



Nutrition and Cardio-metabolic Health: Lessons, Resolved Issues and Unanswered Questions

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Abstract

The Global Burden of Disease Study 2017 has concluded that inappropriate diet is associated with approximately one-fifth of the total mortality worldwide. It is challenging to study the effects of nutrition on cardiovascular diseases owing to inherent biases and problems involved in confirming the type and proportion of nutrients consumed. Thus, it is difficult to arrive at a solid conclusion regarding what foods are healthy. Furthermore, there are many foods about which there are prevailing controversies, such as saturated fats, wheat products and certain types of cooking oils. The present article attempts to review the abundant data on this subject and suggest recommendations regarding foods that are healthy, unhealthy and still controversial, i.e., those needing further evaluation.

■ Keywords

- Body weight
- Cardiovascular diseases
- Diet
- Risk factors
- Nutritional status

■ Introduction

Inappropriate diet is among the leading risk factors for morbidity and mortality worldwide. The Global Burden of Disease Study 2017 concluded that 11 million deaths (i.e., approximately one-fifth of all deaths in 2017) were attributable to diet-associated risk factors.¹ The ideal diet has been controversial since a long time; foods formerly considered unhealthy (for example, eggs because of their cholesterol content) are now considered healthy, and staple food items (for example, cereals, bread and potatoes) are now considered suspects. Studies on food items are subject to bias and uncertainty as these data are usually derived from population studies and meta-analyses based on food frequency questionnaires in a limited subset of the population, often at only one point in time and for a limited period.² Moreover, dietary patterns in populations tend to change over years, both as the population grows older and as newer concepts appear in lay publications and on social media. Therefore, arriving at solid conclusions is difficult and, often, impossible. The purpose of this review is (1) to examine the abundant literature, (2) provide conclusions where the data are uniform and there is a broad consensus and (3) give a balanced view about topics lacking consensus. In addition, this report identifies issues that need further investigation. Because it would be impossible to provide detailed review of the entire literature on nutrition in one article, this article starts with revisiting key lessons over the last few decades of nutrition research.

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■ Lessons from randomized trials, population studies, systematic reviews and meta-analyses:

1. Diet, along with exercise, strongly influences cardio-metabolic risk factors. Parameters such as body weight, body fat (particularly visceral fat), blood sugar level, blood lipid levels, blood pressure, hepatic and renal function, lean muscle and bone mass, inflammation, oxidative stress, endothelial health and gut microbiome are regulated and modified by the food we eat, possibly via hormonal and other influences.^{3,4,5}

2. The macronutrients (carbohydrates, fats and proteins) are neutral for obesity, diabetes and cardiovascular diseases (CVD), implying that individual food choices rather than proportion of nutrients influence health.³

3. There is now growing evidence that the belief of obesity and weight gain being a result of energy imbalance (**the ‘Calories-In, Calories-Out’ or CICO hypothesis**) is an oversimplification of a complex metabolic process. Calorie restriction in any form or exercise to burn calories does result in initial weight loss, but this is not maintained in the long run. Typically, weight loss plateaus within 3–6 months and, on an average, half of the lost weight is regained within 1–2 years.^{5,6,7} Weight loss and maintenance are best achieved with healthy dietary patterns combined with regular exercise, without counting calories or relative proportions of nutrients. Healthy foods result in greater satiety and have higher metabolic expenditure even if they are calorie-dense, whereas unhealthy foods are often associated with quick bursts of energy followed by troughs, leading to craving for foods/snacks (which is related to brain reward mechanisms or falling blood sugar), ultimately leading to insulin resistance, obesity and adverse effects on gut microbiome.^{5,7,8}

4. For the maintenance of body weight as well as overall health, the focus should change from total calories, total fat and saturated fats to overall dietary patterns. Furthermore, for optimal health, the attention of community education should shift from nutrients and calories to healthy food patterns and exercise, because large randomized trials have failed to show any benefit with low-calorie, low-fat or low saturated-fat diets (Women’s Health Initiative).⁹ In contrast, the study showing the maximum health benefits involved a higher fat diet (the PREDIMED study).¹⁰ Even traditional lacto-vegetarianism, which is prevalent in India (deemed ‘healthy’ because of the avoidance of meats), has potential for the consumption of unhealthy foods such as sweets, fries and sodas. Currently, the Mediterranean diet appears to be the healthiest diet pattern on the basis of published study data.^{5,10}

This article presents a brief discussion about the health effects of the macronutrients followed by a review of the data about prominent food items under three headings—(1) *foods that by consensus are considered unhealthy*, (2) *foods that are considered healthy and* (3) *foods with controversial nutritional status*. There is an additional brief discussion on why we crave carbohydrates followed by questions that need further investigation for concrete answers.

