

Nearly one-fifth (19%) of Canadians aged 20 to 79 are reported to have hypertension, and another 20% are prehypertensive.[5] Hypertension has been the leading reason for adult visits to physicians for the past decade, and its prevalence is increasing.[5,8,9]

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The most recent data from the Canadian Health Measure Survey identified 18% of 40- to 59-year-olds as hypertensive. This number rose sharply to over half (53%) for those aged 60 to 79. Prevalence appears to be nearly the same for both men and women.[5,9]

In an Ontario-based study, Leenen et al. found that the prevalence of hypertension was disproportionately high among South Asians and black women.[10] Other Canadian data show that blacks are more likely to have high blood pressure than is the general population, and that Canadians of Chinese origin are more likely to have hypertension than Canadians of European origin.[9]

Complications

The risks associated with hypertension, including heart disease, stroke, congestive heart failure and kidney disease, are continuous, consistent and independent of other risk factors.[3,8,9]

On a population basis, even small reductions in blood pressure can have an enormous impact on morbidity and mortality, or at the very least, delay the onset of hypertension.[2,3] A 5 mm Hg reduction in systolic blood pressure in the population has been estimated to reduce stroke by 14% and coronary heart disease by 9% and to result in a 7% decrease in all-cause mortality.[3]

Etiology

Both genetic and lifestyle factors influence the development of high blood pressure, and diet-related factors likely play a predominant role. More specifically, important causal factors include overweight, excess sodium intake, reduced physical activity, excess alcohol consumption, and a diet low in fruit, vegetables and milk products.[2,3]

While there are other identifiable causes of hypertension, including sleep apnea, stress, certain drugs and concomitant disorders such as parathyroid disease and primary aldosteronism,[3] these will not be addressed in this issue.

Lifestyle Factors Affecting Hypertension

Weight Management

Obesity and hypertension frequently coexist and are considered two major risk factors for cardiovascular disease. Forman et al. report that in the Nurses' Health Study, body mass index (BMI) was the most powerful predictor of hypertension, identifying a 40% risk of hypertension with a BMI of 25 or greater.[11] Both obesity and elevated blood pressure have been associated with increased left ventricular hypertrophy, which is a predictor of cardiovascular events.[12]

Consequently, weight loss for overweight individuals is always included in hypertension management guidelines.[3,5,13] However, individual responses to weight loss interventions vary, particularly long term, and the weight loss effects on blood pressure may be influenced by concurrent factors, including physical exercise, comorbidities and genetic profiles.[13]

A recent study showed the long-term effects of short-term weight loss on incidence of hypertension.[14] While the mechanism of long-term benefit of intervention is uncertain, research strongly supports

Modest weight loss has been shown to reduce hypertension by approximately 20% among overweight, prehypertensive individuals.

the efficacy of weight loss in reducing blood pressure in both normotensive and hypertensive overweight individuals.[12–15] Modest weight loss, with or without sodium reduction, has been shown to reduce hypertension by approximately 20% among overweight, prehypertensive individuals.[2]

Physical Activity

Numerous studies have identified the value of physical activity and aerobic exercise in lowering blood pressure. The magnitude of change has been inconsistent, however, and in more rigorously controlled studies, only modest reductions have been found.[12] Nevertheless, long-term studies such as the Coronary Artery Risk Development in Young Adults (CARDIA) study and the prospective cohort study by Forman et al. of women in the second Nurses' Health Study clearly demonstrate that inclusion of regular physical activity can lower the risk of developing hypertension.[11,16]

Aerobic exercise may indirectly improve endothelial function, which is associated with left ventricular hypertrophy, and may achieve this through its effect on weight reduction.[12]

Alcohol Intake

A direct dose-dependent relationship exists between alcohol intake and blood pressure, and is likely independent of age, obesity and salt intake.[2] While He and MacGregor point out that the effect of alcohol on blood pressure may be transient rather than sustained,[17] there exists strong support for the moderation of alcohol intake to two or fewer alcoholic drinks per day in men and one or fewer drinks per day for women.[2,3,11]

Potassium Intake

There is an inverse relationship between potassium intake and blood pressure, and there is increasing evidence that a potassium deficit plays a critical role in hypertension and cardiovascular risk.[2,18,19]

