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"Fleshing Out" the Benefits of Adopting a Vegetarian Diet

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Dietary and lifestyle changes remain the cornerstone of heart disease prevention.[1,2] It has been estimated that >80% of cardiovascular events can be prevented with dietary and lifestyle modifications.[3] Vegetarian diets are one approach to achieving a heart healthy dietary pattern, low in saturated and trans-fats and high in fiber and antioxidants. While other heart healthy dietary strategies such as low-carbohydrate, low-glycaemic index and Mediterranean diets have been shown to reduce incidence of cardiovascular disease, recent meta-analyses have found that these diets do not consistently reduce low density lipoprotein-cholesterol (LDL-C),[4] a major therapeutic blood lipid target to improve cardiovascular health.[1,2] This lack of consistent effect represents a possible major barrier to recommending these diets to dyslipidemic individuals. The inconsistent lipid benefit with these dietary strategies relate to the higher consumption of saturated fats and an incomplete avoidance of red meat intake, both of which have been implicated in cardiovascular disease risk.[5] Therefore, a complete avoidance of red meat consumption such as the vegetarian diet may represent a dietary strategy to which cardiovascular risk can be reduced through improving blood lipids.

The cardinal feature of vegetarian diets is the absence of animal products, but there are those who claim to follow a vegetarian diet that include some forms of animal flesh.[6] The variation in actual practice, thus has led to subtypes of vegetarianism: (1) pesco-vegetarians, who omit all animal products other than fish; (2) lacto-ovo-vegetarians, who omit all animal products but include eggs and dairy products; (3) lacto-vegetarians, who omit all animal products but dairy products; (4) ovo-vegetarian, which omits all animal products but eggs; and (5) vegans, who omit all animal products including honey. Although there is variation in the practice of vegetarian diets, the common underlying practice amongst them all is the avoidance of consuming red meat. This avoidance of red meat consumption may confer important blood lipid effects that other dietary strategies have not been able to produce.

To provide high-quality evidence to assess the above relationship, Wang et al systematically review and meta-analyze the effects of vegetarian diets on blood lipids from randomized controlled trials to help assess the impact of vegetarian diets on cardiovascular risk, unconfounded by lifestyle habits.[7] The 10 trials assessed the effects of vegetarian diets on blood lipids over an average of 24 weeks. The main finding is that vegetarian diets, compared with omnivorous diets, improve therapeutic targets for cardiovascular disease risk reduction[1,2] including low-density lipoprotein cholesterol (mean difference [MD]=−0.34 mmol/L [95% CI: −0.57, −0.11]; $P<0.001$) and non-high-density lipoprotein cholesterol (HDL-C) (MD=−0.30 mmol/L [95% CI −0.50, −0.10]; $P=0.04$). There were also relative reductions in HDL-C (MD=−0.10 mmol/L [95% CI: −0.14, −0.06]; $P<0.001$), total cholesterol (MD=−0.36 mmol/L [95% CI: −0.55, −0.17]; $P<0.001$), with no effect on triglycerides (MD=0.04 mmol/L [95% CI: −0.05, 0.13]; $P=0.40$). The effect on low-density lipoprotein cholesterol alone would be expected to reduce coronary heart disease risk by ≈22% in someone with average lipid levels.[8] Importantly, the meta-analysis also showed a large and important relative reduction in body weight (MD=−2.88 kg [95% CI −3.56, −2.20]; $P<0.001$). Thus it appears that vegetarian diets compared to omnivorous diets may improve body weight and blood lipids (except for HDL-C and TG), representing a dietary strategy that can improve cardiovascular risk through improvements on dyslipidemia.

One potential concern noted in this meta-analysis is that HDL-C was significantly reduced on vegetarian diets, which may offset the observed health benefits. The observed effect, however, must be interpreted in context of the other findings. Although there was a significant reduction on HDL-C, other

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important cardiovascular risk factors improved. It can be argued that the reduction in other pro-atherogenic lipids (LDL-C and non-HDL-C) and body weight is far more important; as both are established clinical targets while HDL-C is not.[1,2] Observational studies have failed to demonstrate reduced cardiovascular risk in those with a genotype that favours high-HDL-C compared with those with a genotype that favours low-HDL-C.[9] Furthermore, pharmaceutical interventions to raise HDL-C have not resulted in reduced CVD risk.[10] Taken together, these finding supports the emerging understanding that lipid functionality rather than absolute cholesterol mass maybe a better indicator of atherosclerosis risk.[10] In those in whom potentially lowered levels of HDL-C is a concern, other foods that fit with a vegetarian diet such as nuts and olive oil,[11] may be included to raise HDL-C and reduce CVD risk as demonstrated by the PREDIMED trial.[12]