■ Carbohydrates

Carbohydrates account for 50% or more of the daily calorie intake in most populations worldwide. Initial dietary recommendations, starting with the American Heart Association (AHA) in 1957 and the US Government in 1977, advised reducing the consumption of fats, particularly saturated fats, and increasing the intake of carbohydrates to compensate.¹¹ However, it is now established that fruits, vegetables, legumes and minimally processed whole grains are healthy but refined carbohydrates, such as processed sugar, sweets, starches, sugar-sweetened beverages (SSBs; e.g., colas, sweetened juices and energy drinks), bread, most cereals and desserts, are not. Therefore, it is neither advisable to have an unrestricted consumption of carbohydrates nor desirable to have a very low-carbohydrate diet (Atkins’ diet or Keto diets), although the latter is still shrouded in controversy.^{3,5} The 2015–2020 Dietary Guidelines have thus rightly recommended reducing the intake of added sugar as well as refined carbohydrates.¹²

While carbohydrates are neutral for the overall cardio-metabolic health, refined and processed carbohydrates are shown to be unhealthy and have been reported to be associated with obesity, diabetes, lipid abnormalities, hypertension and CVD.^{3,5,13–18} **The metabolism of potatoes and refined flour is similar to that of sugar (as these apparently complex carbohydrates are merely glucose molecules stringed together). Hence, what is more important is their preparation—the fiber content, level of processing and whole-grain content, all of which determine the glycemic response to a food, which is determined by the glycemic index and the glycemic load of foods).**⁵

The deleterious effects of refined carbohydrates on inducing or worsening insulin resistance and weight gain are stronger in women, older individuals and those who lead a sedentary lifestyle than in men, younger individuals and those who lead an active lifestyle.^{5,7} Moreover, people paradoxically believe that they are eating a healthy diet as they are consuming these foods instead of fats, some of which are much healthier than processed foods. Hence, minimising the intake of refined carbohydrates and sugars is a major priority for community health.⁵

■ **Total Fats**

In 1957, the AHA first advocated restricting fats in the American diet. Dietary guidelines have continued to restrict fats, particularly saturated fats, in diet since their regular publication since 1977 for the prevention of obesity and CVD.^{11,12} **There appears to be very little evidence in support of this recommendation. Low-fat diets have not been shown to lower CVD, diabetes or cancer risks (Women’s Health Initiative)⁹ or result in better outcomes in individuals with diabetes (Look AHEAD trial),¹⁴ whereas high-fat diets (comprising 35%–45% of daily-calorie intake as fats instead of the earlier 30%) are at least as effective, if not more, in inducing weight loss and reducing CVD risk.^{5,9,10,19–21}** Several healthy foods, such as nuts, seeds, MUFA- and PUFA-rich oils and seafood, are rich in fats, whereas low-fat processed foods, such as sweets, starch, bread, cereals, most desserts and SSBs, are rich in unhealthy refined carbohydrates. Following a low-fat diet can thus lead to the propagation of unhealthy dietary patterns. Guidelines have influenced the prevalent tendency towards low-fat snacks, dressings and cookies in addition to promoting an excess consumption of refined carbohydrates, which are the only choice for people attempting to restrict fats. **Of note, *trans* fatty acids (TFA), which are found in fried foods, and partially hydrogenated oils, which are undoubtedly unhealthy, should be strictly avoided.**²²

■ **Proteins**

Guidelines advising dietary restriction of red meats and processed meats and compensation with carbohydrates have led to a reduction in the average daily intake of protein to 5%–15% of total calories, whereas a healthier proportion may be closer to 15%–25%. Total proteins appear to have little effect on important risk factors such as blood sugar, blood pressure, serum lipid levels or obesity and, on the basis of limited studies, appear to be neutral for CVD risk. There are also isolated reports of some protection from hemorrhagic strokes seen with animal protein intake; however, the mechanisms are not clear, and a possible protective effect of these proteins or dietary cholesterol against vascular fragility have been proposed.^{5,23,24} Notably, just like total fats or carbohydrates, proteins too come from various sources, both healthy (such as nuts, seeds, fish, cheese and curd) and unhealthy (such as processed and unprocessed red meats). This would again suggest that it is individual foods and the mode of cooking rather than macronutrients per se that are critical for overall health.