With moderate potassium deficiency there is a higher prevalence of elevated blood pressure and increased salt sensitivity.[2,18] However, the interaction of sodium and potassium is likely a greater factor in the pathogenesis of hypertension and associated cardiovascular risk than is a deficit of potassium or an isolated excess of sodium.[19] Consequently, there is strong support for the recommendation to increase the dietary potassium-sodium ratio; the best way to achieve this is through increased consumption of foods high in potassium, such as fruit and vegetables.[19–21]

Salt Intake

Excess salt intake does raise blood pressure, and in particular influences age-related hypertension. Rigorously controlled dose-response trials provide persuasive evidence about the effects of salt (sodium) on blood pressure, with decreases ranging from 2 to 8 mm Hg systolic pressure with sodium reductions of 1,725 to 2,300 mg/day.[3,17,22,23] The changes in blood pressure observed with lowering salt intake have a continuous distribution, but some individuals experience greater or lesser degrees of blood pressure reduction.

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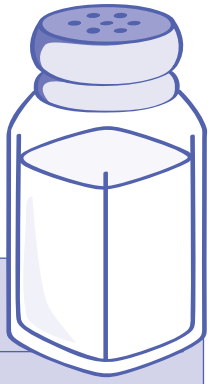
This "salt sensitivity" can occur in both normotensive and hypertensive individuals and appears to increase with age, but is difficult to predict.[2,24] Also, as described above, interactions between sodium and other dietary nutrients, including potassium and calcium, for example, suggest that dietary salt intake may be a factor only when considered in relation to other dietary nutrients.[25,26] This fact highlights the relevance of a healthy pattern of eating rather than a focus on a single nutrient, and will be discussed later.



Did you know?

Salt sensitivity is defined as a 10% difference in blood pressure following a low or high sodium intake.[22] Older adults, people of African descent and individuals with hypertension, diabetes or chronic kidney disease are more prone to the blood pressure–raising effects of increased sodium intake.[2,17,18,22,24]

The angiotensinogen gene has been implicated in hypertension, and variations in this gene may contribute to increased salt sensitivity, resulting in higher blood pressures.[2,17,22] Genotype-specific responses appear to increase with age, resulting in an increase in salt sensitivity in older adults.[17,22]

Sources of Sodium in the Canadian Diet

A large majority of Canadians consume amounts of sodium that far exceed the recommended levels. The 2004 Canadian Community Health Survey (CCHS) found that 80% of men and 69% of women had sodium intakes exceeding 2,300 mg per day, the current tolerable upper level. Similarly, 77% of children aged one to three years and 93% of children aged four to eight exceed the upper limit for sodium. The average amount of sodium consumed by Canadians is estimated to be 3,400 mg per day – 50% more than the tolerable upper limit – with a range of 2,882 to 4,130 mg per day for men and 2,300 to 2,959 mg per day for women.[27]

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Sodium is widely distributed in the food supply. The majority is added during processing (77%), while another 5% is added during cooking. Approximately 11.6% of sodium occurs naturally in foods.[28,29] Table 1 lists the major contributors of sodium in the Canadian diet, as determined by the CCHS.[28]

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As a single strategy, dietary sodium reduction alone may produce only modest changes in blood pressure. However, given the high prevalence of hypertension and the increased incidence with aging, even small reductions in hypertension can have a significant public health impact. Consequently, various countries have implemented long-term strategies to reduce national salt intakes.[23,29]

Table 1. Primary Sodium Sources in the Canadian Diet

Food Category	Percentage Total Dietary Sodium Intake Provided
Breads*	**13.9**
Snack foods, sauces, spreads	**11.6**
Potato chips and salty snacks	1.6
Gravies/sauces	3.8
Butter/margarine	1.7
Cookies and granola bars	1.3
Candy and confections	1.3
Cakes	1.2
Salad dressings	0.7
Processed meats	**8.9**
Soups	**7.4**
Vegetables* (all) plus tomato and vegetable juice	**7.6**
Pasta dishes	**5.7**
Cheese	**5.4**

*Although breads and vegetables are major contributors of sodium, this is a result of the relatively large quantity of these foods consumed, rather than their high sodium content. Canned or pickled vegetables account for 1.3%.

What's New?