The strengths of this study include its rigorous search criteria, clear inclusion and exclusion criteria, and an ability to look at several lipid markers of cardiovascular risk. Its limitations are shared by most meta-analyses of randomized trials in nutrition including lack of blinding of participants (which may have led those assigned to vegetarian diets to change their lifestyle in other ways), the small number of studies that allowed for estimates of the effects on the total cholesterol:HDL-C ratio, and possibly intractable confounding by changes in body weight between the studied groups. Further analyses using meta-regression analyses, to derive an estimate "adjusted" for change in body weight, may help to clarify this point. Nevertheless, it is of great public health importance that these diets did lead to meaningful changes in body weight, a desirable part of an overall strategy for cardiovascular risk reduction. Furthermore, it is known that diets rich in plant foods with cholesterol-lowering properties, such as the Dietary Portfolio, lower blood lipids and blood pressure independent of body weight change.[13]

The cardioprotective advantage of vegetarian diets has long been long recognized. In a systematic review and meta-analysis of prospective cohorts, vegetarian compared with non-vegetarian diets reduced ischemic heart disease risk by $\sim$30% (risk ratio [RR]= 0.71 [95% CI: 0.56, 0.87]),[14] a risk reduction that is similar to what was reported in PREDIMED trial where modified-Mediterranean diets was compared to a low-fat diet with a 5-year follow-up duration.[12] Furthermore, improvement of the risk factors of cardiovascular disease have been reported. Compared to non-vegetarian diets, vegetarian diets have shown significant benefits on blood pressure, glycaemia, and body weight.[15–17]

The benefits of the vegetarian diet underscores the importance of taking a whole dietary approach to managing cardiometabolic health. Though the cardiometabolic benefits of vegetarian diets are widely attributed to the complete avoidance of red meat,[6] it is important to emphasize that the vegetarian diet are also healthy because of the reciprocal increases in the intakes other healthy foods.[18] In a national survey lead by the United States Department of Agriculture (USDA), the overall dietary pattern of self-defined "vegetarians" compared to non-vegetarians were generally found to be healthier.[19] Compared with non-vegetarians, vegetarians eat diets lower in total fat, saturated fat, and cholesterol and higher in fiber.[19] They also consume more grains, legumes, vegetables (green leafy and yellow), fruit, and wine.[19] The health benefits seen with vegetarian diets are likely related to synergy among many healthy plant foods. Nevertheless, it is possible to eat a vegan diet that is highly processed, rich in fat and hydrogenated oils and low in fiber; this sort of diet will not provide health benefits solely because it is devoid of animal flesh. Other dietary patterns such as Mediterranean diets, plant-based diets, or the DASH diet, have been consistently associated with good health and also combine a number of healthy and highly-nutritious minimally processed foods, including of some of the same ones found in vegetarian diets.[1,2] These shared characteristics underscore the importance of viewing diets as more than a defining characteristic of avoidance or overconsumption of single nutrients or food groups.

Beyond effects on cardiovascular health, plant-based diets may be kinder to the environment, if harvested and supplied responsibly. The environmental and economic impact of food choice must be considered in light of air and water pollution, loss of biodiversity, and destruction of ecosystems. A plant-based diet reduces the demand for raised livestock, which is a major stress on ecosystems and on the planet as whole.[20] Adopting a plant-based diet will not eliminate these problems altogether, especially in the face of a growing global population, but switching to more locally produced, plant-based foods will reduce the burden of agriculture and fossil fuel used for transportation. In a comparative study between nonvegetarians and vegetarian diet adopters living in California, vegetarian diets still demonstrated needs for natural resources for cultivation, but compared to nonvegetarian diets, these diets required 2.9 times less water, 2.5 times less primary energy, 13 times less fertilizer, and 1.4 times less pesticides.[21] Thus, a switch to a more sustainable diet primarily based on plant foods represents a way to ensure both environmental sustainability and human health.

