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Coffee as a Functional Beverage

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9 Coffee as a Functional Beverage

Victoria Burgess, Lem Taylor, and Jose Antonio

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9.1 INTRODUCTION
Caffeine is the most commonly consumed drug in the world and has been used for centuries for a variety of reasons. Caffeine is a common substance in the diets of a variety of individuals ranging from athletes to elderly. Today, caffeine can be found in numerous products such as sports gels, energy drinks, and alcoholic beverages.1

Coffee is likely to be the primary delivery system for caffeine today. For most people, caffeine and coffee are synonymous, but these two should not be thought of as the same. There are other ingredients in coffee besides caffeine that exert a biological effect. Caffeine can have many effects in the body, but typically caffeine is thought of as a way to boost a person’s energy level on both a psychomotor level (i.e., awareness) as well as a physiological level (i.e., energy), which is clearly a role that caffeine can play.2 These two factors alone are probably the sole reason that many people consume coffee as part of their daily ritual, and this aspect of coffee consumption is very important.

The following chapter will discuss the background of coffee and its role as a functional food. This discussion will include types of coffee, the ingredients in coffee, the effects of coffee on energy metabolism, and its role as a drink that can enhance various aspects of health and possibly prevent or reduce the risk of some diseases. The effects of caffeine on various diseases and health conditions need to be discussed due to the fact that caffeine is the active ingredient in coffee in most preparations.

9.2 INTRODUCTION TO COFFEE AND CAFFEINE
The popularity of coffee has increased dramatically over the last decade. Drinking coffee is a ritual that suits a variety of situations, from jump-starting your day to an aspect of social engagement. Traditionally, caffeine is typically associated with coffee consumption, and this is probably the most popular form of caffeine in the U.S. today. There are many different types of coffee, and they usually differ on factors
such as taste or flavor, type of preparation, and the caffeine content of various types. Obviously, the brand of the product and the flavor usually have something to do with the content of caffeine, but most caffeine in food products typically contains chocolate or coffee flavoring. Caffeine content can range from a couple of milligrams in an ounce of milk chocolate to \( \sim 115 \) mg in 12 oz of a Red Bull energy drink.

The most popular form of caffeine ingestion is via coffee, and the content typically depends on the method and duration of brewing; caffeine concentrations can range from 65 mg in 7 oz of instant coffee to 175 mg in 7 oz of drip-brewed coffee. Table 9.1 gives a comprehensive list of the caffeine contents of various consumer products.

### 9.3 DOSES OF CAFFEINE

The caffeine content of coffee is one of its important aspects for many people when they drink coffee. Caffeine is a derivative of methylxanthine and is found in numerous consumer products in the U.S. The following section will address the topic of caffeine doses, particularly the doses used in research settings and/or the doses that are allowed to be used by athletes before “caffeine doping” is reached. All of these factors are important in considering how much caffeine one should ingest for both optimal performance and safety.

Whether you are drinking coffee, tea, or taking caffeine pills, the amount of caffeine that an individual consumes is important to consider. Research has focused on varying levels of caffeine ingestion to determine optimal doses for different situations. In research trials, the most commonly used dose of caffeine is approximately 6 mg/kg of body weight, and this dose has been shown to give improved endurance exercise capacity and performance.\(^3\)\(^\text{–}\)\(^6\) Other doses have been used as well in research trials, with increases in performance still evident. Doses ranging from 1.5–2.9 mg/kg of body weight have been reported to increase performance.\(^8\) Alertness, mood, and cognitive processes have been found to improve after a low dose of caffeine (\( \sim 200 \) mg), and these findings support other evidence that caffeine can have an ergogenic effect at intakes as low as 1–3 mg/kg of body weight.\(^7\)\(^\text{–}\)\(^11\) On the other hand, doses as high as 13 mg/kg of body weight have been used in research, and have been found to reduce RPE during submaximal exercise and increase exercise performance.\(^4\)\(^,\)\(^5\) Caffeine is not banned or restricted by the IOC.