The characteristics of individual foods are now discussed in order to determine which foods can be consumed ad lib,

whose intake should be restricted and whose intake should be minimised or avoided. An understanding of healthy and unhealthy foods could help in controlling the ongoing epidemics of obesity and CVD.

1. Foods that by consensus are considered unhealthy

This category includes processed and unprocessed red meats, foods rich in TFA, certain oils (such as those containing high amounts of TFA), refined carbohydrates, starches, processed sugar, sweets, SSBs and excess salt. These are to be minimised or avoided altogether, with the exception of fresh unprocessed meat, which may be consumed once or, at most, twice a week.

2. Foods that have broad consensus of being useful or neutral for CVD (Table 1)

Healthy foods include fresh vegetables and fruits, nuts and seeds, whole grains, fish and fish oil, certain extra-virgin (unrefined) oils, legumes and non-fat components in vegetable oils such as phenolics; on the other hand, dairy foods (certain milk products such as curd and cheese), white meat and possibly tea and coffee are considered neutral, or even healthy. These foods can be consumed more liberally (within reasonable limits), particularly if they replace foods in category 1 (such as processed meats, refined carbohydrates, starch and sugary desserts).

Table 1: Foods considered healthy or health neutral with evidence base

Broad consensus	General consensus with some uncertainty	Controversy with respect to evidence and prevailing guidelines
Fresh vegetables and dietary fibre	n-3 and n-6 PUFA	Low-fat milk
Curd/yogurt	Plant derived MUFA	Cheese
Fresh fruits	Certain oils (EVOO, canola and soybean)	Certain oils (coconut, sunflower and safflower)
Nuts and seeds	White meat	Tea/coffee
Whole grains	Phenolics, flavones	Vitamin D
Fish and fish oil		Eggs
Legumes		Probiotics

PUFA, polyunsaturated fatty acid; MUFA, monounsaturated fatty acid; EVOO, extra-virgin olive oil

3. Foods with controversial nutritional status

This category includes foods rich in saturated fats (such as butter and ghee), refined wheat products, other dairy items (low-fat or full-fat milk), eggs, coffee, foods containing vitamin D, specific oils and fatty acids and probiotics. The aforementioned food items have conflicting data: either they were considered healthy earlier and are now thought to have deleterious effects in certain forms or have conventionally been deemed avoidable but are now believed to have possible beneficial effects (such as foods rich in saturated fats and full-fat milk).

There is too little evidence to draw conclusions upon some other popular recommendations: organic foods, grass-fed meat vs. grain-fed meat, modified vs. non-genetically modified foods, etc.

■ Category 1: Foods considered unhealthy (Table 2)

Table 2: Foods considered unhealthy with evidence base

Broad consensus	General consensus with some uncertainty	Controversy with respect to evidence and prevailing guidelines
Processed meats	White potatoes	Saturated fats and butter
Partially hydrogenated vegetable oils (TFA)	Excess unprocessed red meats	Dietary cholesterol and eggs
Refined grains and starch		Whole-fat vs. low-fat milk
Sugars and SSBs		Non-caloric sweeteners
Excess sodium		Moderate amounts of unprocessed meats
Excess alcohol		
Sweets and desserts		

TFA, *trans* fatty acids; SSBs, sugar-sweetened beverages

Red meats

Although there is controversy, it is the general consensus that the consumption of red meats (such as pork, mutton, beef and venison) should be limited. In addition to increased CVD risk, studies link daily consumption of red meats (particularly processed meats) with diabetes and cancers.^{25,26,27} There is no solid evidence for this association yet; furthermore, a study on the diet of 42 European countries reported a protective effect of an increased consumption of animal proteins.²⁴ The reported harmful effects may be largely due to the excess sodium consumption through meats (even more so in processed meats such as bacon, salami, sausage and low-fat processed deli-meats like chicken, turkey, pork and roast beef). Therefore, unprocessed red meats can be occasionally consumed (for example, 1–2 servings/week) as a good source of complete protein, iron and zinc, while the consumption of processed meats should be minimized or avoided. Both varieties are associated with an increased risk of diabetes (processed meats are nearly twice as likely as unprocessed meats when compared in grams), possibly because of the iron content and other constituents like advanced glycation end-products, nitrates/nitrites and trimethylamine-N-oxide.^{5,27}

