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Expert report

Coffee and its effect on digestion

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Overview

There have been a number of studies published on coffee and its effect on different areas of digestion; some reporting favourable effects, while other studies report fewer positive effects. This report provides an overview of this body of research, highlighting a number of interesting findings that have emerged to date.

Digestion is the breakdown of food and drink, which occurs through the synchronised function of several organs. It is coordinated by the nervous system and a number of different hormones, and can be impacted by a number of external factors. Coffee has been suggested as a trigger for some common digestive complaints from stomach ache and heartburn, through to bowel problems.

Research suggests that coffee consumption can stimulate gastric, bile and pancreatic secretions, all of which play important roles in the overall process of digestion[1–6]. Gastric complaints such as heartburn and gastro-oesophageal reflux disease (GORD), as well as gastric and duodenal ulcers, can be causes of pain and discomfort for some. Coffee drinking is not considered a major trigger of heartburn or GORD[7–14], and is not associated with the development of gastric or duodenal ulcers[12]. A further consideration in the process of digestion is the motility of the colon, which should strike a balance between ensuring complete digestion without triggering issues associated with increased or reduced transit speed. Coffee can stimulate the motor activity of the colon and in turn may help reduce the risk of constipation[7,15–18]. Finally, coffee drinking seems to have a favourable effect on the gut microflora, an area of emerging and expanding research[19–21].

Here we look at some of the common questions raised about the effect of coffee on digestion, what current research tells us, and acknowledging that there are areas where the research is limited, and further work would be beneficial.

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Coffee, a diet staple for millions

Coffee is enjoyed by millions of people around the world and is one of the most researched food or drink items. It naturally contains a variety of compounds including caffeine, polyphenols (such as chlorogenic acid), trigonelline and the diterpenes, cafestol and kahweol[22]. These compounds contribute not only to the unique flavour but also to the physiological effects of coffee.

Caffeine is a major pharmacologically active compound in coffee and it is a mild central nervous system stimulant[23–25]. Based on a review by The European Food Safety Authority (EFSA) on the Safety of Caffeine it is suggested that a moderate caffeine consumption, of around 400mg caffeine per day (the equivalent of up to 5 cups of coffee), can be enjoyed as part of a healthy balanced diet and an active lifestyle[26]. Pregnant and breastfeeding women are advised to limit their caffeine intake to 200mg per day[26]. A typical cup of coffee provides approximately 75–100mg caffeine, or around 60mg in an espresso.

400mg

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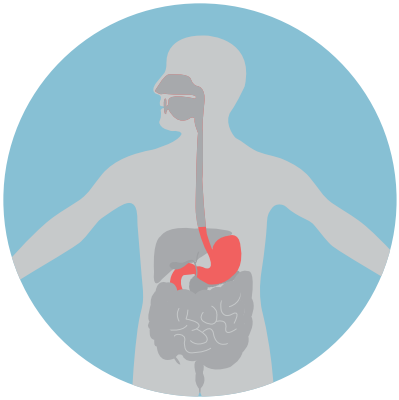
What effect can coffee have on the stomach?

The stomach forms part of the upper gastro-intestinal (GI) tract. This is where hormones, enzymes and acid are secreted and combine with ingested food and drink, as part of the process of digestion. Stomach acid also plays an important role in destroying microorganisms in ingested food.

Research suggests that coffee consumption stimulates the secretion of gastrin, the hormone produced by the cells of the stomach wall, which in turn stimulates the production of gastric acid[1]. Coffee drinking can also temporarily increase salivary gastrin[2]. Interestingly, the secretion of gastric acid may vary depending on the roasting of the coffee consumed[3]. Dark roasted coffee is suggested to be less effective at stimulating gastric acid secretion, possibly because the process of roasting can affect some of the compounds naturally present in coffee including chlorogenic acid and trigonelline[3]. However, further research is required to fully understand these associations.



Adenosine is a compound involved in metabolism throughout the body and it has been established that caffeine has a direct effect on adenosine receptors (as an antagonist)[27,28]. Adenosine receptors are involved in the role caffeine plays in increasing alertness and performance[28] (see explanatory video), and adenosine may be associated with the modulation of gastric acid secretion, by acting in the gastric mucosa[4]. This occurs through adenosine suppressing gastrin release and inhibiting gastric acid secretion[4,5]. It is thought that caffeine may antagonise this receptor and in turn stimulate gastric acid secretion, although more research is needed in this area.

