

Preventing Disease with Diet and Exercise



Khursheed N. Jeejeebhoy, MBBS, PhD, FRCPC

Presented at the University of Toronto's Primary Care Today: Educational Conference and Medical Exposition, Toronto, Ontario, May 2007.

Over the last century, our lifespan has increased by 30 years from 50- to 80-years-of-age. However, this increase in lifespan has come at a cost which often means a long, but not necessarily healthy life. We have disabled seniors guzzling handfuls of pills each day with several plastic and metal prosthetic devices residing in their bodies. In contrast to this, we also have 90-year-olds who are active and free of disease. We refer to them as having "good genes." The question is whether we are doomed to depend on our genes or can we change our environment; thus change the response of our genetic self to be healthy?

This article will show evidence-based information which indicates that we can live a long and healthy life by modifying the action of "harmful genes."

Environment

I was struck by the effect of our environment on individuals when visiting Australia. The aboriginal population living in the bush were healthy and strong. Those living in an urban community, such as Alice Springs, were diabetic, hypertensive and had coronary artery disease (CAD). The same genes but different environment made all the difference in their health.

Similarly, persons living in remote villages in the Dominican Republic have longer life-spans than those living in the city.

The level of exercise along with the type and amount of dietary intake in the two environments is what makes the difference. To illustrate this point, a randomized controlled trial in patients with stable angina¹ showed that exercise training was better than angioplasty in terms of event-free survival, better ability to exercise and work and, more importantly, the diameter of the coronary artery became smaller with time in the angioplasty group as compared with the exercise group. In these patients, lifestyle change was better than a modern marvel of technology.

In another context, the effect of diet components on all causes of death, cardiovascular (CV) and cancer deaths was studied in a Greek population of 22,043 adults who were followed for 44 months.² A 10-point score for adherence to a Mediterranean diet (Table 1) was used to determine the effect of diet on outcome. Over the 44 months, there were 275 deaths. A two-point increase in adherence to a Mediterranean diet was associated with a 25% reduction in overall mortality as well as a similar reduction in mortality due to CV disease and cancer.

Table 1

Definition of a Mediterranean diet

- High intake of:
 - Vegetables
 - Legumes
 - Fruits and nuts
 - Cereal
 - Fish
- Low intake of:
 - Meat
 - Poultry
 - Dairy products
- A high monounsaturated-to-saturated fat ratio
- Moderate alcohol intake

A single-blind randomized, controlled trial of in 1,000 patients with angina pectoris, MI or surrogate risk factors for CAD was performed. Four-hundred and ninety-nine patients were allocated to a diet rich in whole grains, fruits, vegetables, walnuts and almonds. Five-hundred and one patients consumed a controlled local diet similar to the Step I National Cholesterol Education Program (NCEP) prudent diet.³ The results showed that total cardiac endpoints were significantly fewer in the intervention group than in the control group (39 vs. 76 events, $p < 0.001$). Sudden cardiac deaths were also reduced (six vs. 16, $p = 0.015$), as were nonfatal MIs (21 vs. 43, $p < 0.001$).



Dr. Jeejeebhoy is an Emeritus Professor of Medicine, University of Toronto and a Physician, St. Michael's Hospital, Toronto, Ontario.

The role of diet and exercise

It is obvious that diet and exercise can have profound effect on hard endpoints such as death. The question is how does it work?

Metabolic syndrome

The major cause of morbidity and mortality in Western countries and, increasingly with the rise of prosperity in countries such as India and China, is the Insulin Resistance Syndrome or Metabolic syndrome. This is defined as fasting hyperinsulinemia alone or with fasting blood glucose levels > 6.1 mmol/L with at least two of the following:

1. Abdominal obesity of waist-to-hip ratio > 0.9
2. Dyslipidemia defined as triglyceride levels > 1.7 mmol/L or HDL-C < 0.9 mmol/L
3. BP $> 140/90$ mmHg or on antihypertensive drugs

The major peripheral site of insulin resistance is skeletal muscle. Glucose disposal by muscle in insulin-resistant subjects is reduced due to reduced glucose transport-phosphorylation and reduced glycogen synthesis.⁴ In contrast, adipose tissue is not insulin resistant and the high insulin-glucose levels promote fatty acid synthesis from glucose and deposition in adipose tissue.

Effect of exercise on insulin resistance

Aerobic exercise at 65% of maximum volume (V) O_2 for 45 minutes three times a week for six weeks increases glucose transport into muscle and glycogen synthesis to well within the normal range. Aerobic exercise makes an individual with genetic insulin resistance insulin sensitive.

Resistive or strength training exercise

The effect of aerobic exercise has been indicated above in reducing insulin resistance. The other form of exercise is resistive or muscle-building. This form of exercise involves movements against resistance or weights for different muscle groups. It has been shown that a reduced insulin resistance was found in subjects 50- to 80-years-of-age who performed this type of exercise for 1.25 hours, three times a week.⁵ The exercise trained different muscle groups at 80% of maximum resistance tolerated for 24 repetitions.