Of greater relevance, there is little data to support the recommendation that meats should be chosen on the basis of their fat content because there is a lack of solid evidence for recommending lean or low-fat meats (maximum data are available for harmful effects associated with low-fat deli meats).^{5,24,26} Sufficient evidence is not available to support the consumption of grass-fed meat over grain-fed meat, although grass-fed meat tends to have more n-3 fatty acids.⁵

Oils

Oils are classified on the basis of their fatty acid content (which constitute >95% of the oil), i.e., saturated fats, PUFA and MUFA. However, the remaining non-glyceride components are also important and include sterols; alcohols; tocopherols (tocopherols and tocotrienols); phenolic compounds; complex lipids and unique components such as ubiquinones, lignans and flavonoids.²⁸

The maximum beneficial data is available for extra-virgin olive oil, largely on the basis of the PREDIMED study,¹⁴ although its value has somewhat diminished in view of its later retraction and re-publication in 2018 (even though it was with similar results).²⁹ Other oils with supporting evidence include soybean and canola oils. The recent practice of blending oils to obtain a healthy fatty acid composition (an optimal mixture of MUFA and PUFA along with other healthy non-glyceride components) may be reasonable but is yet to be systematically studied. Additionally, coconut oil has been discarded as ‘poison’ without a fair trial (in view of its high saturated fat content). A recent study demonstrated that changes in lipoprotein levels after a diet enriched with coconut oil are similar to those after a diet enriched with olive oil but not butter, despite the former having >80% saturated fatty acid. This observation is consistent with that of a decreased total cholesterol/high density lipoprotein cholesterol (TC/HDL-C) ratio when lauric acid replaces carbohydrates,⁴ emphasising that lipoprotein levels depend upon foods consumed and cooking methods in addition to the fatty acid content.³⁰ Considering that it has been a staple for several decades in many parts of India and has medium-chain fatty acids that may be beneficial, coconut oil deserves further evaluation.

However, TFA, which are found in hydrogenated oils and are further generated by deep frying and re-frying foods in the same oil (as is the practice in sweet shops), have a strong association with CVD and diabetes and its consumption should, therefore, be restricted as much as possible.²²

Sugars, SSBs and why we crave carbohydrates

Long thought to be a relatively benign source of ‘empty calories’, sugars and SSBs are some of the most addicting and harmful foods available. The average American consumes over 100 pounds of sugar in a year, topping in per-capita sugar consumption globally. High intake of sugar has been linked to obesity and associated lifestyle diseases such as diabetes; hypertension; lipid abnormalities, particularly high serum triglyceride levels, and CVD; furthermore, there is some evidence linking it with dementia.^{5,13,14-18} In sugar-consumption charts, India ranks at the bottom, which is possible because a substantial population is not exposed to SSBs and desserts

since they reside in villages. **Our continued obsession with the sweet taste largely stems from the myth that calories from sugar are merely ‘empty calories’ and benign indulgence. Nothing could be further from the truth. It is thus a wonder that society at large not only continues to relish sugary desserts and colas but also lets children get addicted to sugar as soon as they wean.**

A study published in *Circulation* in 2015 estimated the mortality attributable to the consumption of SSBs alone at approximately 184,000 in the year 2010, which is nearly 3/4th of that attributable to diabetes (the remaining is attributable to heart disease and cancers).¹⁷

Added sugar quickly raises the blood sugar levels, and SSBs induce an immediate high but little satiety owing to the high glycemic index and absence of redeeming fiber. These surges in blood sugar levels lead to insulin release, which results in a quick uptake of glucose by tissues (thereby lowering the blood glucose levels) and suppression of fat burning for fuel. Sugars and refined carbohydrates are rapidly digested within 2–3 hours (i.e., most easily metabolized), whereas it takes 6–8 hours to digest proteins and even longer to digest fats. *The immediate satisfaction and energy provided by sugars is followed by a fall in sugar levels within 2–3 hours, which kicks off the vicious cycle of craving carbohydrate (due to repeated troughs and peaks in blood sugar levels and possible stimulation of reward centers in the brain), ultimately leading to insulin resistance and weight gain.*^{5,17,18}