In conclusion, other established dietary strategies such as the low-carbohydrate, low-glycaemic index and Mediterranean diets have been shown to improve cardiometabolic risk because of the combination of healthy foods eaten together, but effects of these diets on serum lipid risk factors for CVD is less clear.[4] While the vegetarian diet is similar in dietary composition to the Mediterranean diet, it also includes the complete avoidance of red meat and

reciprocal increases in other healthy foods. This difference in dietary practice may explain the improvement in blood lipids (except for HDL-C) that is not seen previously in these dietary strategies.[7] Therefore, vegetarian diets may represent an alternative and sustainable dietary strategy to which individuals with dyslipidemia can follow to improve cardiovascular risk.

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References

1. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. *Circulation*. 2002;106:3143–3421.
2. Anderson TJ, Gregoire J, Hegele RA, Couture P, Mancini GB, McPherson R, Francis GA, Poirier P, Lau DC, Grover S, Genest J Jr, Carpentier AC, Dufour R, Gupta M, Ward R, Leiter LA, Lonn E, Ng DS, Pearson GJ, Yates GM, Stone JA, Ur E. 2012 update of the Canadian Cardiovascular Society guidelines for the diagnosis and treatment of dyslipidemia for the prevention of cardiovascular disease in the adult. *Can J Cardiol*. 2013;29:151–167.
3. Stampfer MJ, Hu FB, Manson JE, Rimm EB, Willett WC. Primary prevention of coronary heart disease in women through diet and lifestyle. *N Engl J Med*. 2000;343:16–22.
4. Ajala O, English P, Pinkney J. Systematic review and meta-analysis of different dietary approaches to the management of type 2 diabetes. *Am J Clin Nutr*. 2013;97:505–516.
5. Pan A, Sun Q, Bernstein AM, Schulze MB, Manson JE, Stampfer MJ, Willett WC, Hu FB. Red meat consumption and mortality: results from 2 prospective cohort studies. *Arch Intern Med*. 2012;172:555–563.
6. Fraser GE. Vegetarian diets: what do we know of their effects on common chronic diseases? *Am J Clin Nutr*. 2009;89:1607S–1612S.
7. Wang F, Zheng J, Yang B, Jiang J, Fu Y, Li D. Effects of vegetarian diets on blood lipids: a systematic review and meta-analysis of randomized controlled trials. *J Am Heart Assoc*. 2015;4:e002408 doi: 10.1161/JAHA.115.002408.
8. Gotto AM Jr, Grundy SM. Lowering LDL cholesterol: questions from recent meta-analyses and subset analyses of clinical trial DataIssues from the Interdisciplinary Council on Reducing the Risk for Coronary Heart Disease, ninth Council meeting. *Circulation*. 1999;99:E1–E7.
9. Voight BF, Peloso GM, Orho-Melander M, Frikke-Schmidt R, Barbalic M, Jensen MK, Hindy G, Holm H, Ding EL, Johnson T, Schunkert H, Samani NJ, Clarke R, Hopewell JC, Thompson JF, Li M, Thorleifsson G, Newton-Cheh C, Musunuru K, Pirruccello JP, Saleheen D, Chen L, Stewart A, Schillert A, Thorsteinsdottir U, Thorgeirsson G, Anand S, Engert JC, Morgan T, Spertus J, Stoll M, Berger K, Martinelli N, Girelli D, McKeown PP, Patterson CC, Epstein SE, Devaney J, Burnett MS, Mooser V, Ripatti S, Surakka I, Nieminen MS, Sinisalo J, Lokki ML, Perola M, Havulinna A, de Faire U, Gigante B, Ingelsson E, Zeller T, Wild P, de Bakker PI, Klungel OH, Maitland-van der Zee AH, Peters BJ, de Boer A, Grobbee DE, Kamphuisen PW, Deneer VH, Elbers CC, Onland-Moret NC, Hofker MH, Wijmenga C, Verschuren WM, Boer JM, van der Schouw YT, Rasheed A, Frossard P, Demissie