### 9.4 COFFEE AND CAFFEINE IN WEIGHT LOSS AND ENERGY EXPENDITURE

Like other stimulants, caffeine has been advertised and sold as a way to stimulate energy expenditure and weight loss. This potential effect on weight management is important to coffee’s role as a functional food. The fact that coffee is consumed by so many people and can be a potent dose of caffeine could indicate that daily coffee consumption can be important in augmenting energy expenditure and, as a corollary, weight loss.

As discussed with caffeine’s role as an ergogenic aid in endurance exercise, caffeine can stimulate both lipolysis and energy expenditure.\(^12\) Many studies have been performed on the results of caffeine
ingestion, with some examining caffeine alone, whereas others have examined caffeine combined with various herbal and vitamin products like ephedra, green tea extracts, calcium, tyrosine, chromium picolinate, capsaicin, garcinia cambogia, and so on. Caffeine has even been examined when combined with another popular stimulant in the U.S., cigarette smoking, in which caffeine was suggested to increase energy expenditure in an additive manner from the smoking stimulant. This has been stated to be due to the thermogenic effect of both nicotine and caffeine, and when combined, produces additive effects. The method of administration has varied from coffee and/or tea ingestion to administering caffeine-containing pills. The following section will discuss the pertinent research involving caffeine and possibly coffee’s effect on energy expenditure as well as possible weight loss that could result from this decreased energy state.

Some of the original work on caffeine and energy expenditure came out of the American Journal of Clinical Nutrition in the late 1980s. Initial findings suggested that a single dose of 100 mg of caffeine had a significant effect on the resting metabolic rate (an increase of 3%–4% over 150 min) in a variety of populations. These findings led the authors to suggest that caffeine can have a significant effect on energy balance at a commonly consumed dose and possibly have positive effects in the treatment of obesity. Subsequent studies confirmed these findings, with one study reporting that caffeine ingestion increased energy expenditure by 7%, while also lowering plasma insulin and norepinephrine levels and increasing the appearance of free fatty acids in the blood. Koot and Deurenberg reported similar findings of a 7% increase in energy expenditure for 3 h following ingestion of 200 mg of caffeine, which was administered as coffee. Clearly, older studies have shown caffeine to have an effect on the metabolic rate of humans, and recent research has continued to back this notion.

More recent research on the effects of caffeine continues to support its role in increasing energy expenditure. As mentioned earlier, caffeine is now being combined with a variety of products to promote a thermogenic effect. One example in the literature used the combination of capsaicin, catechins, caffeine, tyrosine, and calcium. This study reported an increase in energy expenditure of 2% over a 7-d period when these products were ingested as bioactive food products. Another recent study that looked at caffeine alone found an increase in energy expenditure of 13%, with the doubling of lipid turnover. These researchers concluded that the effects of caffeine alter energy expenditure and are mediated via the sympathetic nervous system. Furthermore, they explain the lipid mobilization action of caffeine in two ways: increased mobilization alone is insufficient to drive oxidation, or large increments in lipid turnover can result in an increase in lipid oxidation. This lipid turnover rate, however, largely depends on the individual’s body composition profile. The leaner individual has a higher oxidation after coffee consumption than one who is overweight. In recent years, it has become quite common and popular to consume green tea for weight loss and energy expenditure due to its two main components in the ingredients, caffeine and catechin.

Clearly, caffeine does play a role in metabolism and energy expenditure. One can debate how much caffeine is necessary and the optimal time to consume it. One solution to this is to incorporate it into products that consumers use daily or at least regularly. Even coffee, which is consumed many times a day by millions of people, has now been modified by adding some of these products, plus additional caffeine. These products do have some credibility, and early research has found some functional coffee beverages to have significant effects on energy expenditure, body weight, and fat loss when compared to regular caffeinated coffee (Experimental Biology Meeting, 2006; Ron Mendel, Ph.D., personal communication). It has yet to be determined whether caffeine and the many products that contain significant amounts of it have long-term effects on energy balance. Despite this, the role of coffee as a functional food is intriguing because of the popularity of consumption on a broad scale.