Over the last century, our lifespan has increased by 30 years from 50- to 80-years-of-age.

Another study found that resistive exercises have major benefits in musculoskeletal health. Subjects (87-years-of-age) who could not walk were randomized to placebo exercise or to resistive exercise of the extensor muscles for 45 minutes three times a week. Resistive exercise significantly improved stair climbing and self-mobility due to improved strength and balance of wasted muscles in these otherwise chair-bound persons.⁶

Effect of diet on insulin resistance

The effect of feeding a carbohydrate source on blood insulin and glucose levels varies depending on the chemical structure of the carbohydrate. Soluble carbohydrates, such as sugar or

glucose, are rapidly absorbed and result in marked increases in blood glucose and insulin levels. The same amount of carbohydrate fed as a raw starch results in a small increase in blood glucose and insulin levels. The ratio of the area under the curve of the blood glucose response over two hours, after feeding a given source of carbohydrate (e.g., starch), divided by the area when fed glucose, is called glycemic index.⁷ The lower the glycemic index, the slower the release of carbohydrate from the given food with consequent lower blood glucose and insulin levels. Eating low glycemic index foods reduces the insulin response to a given carbohydrate and prevents hyperlipidemia.⁵

Effect of weight loss on insulin resistance

In addition to the unique effects of dietary components and exercise, the third way of altering insulin resistance is weight reduction, which in this context means the reduction of abdominal fat. However, being overweight is not the same as insulin resistance. Weight reduction only benefits patient who are not only overweight but also insulin-resistant. This fact is illustrated by a study of 24 obese women who were tested for insulin resistance by infusing a standard amount of glucose and insulin and measuring their steady-state blood glucose levels. In the insulin-sensitive individuals, the mean steady-state blood glucose was 3.8 mmol/L, whereas in the insulin-resistant women of the same degree obesity and who were infused at the same rate with both glucose and insulin, their blood glucose was markedly elevated at 12.1 mmol/L. Both groups were given a calorie-restricted diet and lost about 8 kg of weight. On repeating the

insulin clamp, the steady-state blood glucose in the sensitive group did not change but the resistant group showed a significant fall in steady-state glucose levels from 12.1 mmol/L to 8 mmol/L.⁸

Persons living in remote villages in the Dominican Republic have longer lifespans than those living in the city.

Diet composition and weight loss

Diets cause weight loss by simple mass balance, namely if energy restriction, in relation to requirements, causes weight loss. The main reasons why diets do not work is that reducing intake causes hunger and, ultimately, a desire to eat more. The successful diet among other factors should reduce intake when the person is allowed to eat the given diet *ad libitum*.

Two trials compared energy intake (with a fat restricted diet soluble carbohydrate [sugar and refined starches] diet) with a fat restricted complex carbohydrate and a control group (usual food choices). All were permitted to be eaten *ad libitum*.^{9,10}

Complex carbohydrate diet

The complex carbohydrate diet resulted in a lower intake of calories as compared with the others by about 300 Kcal/day. These trials showed that a low-fat, high-complex carbohydrate diet resulted in greater weight loss, lower

cholesterol and a stable triglyceride level in blood; whereas a low-fat, high simple carbohydrate diet increased energy intake resulting in no change to weight or cholesterol and increased triglycerides in the blood.

From these trials it can be concluded that for weight control, it is necessary to take a diet rich in complex carbohydrates and low in sugars or refined carbohydrates.

Protein

Another dietary component which reduces intake of energy when allowed to be eaten *ad libitum* is protein. Higher protein intakes, as given in the Atkins diet, clearly reduce intake and increase weight loss in comparison to Zone and Learn diets which restrict fat intake and the Ornish diet which almost eliminates fat in the diet.¹¹ It was shown that obese subjects following the Montignac diet (rich in protein with 30% energy intake) *ad libitum* consumed significantly less energy than those randomized to a American Heart Association Step 1 diet, which is low in fat but has only 15% protein.¹²

Diet and hypertension

The Dietary Approaches to Stop Hypertension (DASH) study showed that a diet rich in fruits, vegetables and milk (high in potassium and calcium) significantly reduced BP.¹³ Furthermore, even when this diet was eaten, an additional reduction in BP was achieved by reducing sodium intake to 50 mmol q.d.¹⁴


Do diet and exercise alter outcome?