The stomach contents are gradually emptied into the small intestine, and coffee consumption does not appreciably influence the rate of stomach emptying[1,29–33].

Overall, coffee consumption seems to stimulate digestion in the stomach by stimulating the release of gastrin and gastric acid[1,2], but does not appreciably influence the rate of gastric emptying[29–33].

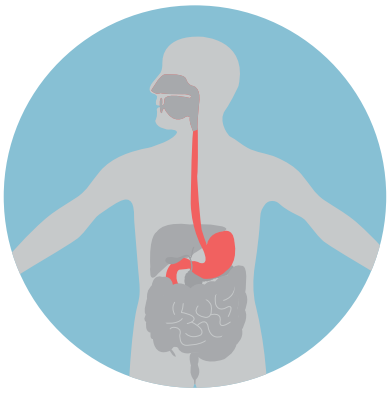
"Interestingly, the secretion of gastric acid may vary depending on the roasting of the coffee consumed[3]."

Can coffee trigger heartburn or GORD?

Heartburn and gastro-oesophageal reflux disease (GORD) are closely related but are not the same condition. Heartburn is a symptom of acid reflux from the stomach into the oesophagus which can range in severity from mild to severe, and cause pain or burning in the upper abdomen.

GORD is a chronic, more severe acid reflux condition caused by return of stomach acid into the oesophagus. Symptoms may include frequent heartburn, regurgitation of food or liquid and difficulty swallowing.

A common question among consumers is whether coffee is associated with heartburn or GORD.



The majority of studies have not identified a link between coffee consumption and the risk of GORD[7–14]. Indeed, a study of Taiwanese people suggested that drinking coffee or tea was not associated with reflux symptoms or oesophageal reflux disease, regardless of additions such as milk or sugar[34]. However, three other studies did suggest that coffee consumption was associated with an increase in GORD[35–37].

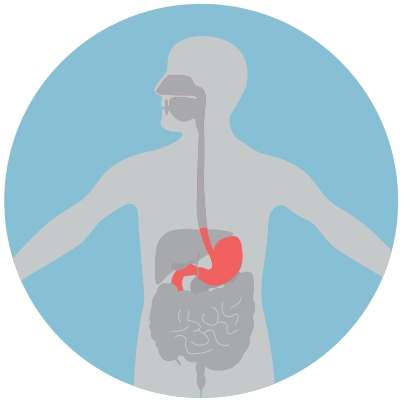
Interestingly, some research has suggested that the variability in gastric response to coffee drinking may relate to differences in the processing of the coffee beans themselves[38]. For example, caffeinated ground coffee appeared to stimulate more acid secretion than decaffeinated ground coffee, whilst their instant counterparts did not differ in their acid-stimulating ability. In relation to gastrin secretion, ground caffeinated coffee and freeze-dried instant coffee both appeared to stimulate higher gastrin levels[38].

In addition to coffee, GORD has been linked to many different foods and drinks including spicy foods, beer, wine, carbonated soft drinks and chocolate, as well as being associated with a higher level of obesity or body mass index[14,39,40]. It is clearly a complex condition and it is difficult to separate out the causes to identify a specific cause in an individual.

On review of the evidence, most research suggests that there is not a link between coffee drinking and the incidence of GORD[7–14], although some variability does exist which has been suggested to relate to the degree of roasting of coffee[38]. It is an area where additional research would be helpful.

"The majority of studies reviewed suggest that coffee is not a major trigger of heartburn or GORD[7–14]"

Is coffee associated with the development of gastric or duodenal ulcers?



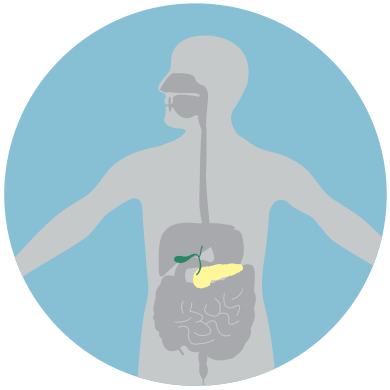
Gastric ulcers develop in the lining of the stomach, whilst duodenal ulcers develop in the first part of the small intestine (duodenum). Ulcers can cause abdominal pain, nausea, heartburn and a feeling of fullness, and are often associated with the bacterium Helicobater pylori, or regular use of certain medications[41].