S, Willer C, Do R, Ordovas JM, Abecasis GR, Boehnke M, Mohlke KL, Daly MJ, Guiducci C, Burtt NP, Surti A, Gonzalez E, Purcell S, Gabriel S, Marrugat J, Peden J, Erdmann J, Diemert P, Willenborg C, Konig IR, Fischer M, Hengstenberg C, Ziegler A, Buysschaert I, Lambrechts D, Van de Werf F, Fox KA, El Mokhtari NE, Rubin D, Schrezenmeir J, Schreiber S, Schafer A, Danesh J, Blankenberg S, Roberts R, McPherson R, Watkins H, Hall AS, Overvad K, Rimm E, Boerwinkle E, Tybjaerg-Hansen A, Cupples LA, Reilly MP, Melander O, Mannucci PM, Ardissino D, Siscovick D, Elosua R, Stefansson K, O'Donnell CJ, Salomaa V, Rader DJ, Peltonen L, Schwartz SM, Altshuler D, Kathiresan S. Plasma HDL cholesterol and risk of myocardial infarction: a mendelian randomisation study. *Lancet*. 2012;380:572–580.
10. Ridker PM, Genest J, Boekholdt SM, Libby P, Gotto AM, Nordestgaard BG, Mora S, MacFadyen JG, Glynn RJ, Kastelein JJ, JUPITER Trial Study Group. HDL cholesterol and residual risk of first cardiovascular events after treatment with potent statin therapy: an analysis from the JUPITER trial. *Lancet*. 2010;376:333–339.
11. Spiller GA, Jenkins DA, Bosello O, Gates JE, Cragen LN, Bruce B. Nuts and plasma lipids: an almond-based diet lowers LDL-C while preserving HDL-C. *J Am Coll Nutr*. 1998;17:285–290.
12. Estruch R, Ros E, Salas-Salvado J, Covas MI, Corella D, Aros F, Gomez-Gracia E, Ruiz-Gutierrez V, Fiol M, Lapetra J, Lamuela-Raventos RM, Serra-Majem L, Pinto X, Basora J, Munoz MA, Sorli JV, Martinez JA, Martinez-Gonzalez MA. Primary prevention of cardiovascular disease with a Mediterranean diet. *N Engl J Med*. 2013;368:1279–1290.
13. Jenkins DJ, Jones PJ, Lamarche B, Kendall CW, Faulkner D, Cermakova L, Gigleux I, Ramprasath V, de Souza R, Ireland C, Patel D, Srichaikul K, Abdulnour S, Bashyam B, Collier C, Hoshizaki S, Josse RG, Leiter LA, Connelly PW, Frohlich J. Effect of a dietary portfolio of cholesterol-lowering foods given at 2 levels of intensity of dietary advice on serum lipids in hyperlipidemia: a randomized controlled trial. *JAMA*. 2011;306:831–839.
14. Huang T, Yang B, Zheng J, Li G, Wahlqvist ML, Li D. Cardiovascular disease mortality and cancer incidence in vegetarians: a meta-analysis and systematic review. *Ann Nutr Metab*. 2012;60:233–240.
15. Huang RY, Huang CC, Hu FB, Chavarro JE. Vegetarian diets and weight reduction: a meta-analysis of randomized controlled trials. *J Gen Intern Med*. 2015; [Epub ahead of print].
16. Yokoyama Y, Nishimura K, Barnard ND, Takegami M, Watanabe M, Sekikawa A, Okamura T, Miyamoto Y. Vegetarian diets and blood pressure: a meta-analysis. *JAMA Intern Med*. 2014;174:577–587.
17. Yokoyama Y, Barnard ND, Levin SM, Watanabe M. Vegetarian diets and glycemic control in diabetes: a systematic review and meta-analysis. *Cardiovasc Diagn Ther*. 2014;4:373–382.
18. Sievenpiper JL, Dworatzek PD. Food and dietary pattern-based recommendations: an emerging approach to clinical practice guidelines for nutrition therapy in diabetes. *Can J Diabetes*. 2013;37:51–57.
19. Haddad EH, Tanzman JS. What do vegetarians in the United States eat? *Am J Clin Nutr*. 2003;78:626S–632S.
20. Tilman D, Clark M. Global diets link environmental sustainability and human health. *Nature*. 2014;515:518–522.
21. Marlow HJ, Hayes WK, Soret S, Carter RL, Schwab ER, Sabate J. Diet and the environment: does what you eat matter? *Am J Clin Nutr*. 2009;89:1699S–1703S.

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