9.5 EFFECTS OF COFFEE (CAFFEINE) IN THE BRAIN AND BODY

Caffeine and caffeinated coffee can have a stimulatory effect on mental performance. This effect of consuming caffeine has been well documented. One study, in particular, suggested that consuming caffeinated beverages can maintain both cognitive and psychomotor performance throughout the day. Because coffee is a caffeinated beverage, these beneficial effects could be associated with
daily coffee consumption. In fact, additional research has focused specifically on the effects of caffeinated vs. decaffeinated coffee on various cognitive function variables. The results of this study suggest that lifetime and current consumption of caffeinated coffee may be associated with better cognitive performance among women, especially in elderly populations. Further, caffeinated coffee consumption has been shown to decrease the risk of Alzheimer’s disease.

9.6 EXERCISE PERFORMANCE WITH COFFEE AND CAFFEINE CONSUMPTION

As we have discussed, caffeine is a popular drug all over the world as well as a frequently used ergogenic aid among athletes. There is substantial research that supports the fact that caffeine consumption can have beneficial effects on exercise performance. The following section will discuss the evidence to support caffeine’s role in exercise performance.

Caffeine has been shown to improve performance and increase endurance during prolonged exercise, and in smaller amounts in shorter-term endurance performance. This enhanced performance in endurance exercise is typically not associated with elevations in VO\(_2\) max and/or any parameters related to it, but it could allow an individual to compete at a higher power output or give the ability to train longer. Other reported benefits include a reduction in perceived leg pain induced by exercise and improved psychomotor performance (reaction time) during exercise. Improved concentration, improved cognitive performance after exercise, a reduction or delay in fatigue, and enhancement in alertness have also been reported. The benefits of caffeine consumption are clear. The evidence supporting a functional role for coffee consumption on exercise performance is discussed next.

The research on coffee and caffeine intake on exercise performance began in the 1970s and is still being conducted today. One classic study was performed by Costill and colleagues to determine the effects of caffeine ingestion on performance during prolonged exercise. This study utilized a cycle ergometer at 80% of VO\(_2\) max until exhaustion following the consumption of either decaffeinated or regular coffee (330 mg of caffeine) to determine the physiological effects of caffeine. The results found that the caffeine group exercised longer (90.2 min) than the decaffeinated group (75.5 min), and the caffeine group also showed an enhanced fat-burning effect. In addition, the caffeine group also reported a lower rating of perceived exertion during the exhaustive exercise bout. Other studies have shown similar results when coffee was used as the means of caffeine administration. A more recent study determined that various forms of caffeine ingestion all resulted in significant increases in time-to-exhaustion exercise when compared to placebo groups. Furthermore, this study demonstrated that prior coffee consumption did not decrease the ergogenic effect of anhydrous caffeine ingestion on exercise performance.

While in the past, studies were sparse as far as coffee as a means of caffeine administration, recent studies have examined this method of consumption. It has been noted that caffeine consumed in the form of coffee improves performance in the same way other forms of caffeine are consumed. When ingesting coffee during low-intensity exercise, fat oxidation significantly increased. In addition to increased performance after the ingestion of coffee, it has also been found to decrease perceived exertion during performance.