The addiction potential of sugar has been linked to brain reward mechanisms: overweight men given iso-caloric milk shakes reported greater hunger if their shake was sweetened with corn syrup rather than low-glycemic corn starch and stimulation of brain regions associated with reward and craving (nucleus accumbens) were observed on functional magnetic resonance imaging scans in the late post-prandial period (4 hours after the meal). Higher initial glucose peak and lower glucose levels at 4-hour post meal coincide with the peak and trough of blood glucose that correlates with increased hunger and food consumption.^{8,31} Hence, the World Health Organization (WHO) recommends restricting the consumption of added sugars to under 10% of total calories consumed/day (i.e., 6 teaspoon/day for females and 9 teaspoon/day for males); however, an average American consumes over twice as much daily.³² This recommendation is based on sound data that sugar consumption is associated with increases in the body weight, blood sugar levels, lipid levels and blood pressure.¹³⁻¹⁷

SSBs have a strong association not only with diabetes but also with CVD and obesity. They are the single most incriminated factor for weight gain (owing to the poor effect of sugar or refined carbohydrates on satiety),

particularly in children and young adults, which is a very disturbing trend. In addition, sweeteners are not much better either; diet sodas are linked to having adverse impact on insulin sensitivity, hormone levels and gut microbiome, thus repudiating any claim to weight loss or health.^{5,13-18}

High-fructose corn syrup (HFCS), the chief sweetening agent in most sodas and many sweets and bakery items, has attracted a lot of publicity lately. Although the common variety is HFCS-55, which has 55% fructose and 45% glucose as opposed to the 1:1 ratio in sucrose, there appears to be little difference metabolically between the two.^{7,33}

A large glucose meal results in hyperglycemia followed by insulin release, which rapidly brings down the blood sugar levels to normal by promoting its uptake by tissues. The remaining glucose is deposited in the muscles as glycogen if the muscle stores are empty due to recent exercise; otherwise, it is converted to fat by hepatic de novo lipogenesis. On the other hand, there is no blood sugar or insulin response to fructose, which can be digested only by the liver; therefore, excess intake promotes obesity, hepatic lipogenesis, fatty liver, visceral fat deposits, hyperuricemia and, ultimately, metabolic syndrome.³² Whole fruits have fiber, vitamins and minerals and a limited amount of fructose; therefore, they are beneficial. HFCS or sweetened juices, on the other hand, have excess fructose but no fiber, which sets off the abovementioned cycle.^{5,7,33}

Thus, the intake of both sucrose and HFCS leads to adverse metabolic consequences; on the contrary, fruits are healthy because they are slowly absorbed as they contain high amount of fiber and low amount of fructose and, additionally, possess healthy vitamins and minerals. Fresh fruit juices are better than canned juices, particularly artificially sweetened juices, as they have a lower association with weight gain or diabetes. However, not more than 1 serving/day is recommended in view of the risk of weight gain due to higher glycemic index and load.⁵

Sodium

Another nutrient of special interest is sodium, which has been uniformly criticized. Dietary guidelines have differed from recommending severe restriction (<2000 mg of salt/day) to proposing moderate restriction (up to 5000 mg/day, owing to recent studies indicating a J-shaped relationship, with increased CVD risk associated with intake of <3000 mg/day). Foods such as bacon, meats, canned foods, salted nuts, added salt in home-cooked food and packaged foods are sources of sodium.

The intake of sodium increases blood pressure in a dose-dependent manner, while also correlating with increased risk of stroke and coronary heart disease (CHD) mortality.

Difficulties in the accurate estimation of daily intake have prevented the formation of consensus. However, currently available data suggest a 32% reduction of CVD risk with the restriction of sodium intake to 2300 mg/day, a target that has not been achieved in any country so far.^{5,34}

Trans fatty acids

TFA include MUFA and PUFA with one or more double bonds in *trans* position rather than *cis* position. They naturally occur in small amounts in meats and milk of some ruminants, constituting <<1% of daily calorie intake. On the other hand, industrially produced hydrogenated oils (manufactured with the aim to increase the shelf life of oils by delaying rancidity, thereby making them more suitable for frying, baking and packaging) contain much higher amounts of TFA and have been linked to diabetes, CVD and visceral obesity. Additionally, frying at high temperatures generates more TFA, and this being the common practice in sweet shops (and most homes, too) is even more unhealthy.