Canadian Perspective

The Canadian Heart Health Strategy and Action Plan aims to reduce sodium in the Canadian diet to 2,300 mg per person per day by the year 2016, and to achieve a 5% reduction per year. Sodium reduction targets are currently being developed for processed food categories and foods sold through food service establishments, and are expected to be released by summer 2010. The technical feasibility of these reductions and potential timeframe issues are currently being discussed with stakeholders.[9,30]

Complexity of Reducing Salt: Challenges to the Food Supply

The reduction of salt in food is complex, since its function varies depending on the food. Salt or sodium is not only used as a flavouring, but also as a preservative and antibacterial agent, and to alter the texture or structure of foods.[30,31] It is also inherent in some foods naturally, making it difficult to alter.

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Some major concerns about the sodium reduction process have surfaced:[28,30]

- Reformulation of foods can be challenging – in some food products, salt reduction could cause fundamental changes, rendering them unacceptable or leading to food safety concerns.
- To ensure consumer acceptance, a gradual reduction of sodium is necessary; gradual reductions will likely require repeated reformulations over time.
- A 5% to 10% reduction in the sodium used for flavouring may be easy during the early years of the process, but larger reductions are more challenging.
- Replacing salt with other ingredients, such as monosodium glutamate, may impart other undesired effects for some people.
- Public education is critical to success. There needs to be a partnership between consumers and the food industry so that consumer demand for lower-sodium products will be backed up with actual purchases.
- Care needs to be taken to ensure that nutrient-rich foods are not excluded from the diet based on sodium level alone. As demonstrated in the DASH diet (see page 7), moderate amounts of foods such as cheese, which is higher in salt, can successfully be incorporated into a healthy eating pattern.

Eating Patterns vs. Individual Nutrients

While sodium restrictions have been shown to reduce blood pressure, particularly in older hypertensive individuals, an overall healthy eating pattern may be the best approach to prevent and manage hypertension.[14,15,25] In a review of behavioural strategies to treat high blood pressure, including sodium restriction; alcohol moderation; and potassium, magnesium and calcium supplementation,

While sodium restrictions have been shown to reduce blood pressure, particularly in older hypertensive individuals, an overall healthy eating pattern may be the best approach to prevent and manage hypertension.

Blumenthal et al. concluded that the Dietary Approaches to Stop Hypertension (DASH) diet was the optimal approach to blood pressure management.[15] This dietary pattern – high in fruit, vegetables and lower-fat dairy products – has been extensively studied, with positive results.[4,32–36]

Research has demonstrated that sodium reduction to current recommended levels is less effective than the DASH diet in reducing blood pressure, suggesting that for the majority of people, salt reductions alone may not be an adequate strategy for blood pressure management.[3,4,21,23] McCarron provides further support for the DASH diet by stressing that while excess salt does elevate blood pressure, this may be more of a concern if overall diet quality is poor – that is, low in vegetables, fruit and milk products.[25]

The DASH Diet

The rationale behind the initial DASH trial was to test a pattern of eating, rather than individual nutrients, that would be acceptable to most Americans. The initial DASH trial was a controlled multi-centre feeding study of 459 adults, both normotensive and hypertensive. Baseline mean +/– standard deviation systolic and diastolic blood pressures were 131.3 +/– 10.8 mm Hg and 84.7 +/– 4.7 mm Hg, respectively. After three weeks on a typical American diet, subjects were randomized into three groups for an eight-week intervention. Body weight and sodium intake (approximately 3,000 mg) were held constant, and physical activity level did not change during the trial.[33–35]

The DASH diet (with the addition of milk products) resulted in a blood pressure reduction twice that of the fruit and vegetable diet alone.

While the fruit and vegetable group showed significant reduction in blood pressure compared with the control diet, the DASH diet (with the addition of milk products) resulted in a blood pressure reduction twice that of the fruit and vegetable diet alone. In hypertensives, the blood pressure–lowering effect of the DASH diet was similar to that observed in single-drug therapy for mild hypertension.[2,24,32,35]

The effects of the DASH diet were significant in all subgroups – men, women, blacks, nonblacks, and hypertensive and normotensive individuals. The blood pressure–lowering effects were striking and were significantly greater in hypertensives (reductions of 11.6 mm Hg systolic and 5.3 mm Hg diastolic) than in nonhypertensive subjects (3.5 and 2.2 mm Hg), and greater in blacks (6.9 mm Hg reduction in systolic and 3.5 mm Hg diastolic) than in Caucasian subjects (3.3 and 2.4 mm Hg).[2,34,35]