In addition to these ergogenic effects, caffeine has not been associated with any negative effects on exercise performance including rehydration status, ion imbalance, or any other negative effects on exercise performance. Caffeine consumption stimulates a mild diuresis similar to water, but there is no evidence that the fluid–electrolyte imbalance is negatively affected on exercise performance. In fact, caffeine consumption doses ranging from 100–680 mg of caffeine have rarely affected the differences in urine output when compared to placebo. The effect on fluid–electrolyte imbalance is also affected by caffeine tolerance, and the chance of affecting it is reduced in individuals that regularly consume caffeine. Overall, whether it is coffee or another caffeine-containing product, individuals who consume caffeine in moderation and maintain a typical diet will not incur any detrimental fluid–electrolyte imbalances. Further, sweat rate and heat dissipation are not altered by the addition of caffeine alone.
Despite all of these reported benefits, the mechanism of action for the respective effects is still unclear. Traditionally, the benefits of endurance exercise were associated with increased free fatty acid oxidation\(^{27,33}\) and subsequent sparing of muscle glycogen.\(^{34,35}\) These effects of caffeine ingestion are most likely due to the competitive antagonism of adenosine receptors at physiological concentrations, especially at low doses.\(^{36}\) Despite the findings of these studies, many other studies disagree with the mechanism of action in which caffeine is exhibiting these effects.\(^{7,37}\) The primary argument in these studies is that performance enhancement has been shown to occur without changes in catecholamine or FFA/glycerol concentrations during exercise.\(^{7}\) Together, these findings suggest that caffeine has an effect at the level of the skeletal muscle, which could be the result of the ergogenic effect.\(^{7,37}\)

Recent studies are in agreement with the notion that the effect of caffeine is mediated at the skeletal muscle level. One study found that anaerobic exercise performance was increased following caffeine ingestion resulting from stimulation of the skeletal muscle by caffeine.\(^{38}\) This has been found to promote greater force output due to excitation contraction coupling.\(^{39}\) Other studies have suggested that caffeine has an effect on calcium release via the ryanodine receptor,\(^{40}\) and this release was not a result of adenosine antagonism.\(^{41}\) In addition, studies have found that caffeine ingestion can potentiate submaximal skeletal muscle contractile force,\(^{3,42}\) thus eliciting an ergogenic effect. This is most pronounced in slow twitch muscles.\(^{43,44}\) The most recent study exhibiting these findings found that caffeine ingestion of 6 mg/kg of body weight potentiated contraction force during low frequency stimulation.\(^{3}\) These authors suggested that, in view of the known effects of caffeine on the ryanodine receptor, these data are consistent in demonstrating that caffeine can potentiate calcium release from the SR and further suggest that caffeine’s ergogenic effects are at least partly mediated by direct effects at the skeletal muscle level.\(^{3,7}\) In addition, the researchers suggest that since caffeine ingestion has no effect on MVC, high-frequency stimulation is consistent with the fact that caffeine has lesser to no effects on maximal strength and high-intensity exercises,\(^{3}\) as has traditionally been thought to be the case. Additionally, caffeine does not impair protein synthesis, mTOR signaling, or muscle hypertrophy, as some studies have suggested.\(^{45}\)

Another possible mechanism that may partially explain caffeine’s ergogenic effects involves its relationship to RPE and perceived pain. Research has suggested that caffeine ingestion increased high-intensity cycling performance; the authors reported that the reduction in RPE, as well as an elevation in blood lactate concentration, could be the reason for the ergogenic effect.\(^{46}\) A meta-analysis on caffeine ingestion and RPE levels also suggests that caffeine reduces RPE levels during exercise, thus eliciting an important ergogenic effect.\(^{15}\) These studies agree with a previously cited report that caffeine ingestion significantly reduced leg muscle pain ratings during moderate-intensity cycling exercise. The researchers suggested that caffeine’s hypoalgesic properties could play a role in improving exercise performance.\(^{24}\) Although they are not the same, RPE and perceived leg pain could be associated with one another, thus suggesting that the decreased RPE and/or perceived pain resulting from caffeine ingestion could be one factor in the ergogenic effects of endurance exercise performance.\(^{21,37,38}\) In addition to leg muscle pain ratings and caffeine, RPE breathing has also been found to be significantly lower following the ingestion of caffeine during cycling trials.\(^{48}\) Caffeine was, however, found to increase feelings of nervousness and restlessness post-exercise after consuming caffeine. This should be taken into consideration when supplementing with caffeine for performance.