The consistent adverse effects of TFA can be attributable to their effects on lipids as well as other parameters. They are shown to raise the low density lipoprotein (LDL) cholesterol, triglyceride and ApoB levels, while lowering the HDL cholesterol and ApoA levels. These in turn increase the CVD risk. Other effects include insulin resistance, visceral obesity, inflammation, damage to vascular endothelium and, possibly, increased cardiac arrhythmias.²²

■ **Category 2: Healthy foods**

Some items in category 2 have enough data in support of them being healthy: there are multiple population studies providing compelling evidence towards the beneficial effects of eating non-starchy vegetables, particularly green, leafy vegetables and moderate consumption of fruits,³⁵ nuts, seeds,³⁶ fatty fish and fish oils.⁵ These food items have been consistently shown to improve metabolic parameters, are neutral or beneficial for weight maintenance and reduce CVD risk and risk factors. The Global Burden of Disease 2017 Diet Collaborators published the pooled data from 195 countries and concluded that low intake of whole grains and fruits were among the three leading dietary risk factors for deaths.^{1,5}

Phenolic compounds

Several phenolic compounds, such as flavonols (in onions, broccoli, many fruits and tea), flavones (in parsley), isoflavones (in soy) and catechins (in cocoa, grapes, red wine and tea), have documented cardio-metabolic effects, although their variability precludes the formation of definite guidelines. However, notably, several food items that have been deemed healthy, such as extra-virgin olive oil, nuts and berries, are rich in these compounds.²⁸

Vitamins and minerals

Findings of observational studies have suggested a reduced risk of CVD with the intake of vitamins; however, results of randomized trials involving folate, vitamin B group, beta-carotene and vitamins C and E have generally been neutral. This may be because the duration of treatment was not sufficiently long or that they are more effective for primary than for secondary prevention. In addition, the benefits seen with vegetables, fruits and nuts may be secondary to factors (dietary or non-dietary) other than vitamins, and hence, their benefits are not replicated by synthetic vitamins. Vitamin D has invited a lot of investigation recently; however, there is currently no evidence suggesting that it is useful in preventing CVD.⁵

Potassium has been reported to lower blood pressure, particularly in individuals with hypertension and is thus associated with a reduction in CVD risk, particularly strokes. Therefore, diets that recommend high intake of fruits, vegetables and nuts, such as the Mediterranean diet or the modified DASH diet (with higher fat), lower the risk of CVD and are very beneficial if regularly followed.^{5,36,37}

Other minerals, such as calcium and magnesium, may also help in lowering blood pressure, but the data are only for short-term consumption. In contrast, long-term consumption of calcium supplements and vitamin D appear to have an increased risk of myocardial infarction. These are, therefore, not yet advised for controlling high blood pressure or preventing CVD.⁵

■ **Category 3: Foods with controversial nutritional status**

Saturated fats

Saturated fats are the most contentious of nutrients. For decades, they were labelled as the principal risk factor for CVD; however, the majority of recent studies negate any such association. While their consumption leads to an increase in LDL cholesterol levels, they also significantly increase HDL cholesterol levels, while substantially reducing triglyceride levels. Because they have no major impact on Apo B but additionally reduce lipoprotein (a), replacement of refined carbohydrates with saturated fat could be a metabolically healthy substitution. Furthermore, like all other dietary components, saturated fats are also heterogeneous: they are found in both healthy and unhealthy foods (for example, milk, cheese, curd, butter, ghee, chicken, seafood, meats, fried foods, vegetable oils and nuts). It is also disconcerting to note that tissue levels of most saturated fatty acids commonly result from hepatic synthesis due to carbohydrate consumption (particularly starch) rather than from meats or dairy.^{5,38-40}

Thus, simply judging a fat by its fatty acid content and ignoring its other properties results in an incomplete view of nutrition. In fact, replacing vegetable oils and occasional consumption of neutral butter or unprocessed meats with lean processed deli-meats or processed carbohydrates has been demonstrated to be more harmful in terms of both diabetes and CVD.⁵

Metabolically speaking, PUFA appear to be the healthiest nutrient (and this particular detail is responsible for the guideline to recommend substitution of saturated fatty acids with PUFA),^{12,41,42} whereas MUFA appear to be neutral. Notably, the largest trials of PUFA substitution have shown inconsistent results, whereas trials of adding PUFA have shown beneficial CVD end points. The recovered results of the largest study **the Minnesota Coronary Experiment**⁴³ indicate reduction in serum cholesterol levels but increase in mortality (particularly in individuals aged >65 years). Therefore, it is difficult to reach a firm conclusion, save that healthy fat containing foods may be more beneficial than refined, processed carbohydrates and that PUFA could be useful, provided saturated fats are not strongly restricted. This is in contrast to the existing guidelines that recommend restricting saturated fatty acid intake to <6% of total daily calories in individuals at risk of CVD.¹²