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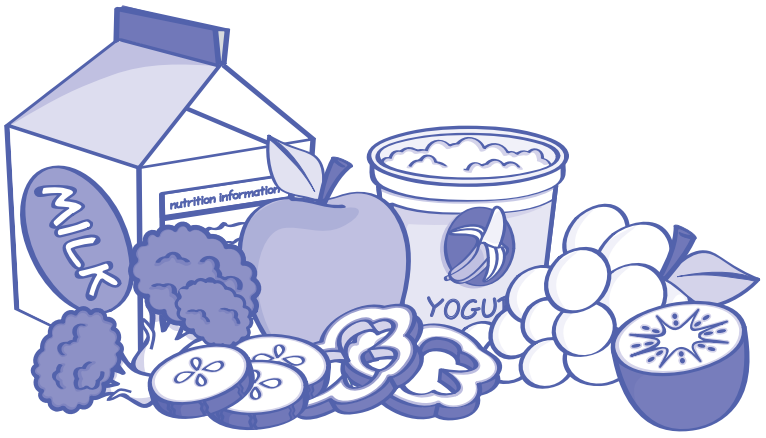
Table 2. DASH Trial

Intervention Group	Components of Diet during Intervention
Control group	**Standard American diet with:** • 3.6 servings/day of fruit and vegetables • 0.5 serving/day of milk products
Fruit and vegetable group	**Inclusion of:** • 8–10 servings/day of fruit and vegetables • 0.3 serving/day of milk products
Combination diet (DASH)	**Inclusion of:** • 8–10 servings/day of fruit and vegetables • approx. 3 servings/day of milk products - 1% and fat-free milk and yogurt - 39 g of cheese (27 g regular fat; 12 g low-fat) • reduced saturated fat, total fat and cholesterol

Since the initial trial, the DASH diet has been re-examined several times, with positive outcomes. The DASH Sodium trial studied the DASH diet and a control diet at three different sodium levels. At each level of sodium, the DASH diet resulted in significantly lower systolic blood pressure than the controls. The combined effects on blood pressure of sodium restriction and the DASH diet were greater than the effects of either intervention alone; the combination was particularly effective in older hypertensive individuals, compared with younger normotensive subjects.[4,12,24]

The PREMIER clinical trials examined the DASH diet in a free-living setting rather than a controlled environment; the ENCORE study examined the DASH diet alone and in combination with exercise and weight loss. These studies again demonstrated the blood pressure–lowering ability of the DASH diet. The addition of weight loss and exercise led to an even greater decrease in blood pressure.[36,37]

As a result of the body of evidence supporting the blood pressure–lowering effects of the DASH diet, the diet is currently advocated in several scientific reports and national guidelines, including the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure, as well as the evidence-based recommendations of the Canadian Hypertension Education Program.[3,6]



Milk Products and Blood Pressure Reduction

Extensive research has been done on the impact of non-dietary and dietary sources (mainly from dairy foods) of calcium on blood pressure. Some of these studies no doubt influenced the design of the DASH trials, which attempted to determine the combined effect of modifying nutrients such as calcium, magnesium and potassium on blood pressure.[24,33,38,39]

Kris-Etherton et al. provide an extensive review of both epidemiological and randomized clinical trials examining the positive role of calcium and/or dairy foods on lowering blood pressure.[24] Similarly, German et al. provide a thorough examination of the beneficial influence of dairy foods on blood pressure and overall cardiovascular disease risk.[40] The potential benefits of dairy foods in blood pressure regulation have been attributed to their major components, including calcium, potassium, magnesium and milk peptides.[24,40–43]