In conclusion, despite the fact that the mechanism of action is somewhat still debated, caffeine consumption can result in improved exercise performance on a variety of levels. Caffeine is the most commonly consumed drug in the world, and athletes frequently use it as an ergogenic aid. Caffeine consumption improves performance and endurance during prolonged, exhaustive exercise and, to a lesser degree, caffeine enhances short-term, high-intensity athletic performance. In addition, caffeine improves concentration, reduces fatigue, and adds to alertness; all of these factors can improve performance in different events. Habitual intake does not diminish caffeine’s ergogenic properties. Caffeine is safe and does not cause significant dehydration or electrolyte imbalance during exercise. The role of coffee ingestion has also been shown to be an effective way of administrating caffeine as an ergogenic aid, thus substantiating coffee’s role as a functional food.
9.7 CAFFEINE CONSUMPTION TIMING FOR PERFORMANCE

Caffeine is absorbed rapidly into the blood stream and peaks within 30–60 minutes; thus, timing for performance is important. When taking within 60 minutes, enhanced performance has been found. Different sources of caffeine have been found to peak at different times after ingestion; however, all were within 60 minutes of intake. For example, in a random, double blind, placebo-controlled study, coffee, cola, and caffeine capsules were ingested at different times. Saliva caffeine levels peaked at 42 minutes for coffee, 39 minutes for cola, and 67 minutes for the capsule.

Additionally, consuming caffeine during performance has been found to enhance performance. In a study that examined a 2-hour time trial, researchers found that taking 1 mg/kg of caffeine every 20 minutes enhanced performance significantly.

9.8 HEALTH-RELATED ISSUES IN COFFEE CONSUMPTION

Based on the fact that billions of individuals worldwide drink coffee, it could be assumed that if there were negative side effects to drinking coffee, the problems would be manifest in large populations of coffee consumers; however, there is no evidence that such harm occurs. In fact, there are data to suggest that coffee consumption may indeed confer numerous health benefits.

9.8.1 BLOOD PRESSURE

One very important marker of health that affects millions of people across the world is blood pressure. The role of coffee consumption and its effects on blood pressure have been studied, and these studies have shown consistent results. One large-scale study examined over 3000 Japanese males who were 48–56 years old and undergoing preretirement health screenings. These individuals completed self-administered questionnaires to determine average coffee intake over the past year. The significant findings of this study revealed that regular coffee drinkers had lower blood pressure than individuals who did not consume coffee. In addition, this effect was demonstrated at all levels of alcohol consumption, cigarette smoking, obesity, and glucose intolerance. Thus, the major conclusions of this study suggest that habitual coffee consumption does not have adverse effects on blood pressure, and drinking coffee does have significant beneficial effects on the blood pressure levels in this population.

A recent meta-analysis found that while caffeine intake produces a slight increase in blood pressure for ≥3 hours, in long-term coffee use, there is no association with coffee consumption and increased blood pressure or risk of cardiovascular disease, even in hypertensive patients.

Other studies examining the relationship between coffee consumption and blood pressure have found similar results. One study examined over a thousand adults during health checkups and revealed that coffee consumption had no significant effects on blood pressure in these individuals or on total or HDL blood cholesterol levels. In addition, these findings revealed a negative correlation between coffee consumption and serum triglycerides in these individuals. These findings further support the beneficial effects of coffee consumption in these populations and show that drinking coffee does not adversely affect these cardiovascular risk factors in adults. Even when consuming a higher intake of coffee (around five cups per day), it was found to only have a small increase in blood pressure. Despite these positive findings, it is important to note that individuals who currently have high blood pressure should be more cautious with coffee drinking and should probably consult a physician before drinking coffee on a regular basis. This suggestion is supported by research that indicates that reducing or restricting coffee intake may have a beneficial effect on controlling high blood pressure in some populations.