Wheat and wheat products

Wheat has been a staple to the vast majority of mankind over the last several decades. The Green Revolution in 1960s transformed agriculture as a result of hybridization of the wheat crop: it grew faster, was hardier and gave higher yield, effectively solving, or at least significantly mitigating, the scourge of famine and starvation. However, it also irretrievably changed the wheat crop: the protein component gluten has changed and amylopectin A is responsible for its high glycemic index. Common wheat (*Triticum aestivum*) consists of 70% carbohydrate, 10%–15% each of indigestible fiber and proteins and a small amount of fat.⁴⁴

The glycemic response to grains is the lowest if the grain is eaten whole or with minimal processing (wherein the bran protects the starchy endosperm portion from being easily digested, for example, quinoa, brown rice or steel-cut oats), is higher if the grain is milled (wherein the bran is still present but the starchy endosperm is more exposed leading to early digestion, for example, chapati made from traditional flour, whole-grain breads and some cereals) and is the highest if the bran and germ are totally removed by processing (wherein only the starchy portion remains, which is easily digested, for example, white bread, white rice, highly refined flour used for cooking these days and most cereals like corn flakes). These items, along with starchy vegetables such as potatoes, are metabolized in a

manner similar to refined carbohydrates; and the glycemic responses to these foods are similar to that to sugar. Of course, sweetened drinks such as sodas are even worse because they do not even contain minute amounts of redeeming fibre.^{5,44}

The deleterious effects of refined carbohydrates on inducing or worsening insulin resistance and weight gain are worse in women, older individuals and those who lead a sedentary lifestyle than in men, younger individuals and those who lead an active lifestyle.^{5,7} Moreover, people get frustrated, believing that they are eating healthy foods instead of fats, some of which are much healthier than these refined foods. Hence, minimising the intake of refined carbohydrates and sugars is a major priority for community health.

Milk and milk products

Conventionally lumped together as a single diet entity, usual dietary recommendations are to use low-fat dairy foods and leave it at that.¹² Although published data do not support this, full-fat milk has been shunned owing to its saturated fat content. Like all foods, milk and milk products have heterogeneous effects on metabolism; for instance, curd and cheese, but not milk, are associated with a reduced risk of diabetes. In addition, curd has protective effects against gestational diabetes. This suggests a beneficial effect of fermentation on milk, possibly because of the synthesis of vitamin K2 by the bacterial cultures used or the presence of probiotics in curd.^{5,45,46} Surprisingly (or perhaps logically, owing to its zero glycemic index), butter also appears to be associated with a lower risk of diabetes. The Fatty Acids and Outcomes Research Consortium (FORCE) results, using biomarker measurements, demonstrated the protective effects of dairy fat against diabetes risk.⁴⁷ Furthermore, 40 g of dairy fat consumed daily in the form of butter or cheese induced differing peaks of postprandial triglycerides, resulting in differential effects on cholesterol and LDL-C, and the results were in favour of cheese.⁴⁸

Their effect on body weight also varies: curd is associated with less weight gain or weight loss, whereas cheese is associated with no weight gain (when consumed as replacement for refined carbohydrates) or weight gain (when eaten along with carbohydrates).⁵ Contrary to popular belief, in children, long-term consumption of low-fat milk is associated with more weight gain than full-fat milk (possibly owing to otherwise increased consumption of carbohydrates that is avoided by the consumption of the more satiating full-fat variety), although this is not noted in adults.

Finally, dairy fat appears to have a protective effect against CVD. Large population-based studies investigating the circulating blood levels of dairy fat and their biomarkers

provide convincing evidence that they are associated with a lower incidence of diabetes and CHD, whereas the evidence for their effect on stroke is not yet clear. Even the consumption of butter has no association with CHD, stroke or total mortality. There appears to be no evidence backing the recommendation to consume low-fat dairy products by children or adults for the prevention of CHD, diabetes or obesity. The previous recommendations appear to be largely based on the earlier belief in the role of saturated fat in the pathogenesis of atherosclerosis. Thus, the available evidence indicates the benefits of regular consumption of curd and, possibly, cheese as well, with the choice between low-fat and full-fat milk being difficult in view of the prevailing guidelines. Physicians can take an informed decision in this regard.^{5,45-47}