Table 3. Milk Products and Potential Mechanisms for Blood Pressure Reduction

Milk Product Component	Potential Mechanism
Calcium	1. Calcium may suppress 1,25-dihyroxyvitamin D. - a diet high in salt can be calciuretic and worsens the impact of a calcium-deficient diet - increased calcium excretion results in increased circulating 1,25-dihydroxyvitamin D and elevated calcium in vascular smooth muscle, leading to an increase in peripheral vascular resistance and blood pressure - dietary calcium may suppress 1,25-dihydroxyvitamin D and thereby lower blood pressure[24,43–45] 2. Calcium may improve the sodium-potassium balance and lower renin-angiotensin activity, leading to lower blood pressure.[42] 3. Hilpert et al. studied the contribution of dairy foods to the DASH diet and examined intracellular calcium (Ca)i, a potential mediator of blood pressure. - inclusion of milk products resulted in significant reduction of (Ca)i and an increase in intracellular magnesium; subjects with greatest drop in (Ca)i had greatest reduction in blood pressure - consumption of dairy foods affects (Ca)i and may improve blood pressure in a subgroup of people[46]
Milk peptides	Both animal and human models have shown fermented milk products (milk fermented with *Lactobacillus helveticus* or by enzymatic treatment, or ripened cheese) have antihypertensive effects. - fermented milk may inhibit angiotensin converting enzyme (ACE), which plays a role in the renin-angiotensin system, an important regulator of blood pressure - milk peptides may preserve endothelial function and possibly improve arterial stiffness, suggesting they may affect blood pressure through more than one mechanism[24,47–50]
Potassium and magnesium	Both potassium and magnesium are associated with blood pressure regulation. While milk products are an important dietary source of these minerals, further investigation is needed to isolate and quantify their individual contributions to blood pressure regulation.[24,44]

Population-Based Approaches to Reduce Hypertension

Extensive efforts to improve physician and public awareness of the importance of hypertension have been underway in Canada since the late 1990s. While blood pressure awareness and management have improved over this period, they remain less than optimal.[51]

In both the United States and Canada, national lifestyle modification recommendations to reduce hypertension have focused on physical activity, weight reduction, dietary recommendations (the DASH diet), salt reduction and moderation of alcohol consumption.[3,9] These modifications have significant potential for systolic blood pressure reduction, as outlined in Table 4.

In terms of lifestyle modifications, weight reduction and the DASH pattern of eating have the greatest potential for lowering blood pressure.[15]

In terms of lifestyle modifications, weight reduction and the DASH pattern of eating have the greatest potential for lowering blood pressure.

The appeal of the DASH diet is that it incorporates commonly available and acceptable foods, which may help to increase adherence and ease of implementation in daily life.[35] Secondly, the DASH diet may in fact blunt the rise in blood pressure from increased salt intake.[18, 32]

Table 4. Lifestyle Modifications to Prevent and Manage Hypertension[3]

Modification	Recommendation	Approximate SBP Reduction (Range)*
Weight reduction	Maintain healthy body weight (body mass index 18.5–24.9 kg/m^2)	5–20 mm Hg/10 kg weight loss
DASH eating plan	Consume a diet rich in fruit, vegetables and low-fat dairy products, with reduced saturated and total fat	8–14 mm Hg
Physical activity	Engage in regular aerobic activity such as brisk walking at least 30 minutes per day, most days of the week	4–9 mm Hg
Dietary sodium reduction	Reduce dietary sodium intake to no more than 100 mmol per day (2.4 g sodium or 6 g sodium chloride)	2–8 mm Hg
Moderation of alcohol consumption	Limit consumption to no more than 2 drinks (e.g., 24 oz/700 mL beer, 10 oz/300 mL wine, or 3 oz/90 mL 80-proof spirits) per day for most men, and no more than 1 drink per day for women and lighter-weight men	2–4 mm Hg

DASH = Dietary Approaches to Stop Hypertension; SBP = Systolic blood pressure

*The effects of implementing these modifications are dose and time dependent and could be greater for some individuals.