While it is clear that diet, exercise and weight loss will reduce insulin resistance, will these measures alter morbidity and mortality? Bijnen, *et al*⁵ followed a cohort of 472 men for five years. The effect of walking or cycling for 20 minutes, three times per week resulted in a risk reduction for mortality of 0.44 (CI 0.25 to 0.80). Past activity was not protective. In a 16 year cohort study, Sandvik, *et al*⁶ showed a graded reduction in mortality with increasing physical activity. The effect of diet on mortality has been discussed earlier.^{2,3}

Conclusion

The data presented above indicate that individuals with a personal or family history of diabetes, CAD and hypertension would benefit from avoiding soluble carbohydrates, eating a diet high in proteins mainly from milk and fish and eating fruits and vegetables *ad libitum* which adds up to the Mediterranean diet.

In addition, regular aerobic exercise, raising the pulse to 65% to 70% of the maximum, three times a week and resistive exercise to avoid muscle loss with ageing:

- improves function,
- reduces the risk of diabetes,
- reduces the risk of CAD and
- may prolong life. 

References

1. Hambrecht R, Walther C, Möbius-Winkler S, et al: Percutaneous Coronary Angioplasty Compared With Exercise Training in Patients with Stable Coronary Artery Disease. A Randomized Trial. *Circulation* 2004; 109(11):1371-8.
2. Trichopoulos, A, Costacou T, Bamia C, et al: Adherence to a Mediterranean Diet and Survival in a Greek Population. *N Engl J Med* 2003; 348(26):2599-608.
3. Singh RB, Dubnov G, Niaz MA, et al: Effect of an Indo-Mediterranean Diet on Progression of Coronary Artery Disease in High Risk Patients (Indo-Mediterranean Diet Heart Study): A Randomised Single-Blind Trial. *Lancet* 2002; 360(9344):1455-61.
4. Perseghin G, Price T, Petersen KF, et al: Increased Glucose Transport-Phosphorylation and Muscle Glycogen Synthesis After Exercise Training in Insulin-Resistant Subjects. *N Engl J Med* 1996; 335(18):1357-62.
5. Iglay HB, Thyfault JP, Apolzan JW, et al: Resistance Training and Dietary Protein: Effects on Glucose Tolerance and Contents of Skeletal Muscle Insulin Signaling Proteins in Older Persons. *Am J Clin Nutr* 2007; 85(4):1005-13.
6. Fiatarone MA, O'Neill EF, Ryan ND, et al: Exercise Training and Nutritional Supplementation for Physical Frailty in Very Elderly People. *N Engl J Med* 1994; 330(25):1769-75.
7. Wolever TM, Jenkins DJ, Jenkins AL, et al: The Glycemic Index: Methodology and Clinical Implications. *Am J Clin Nutr* 1991; 54(5): 846-54.
8. McLaughlin T, Abbasi F, Kim H-S, et al: Relationship Between Insulin Resistance, Weight Loss and Coronary Heart Disease Risk in Healthy, Obese Women. *Metabolism* 2001; 50(7):795-800.
9. Poppitt SD, Keogh GF, Prentice AM, et al: Long-Term Effects of *Ad Libitum* Low-Fat, High-Carbohydrate Diets on Body Weight and Serum Lipids in Overweight Subjects with Metabolic Syndrome. *Am J Clin Nutr* 2002; 75(1):11-20.
10. Saris WHM, Astrup A, Prentice AM, et al: Randomized Controlled Trial of Changes in Dietary Carbohydrate/Fat Ratio and Simple vs. Complex Carbohydrates on Body Weight and Blood Lipids: The CAR-MEN Study. The Carbohydrate Ratio Management in European National Diets. *Int J Obes Relat Metab Disord* 2000; 24(10):1310-8.
11. Christopher D, Gardner CD, Kiazand A, et al: Comparison of the Atkins, Zone, Ornish and LEARN Diets for Change in Weight and Related Risk Factors Among Overweight Premenopausal Women. The A To Z Weight Loss Study: A Randomized Trial. *JAMA* 2007; 297(9):969-77.
12. Dumesnil JG, Turgeon J, Tremblay A, et al: Effect of a Low-Glycemic Index–Low-Fat–High Protein Diet on the Atherogenic Metabolic Risk Profile of Abdominally Obese Men. *Br J Nutr* 2001; 86(5):557-68.
13. Appel LJ, Moore TJ, Obarzanek E, et al: A Clinical Trial of the Effects of Dietary Patterns on Blood Pressure. *N Engl J Med* 1997; 336(16):1117-24.
14. Sacks FM, Svetkey LP, Vollmer WM, et al: Effects on Blood Pressure of Reduced Dietary Sodium and the Dietary Approaches to Stop Hypertension (DASH) Diet. *N Engl J Med* 2001; 344(1):3-10.
15. Bijnen FCH, Feskens EJM, Caspersen CJ, et al: Baseline and Previous Physical Activity in Relation to Mortality in Elderly Men. *Am J Epidemiol* 1999; 150(12):1289-96.
16. Sandvik L, Erikssen J, Thaulow E, et al: Physical Fitness as a Predictor of Mortality Among Healthy, Middle-Aged Norwegian Men. *N Engl J Med* 1993; 328(8):533-7.