Eggs

Eggs, a source of complete protein, are also rich in cholesterol and fat-soluble vitamins. Most studies show no effect or a weak beneficial effect of regular consumption of eggs, which led to the exoneration of eggs by the 2015 Dietary Guideline Advisory Committee. Large population studies suggest no association of eggs with CVD but rather a possible association with diabetes. Although this implication is also controversial because studies with all three possible results (negative, neutral and positive association with diabetes) have been reported, it appears advisable to note the possible increase in the incidence of diabetes in individuals consuming >14 eggs/week, particularly in American studies.⁴⁹ Two large studies on egg consumption recently published reported contrasting results. An American study⁵⁰ in more than 29,000 adults showed a higher risk of CVD and all-cause mortality while a Chinese study⁵¹ in half a million adults suggested a lower risk of CVD associated with the consumption of ≤1 egg/day. In summary, eggs appear to be healthy if they are consumed to replace more harmful food items, such as red meats and refined carbohydrates, but likely to be less healthy than non-starchy vegetables, fruits and fish.⁴⁹⁻⁵¹

Coffee and tea

Coffee, both caffeine and decaffeinated, is associated with a dose-dependent reduction in the risk of diabetes. Its effect on CHD and stroke is more complex: larger population-based studies appear to suggest a J-shaped relation, i.e., a protective effect with up to 3–4 cups/day and the possibility of harmful effects with more than 5–6 cups/day. The results of randomized trials have been small and inconsistent.⁵²

Tea is associated with a similar benefit in reducing the incidence of CVD and diabetes, particularly with >3–4 cups/day in population studies, despite experimental trials not revealing any significant benefit on insulin sensitivity. Briefly, the available data seem to permit the consumption of tea and coffee, with reasonable evidence of benefits of black and green tea in reducing CVD risk.⁵³

■ **Unanswered questions**

Several issues remain unresolved, including the following

1. Confirmation of the benefits of consuming PUFA instead of other fats and carbohydrates.
2. The relative harm or benefit of consuming saturated fats or refined carbohydrates.
3. The putative harms of wheat products.

Therefore, studies regarding these are warranted to establish guidelines regarding the most basic human necessity—food.

■ **Summary**

Studies on healthy diet and nutrition patterns have overturned several conventionally held concepts in the last decade. It is to be reiterated that carbohydrates, fats and proteins are not harmful in themselves; it is different food items in these groups that are healthy or unhealthy. This knowledge directs us to choose between healthy foods rather than choosing between macronutrients: for instance, one can prefer healthy foods like vegetables, fruits, nuts, seeds, etc., and attempt to replace foods that are clearly unhealthy (such as sugars, SSBs, refined carbohydrates and TFA) with foods that are neutral (such as eggs) or probably beneficial (such as curd and cheese), rather than getting frustrated while trying to achieve ideal proportions of fats, proteins and carbohydrates. Furthermore, neither fats nor carbohydrates should be treated as poison; instead, a balanced diet should contain all of them. Reduction in the consumption of carbohydrates by 10%–15% (particularly sugars, SSBs and refined carbohydrates) and addition of some healthy fats and proteins appear to be the best combination. Current general dietary recommendations are summarised in Table 3. The role of exercise in promoting health and fitness has not been discussed here, and it remains one of the cornerstones of a healthy lifestyle.

Table 3: General dietary recommendations

Foods	Recommended amount	Size of 1 serving
Fresh vegetables	3–5/day	1 cup raw veg, 1/2 cup cooked or cut veg, veg soup
Fresh fruits	2–3/day	1 medium size fruit, 1/2 cup fresh or unsweetened canned fruits, one piece about the size of your palm
Nuts and seeds	1/day	1 ounce or a small handful of nuts
Whole grains	2–3/day	1 medium chapatti (multigrain/flour with bran, 1 slice whole-grain bread, 1 cup high fibre cereal, 1/2 cup cooked brown rice
Dairy	2–3/day	1 cup milk/curd (preferred), 1 ounce cheese
Fish/seafoods	2–3/week	100 gram
Vegetable oils	2–5/day	1 tsp oil, prefer unrefined virgin/extra-virgin oils
Processed meats	Maximum 1/week	50 gram
Unprocessed meats	1–3/week	100 gram
Refined grains	<1–2/day	1 medium chapatti (refined flour), 1 slice bread, 1/2 cup rice or cereal, 1 small sweet or dessert
Hydrogenated oils	Avoid as much as possible	Foods made with partially hydrogenated oils, fried foods (particularly re-frying in same oil)
Sugar-sweetened beverages	Avoid as much as possible	300 mL
Sodium	<2.3 g recommended, 2–4 g/day may be acceptable	Not relevant

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