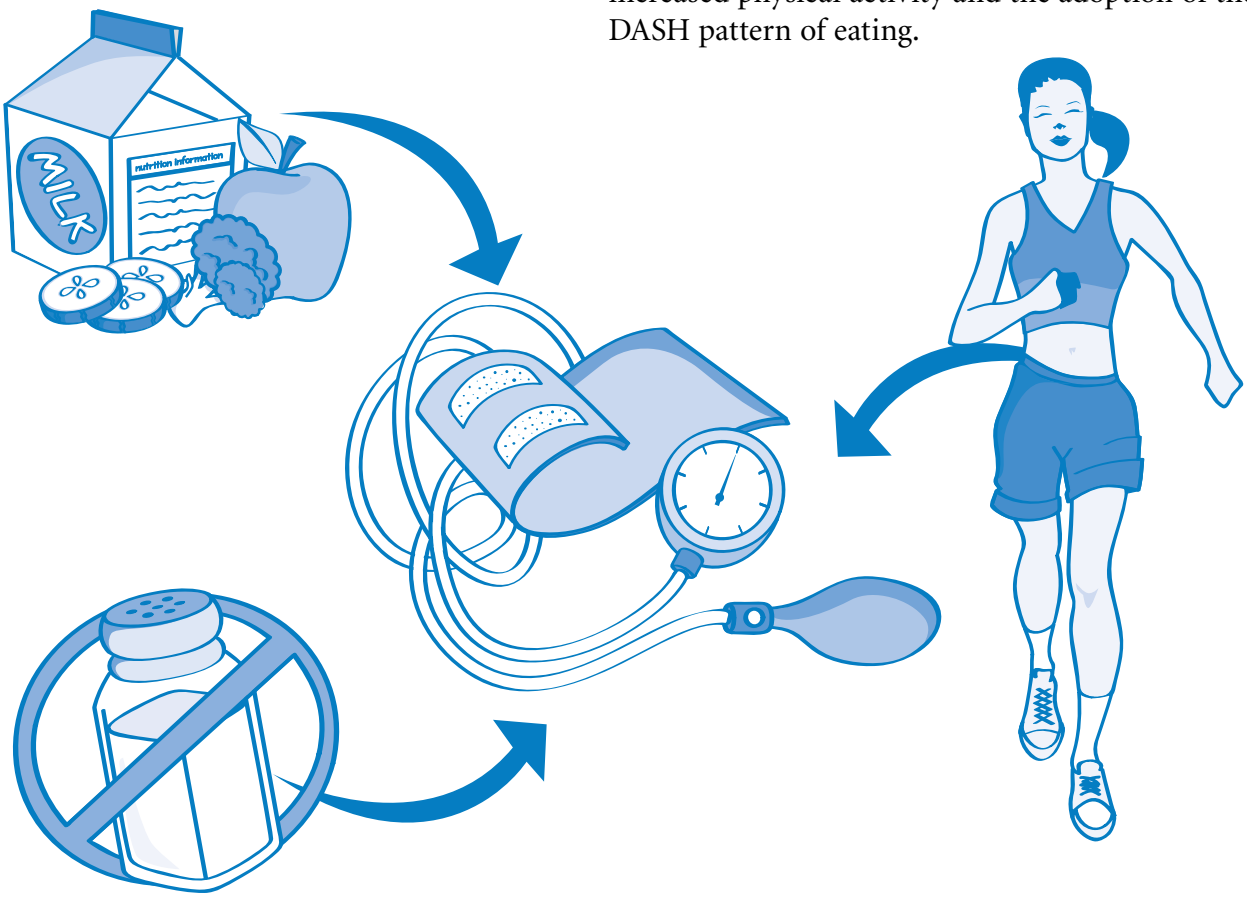
Practical Guidelines

Strategies to reduce the prevalence of hypertension in Canada and worldwide are necessary. Even small reductions in blood pressure, if applied to an entire population, could provide a benefit. At a population level, sodium reduction has been projected to have significant impact; however, as has been seen in other countries, the process of reducing sodium in the food supply is a complex issue and requires time.[17,31] On an individual basis, though, salt reduction alone may not be an adequate strategy for blood pressure management if overall diet quality is poor.

Canadians are under-consuming vegetables, fruit and milk products – the same foods highlighted in the DASH diet.

Currently, the overall diet of Canadians is less than optimal. The Canadian Community Health Survey shows that Canadians are under-consuming vegetables, fruit and milk products – the same foods highlighted in the DASH diet.[27] Consequently, strategies to improve the consumption of these foods are essential for overall health, including blood pressure management, and may provide more benefit than sodium reduction alone can.

Research into multiple health behaviour changes suggests that the introduction of behavioural goals simultaneously, rather than sequentially, may be more effective for success.[31] Therefore, in addition to addressing dietary sodium intake, health professionals need to continue to stress other lifestyle modifications known to reduce blood pressure: weight reduction, increased physical activity and the adoption of the DASH pattern of eating.



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