Overall, habitual coffee consumption does not seem to lead to negative effects on blood pressure, even with those who are predisposed to high blood pressure. In addition, moderate coffee consumption may have a beneficial effect on blood pressure levels.
9.8.2 Cardiovascular Disease

One of the most significant health issues over the last 30 years has been the prevalence of cardiovascular disease. Over the last decade or so, a false impression has risen around the relationship between coffee consumption and an increased risk of heart problems. However, coffee consumption not only does not increase the risk, but, as we will discuss later, it also has beneficial effects on some of the contributing factors that result in cardiovascular disease, like type 2 diabetes and hypertension. In fact, a recent meta-analysis found that habitual consumption of three to five cups of coffee per day is associated with a 15% reduction in the risk of CVD.\(^{57}\)

Other studies have examined the relationship between coffee consumption and various aspects of cardiovascular disease, some of which will be discussed next. One of these studies was performed on over 85,000 middle-aged registered nurses in the U.S. It examined the 10-year incidence of coronary heart disease (CHD) and found no association with caffeine intake from all sources and CHD. In addition, there was no association between CHD and decaffeinated coffee consumption in this population.\(^{58}\) A more recent study conducted in hospitalized patients who had confirmed acute myocardial infarction (heart attack) found that coffee consumption was not associated with the overall rate of death in these individuals.\(^{59}\)

Additional research has supported the idea that coffee consumption does not increase one’s risk of cardiovascular disease. These studies report consistent findings, such as no significant effect of coffee consumption on general mortality and/or cardiovascular disease-associated mortality in men. A lower rate of general mortality was associated with coffee consumption in women.\(^{60}\) The risk of occurrence for a nonfatal heart attack is not associated with coffee consumption in men, and the all-cause mortality rate was decreased by increasing coffee consumption in women.\(^{61}\) In fact, in a large U.S. cohort study, men who drank six or more cups of coffee per day had a 10% lower risk of death, and women had a 15% lower risk.\(^{62}\) Thus, the evidence seems to support the understanding that moderate coffee consumption does not increase an individual’s risk for developing cardiovascular disease. In addition, there is some evidence to suggest that moderate consumption may have some beneficial effects as well, thus providing evidence to support the role of coffee as a functional food.

9.8.3 Diabetes

There is a plethora of fairly recent research to support the inverse relationship between coffee consumption and type 2 diabetes.\(^{62–70,\,80}\) The following section will discuss some of the more relevant examples of the research examining the association with drinking coffee and type 2 diabetes. One general consensus reached in examining the relationship between coffee and type 2 diabetes is that coffee drinking is associated with higher insulin sensitivity and a lower risk of type 2 diabetes.\(^{64,\,68,\,70,\,79,\,81}\) This is important due to the fact that type 2 diabetes is a disease that is characterized by a severe reduction in insulin sensitivity, thus leading to adverse metabolic effects on the body. One study demonstrating the evidence to support this was conducted in about 8,000 healthy individuals aged 35–56 years, who were administered questionnaires to obtain information regarding coffee consumption as well as other general factors. The overall findings of this study demonstrated that high coffee consumption (five cups per day) was inversely associated with insulin resistance, thus promoting a positive effect on insulin metabolism.\(^{62}\) In a recent meta-analysis, it was found that those who drank four to six cups and more than six to seven cups of coffee per day had a lower risk of type 2 diabetes than those who drank less than two cups per day.\(^ {53}\) Further support from the Nurses’ Health Study and Health Professionals’ Follow-up Study that examined approximately 42,000 men and 84,000 women found another inverse association between coffee intake and type 2 diabetes, following the adjustment for age, body mass index, and other risk factors. Additional findings from this study found that total caffeine intake from all sources was associated with a significantly lower risk for diabetes in men and women.\(^{10}\) When looking at the progression of type 2 diabetes on pre-diabetic individuals, it was found that drinking three or more cups of coffee per day had the greatest preventive effect on diabetes onset.\(^{71}\)
Thus, the evidence is clear, and in some cases overwhelming, that drinking moderate to high amounts (four to six cups per day) of coffee has a protective effect on the development of type 2 diabetes in men and women. The implication of reducing the risk of diabetes affects not only the individual, but also clearly our society and economy, due to the substantial costs related to treating this disease. Diabetes is the seventh leading cause of death by disease in the United States. Its incidence will probably continue to rise in the future, with one study projecting that one out of three U.S. adults could have diabetes by 2050. Knowing what we now know about the protective effects coffee can have on this disease, it is clear that this fact alone should justify a role for coffee as a functional food.

9.8.4 Cancer

In a recent meta-analysis, coffee was found to have inverse associations on cancer of many types such as oral, pharynx, liver, colon, prostate, endometrial, and melanoma cancers. A recent study on breast cancer in relation to coffee and tea intake found that women who consume a higher amount of coffee (three to four cups/day) when compared to one to two cups/day had a decrease in breast cancer risk. Tea, on the other hand, was found to increase breast cancer risk.

Breast cancer is not the only form that has been studied in regards to coffee consumption and risk of disease. Other research has suggested that drinking regular coffee (i.e., not decaf) may decrease the risk of developing other types of cancer in men and women. It was noted in one study that the risk for oral/pharyngeal and esophageal cancer was found to decrease with higher coffee consumption. Another study that examined the risk of colon and rectal cancer found a decreased risk of cancer by 26% with those who consume coffee compared to non-coffee drinkers. Caffeinated beverages have no effect on the risk of thyroid cancer, and coffee intake has been shown to have no association with the risk of pancreatic cancer. As you can see, the evidence is pretty clear that frequent coffee consumption does not increase the risk for developing cancer and in some cases, coffee intake is associated with having a preventive effect (see Table 9.2).

To summarize, it is clear that coffee and caffeine consumption has been studied in various aspects of health and disease. Some of the more prevalent diseases in our country were discussed in the text. Coffee has been studied in other aspects of health and disease as well (Table 9.2). Despite traditional beliefs, it is now becoming apparent that both occasional and habitual coffee drinking, which is accompanied by caffeine consumption, does not have a negative affect on health, even in those who suffer from high blood pressure, cardiovascular disease, cardiac arrhythmias, heart failure, or diabetes. Furthermore, drinking coffee does seem to have beneficial effects on one’s health, and not all of these are contributed by caffeine. Taken together, these data provide further evidence to support the role of coffee as a functional food.

9.9 Conclusion and Closing Remarks

This chapter has discussed the various aspects of coffee consumption in both acute and chronic instances. Coffee is one of the most popular beverages in the world and is consumed by millions of people every day. Coffee’s most intriguing and studied ingredient is caffeine. Both coffee and caffeine have been studied in a variety of situations, from psychomotor effects, to performance enhancement effects in exercise, to drinking coffee to prevent a number of diseases. As this chapter has demonstrated, coffee consumption is not dangerous by any means and in most cases can have a multitude of beneficial effects. Traditionally, these beneficial effects have been attributed to the caffeine content of coffee, but we now know that this is not the case in every situation, and the additional ingredients of coffee may also provide beneficial effects. In most cases, a functional food has a special effect on a particular population, but it is clear that the benefits of drinking coffee cover a wide spectrum of the population, and the benefits are not defined in isolated situations. The role that coffee consumption has in preventing some of the most devastating and prevalent diseases should justify the classification of coffee as a functional beverage.
### TABLE 9.2
**Coffee and Caffeine Consumption and Health**

<table>
<thead>
<tr>
<th>Author</th>
<th>Type of Study</th>
<th>Population</th>
<th>Observations of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wadhawan and Anand</td>
<td>Cohort</td>
<td>Individuals with liver disease</td>
<td>Coffee and caffeine consumption improves liver enzymes and decreases mortality.</td>
</tr>
<tr>
<td>Rodriguez et al.</td>
<td>Review</td>
<td>Habitual coffee drinkers</td>
<td>Habitual consumption does not increase risk of CVD. In fact, the consumption of coffee decreased the risk of CVD by 15%.</td>
</tr>
<tr>
<td>Mesas et al.</td>
<td>Review</td>
<td>Habitual coffee drinkers</td>
<td>Blood pressure temporarily increases after the consumption of coffee; however, had no long-term increase on blood pressure.</td>
</tr>
<tr>
<td>Poole et al.</td>
<td>Review</td>
<td>Adult population</td>
<td>Coffee was found to reduce the risk of CVD, cancer, neurological, metabolic, and liver conditions.</td>
</tr>
<tr>
<td>Lee et al.</td>
<td>Cross-sectional</td>
<td>Korean population</td>
<td>Higher coffee consumption was associated with 38% lower odds ratio for stroke in women.</td>
</tr>
<tr>
<td>Schmit et al.</td>
<td>Case-control</td>
<td>Drinkers and non-drinkers</td>
<td>A decrease in odds of developing colorectal cancer was found in drinkers over non-drinkers. Also, the consumption of decaffeinated coffee was also found to have an inverse association.</td>
</tr>
<tr>
<td>Antwi et al.</td>
<td>Case-control</td>
<td>Drinkers and non-drinkers</td>
<td>Consumption of caffeinated coffee is associated with a reduced risk of renal cell carcinoma.</td>
</tr>
<tr>
<td>Je et al.</td>
<td>Meta-analysis</td>
<td>Cases of death</td>
<td>Coffee consumption reduced risk of total mortality. Even high intake of decaffeinated coffee has been found to have a lower risk of mortality.</td>
</tr>
<tr>
<td>Wijarnpreecha et al.</td>
<td>Review</td>
<td>Coffee drinkers and non-drinkers</td>
<td>Nonalcoholic fatty liver disease was found to decrease in those who drank coffee, compared to those who don’t.</td>
</tr>
<tr>
<td>Miranda et al.</td>
<td>Cross-sectional</td>
<td>557 Brazilian men and women</td>
<td>Increased coffee consumption was associated with lower risk of cardiovascular risk factors.</td>
</tr>
<tr>
<td>Rhee et al.</td>
<td>Prospective study</td>
<td>112,935 postmenopausal women</td>
<td>Drinking coffee, caffeinated or decaffeinated coffee, is not a risk factor in hypertension in post-menopausal women.</td>
</tr>
<tr>
<td>Lukic et al.</td>
<td>Experimental</td>
<td>104,080 Norwegian women</td>
<td>Low, moderate, and high coffee consumption was found to reduce the risk of malignant melanoma.</td>
</tr>
<tr>
<td>Larsson et al.</td>
<td>Cohort study</td>
<td>Individuals with gallbladder disease</td>
<td>Two or more cups of coffee per day was associated with a reduced risk of gallbladder cancer.</td>
</tr>
<tr>
<td>Qi and Li</td>
<td>Meta-analysis</td>
<td>Case and controls of patients with Parkinson’s disease</td>
<td>Coffee and tea consumption was found to decrease Parkinson’s disease risk. This reached a maximum at around three cups/day</td>
</tr>
<tr>
<td>Suliga et al.</td>
<td>Cross-sectional</td>
<td>Obese, overweight, and normal-BMI individuals</td>
<td>Lower coffee consumption was related to abdominal obesity, high cholesterol.</td>
</tr>
</tbody>
</table>
REFERENCES

44. Tallis, J., James, R.S., Cox, V.M., Duncan, M.J. The effect of physiological concentrations of caffeine on the power output of maximally and submaximally stimulated mouse EDL (fast) and soleus (slow) muscle. *J Appl Physiol.* 2012; 112(1), 64–71.


Coffee as a Functional Beverage