Much of the research to date has not found any association or effect of coffee consumption on ulcers when comparing those who drink coffee with non-coffee drinkers with no ulcer history[12]. However, those who experience symptoms of ulcers may voluntarily reduce their coffee consumption through a perceived relationship between drinking coffee and their symptoms[42].

Can coffee help gallbladder or pancreatic function?

The gallbladder is an organ that receives and stores bile which is produced by the liver. Bile is secreted periodically from the gallbladder into the small intestine where it is largely involved in the digestion of fats.

Both coffee and decaffeinated coffee can stimulate the secretion of cholecystokinin (CCK), a hormone that stimulates the release of enzymes and bile from the gallbladder and pancreas into the intestine. This effect has been observed with both regular and decaffeinated coffee, which can give rise to increments in plasma CCK and contractions of the gallbladder[6].



CCK has also been shown to stimulate secretions from the pancreas, which contain enzymes for the digestion of lipids, proteins and carbohydrates. Further research has also suggested that coffee consumption may be associated with a reduced risk of pancreatitis[43,44].

Research on gallbladder function has suggested that coffee is also associated with a reduced risk of gallstone disease. One study suggested the risk reduction of gallstone disease was mainly observed in women[45], however other research has shown an effect in both men and women[46,47]. The association seems to be dose dependent, with a greater effect observed with higher intakes of coffee[45,46].

Although the mechanisms are unclear, caffeine is likely to be key as the effect is not observed with decaffeinated coffee[47]. Furthermore, caffeine has been shown to enhance the contraction of the gallbladder[6], which could contribute to a reduced risk of gallstones. Further research is required to understand the mechanisms in more detail.

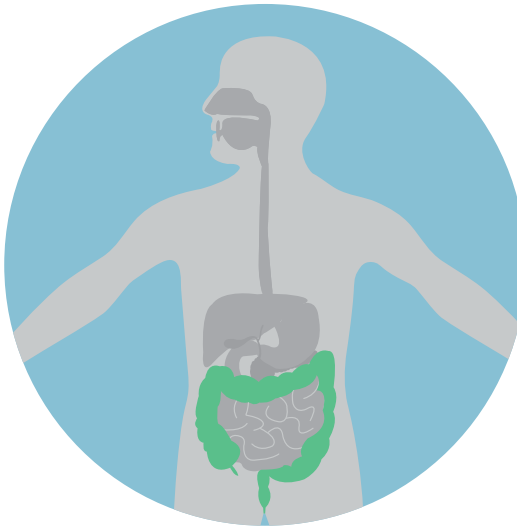
Overall, coffee drinking is associated with a reduced risk of problems associated with the gallbladder such as gallstones and gallbladder disease and with a reduced risk of pancreatitis. Whilst caffeine may be involved in the association, further research is required to fully understand the mechanisms behind the observed associations.

"Drinking coffee may help to reduce the risk of certain digestive disorders, including gallstone disease[44,46,47] and pancreatitis[43,44]"

Does coffee consumption have an impact on the lower digestive tract?

The colon is responsible for the re-absorption of water and processing and elimination of waste products. It is also the area where the gut microflora reside, an increasingly important area of knowledge and research on gut health.

The balance of colonic motility is important to ensure waste is excreted without the complications associated with either constipation or diarrhoea. Although the effects will vary from person to person, coffee seems to stimulate motility in the colon to a greater extent than both decaffeinated coffee and water, and at a similar level to the consumption of a meal[15]. However, further research has suggested that decaffeinated coffee can also stimulate motility[16]. Colonic motility has been shown to increase as soon as four minutes after coffee ingestion[16]. However, this effect is most likely related to an indirect effect of neural or hormonal responses to food intake that stimulate motility rather than coffee per se[17].



In relation to bowel habits, coffee consumption is not associated with the prevalence of chronic constipation[48], and some research suggests that coffee drinking may even be linked to a reduced risk of this condition[18].

An interesting aspect of coffee consumption is in relation to post-operative recovery of GI function. GI function typically reduces after abdominal surgery (such as colorectal or gynaecological). Coffee may help to accelerate the postoperative recovery of GI function in patients, potentially reducing the time to first bowel movement and tolerance of solid food, although the mechanisms behind these effects are not fully known[49,50,51].

Coffee and the lower digestive tract

May help to accelerate postoperative recovery of GI function[49,50,51]

May stimulate motility in the colon to a greater extent than both decaffeinated coffee and water[15]

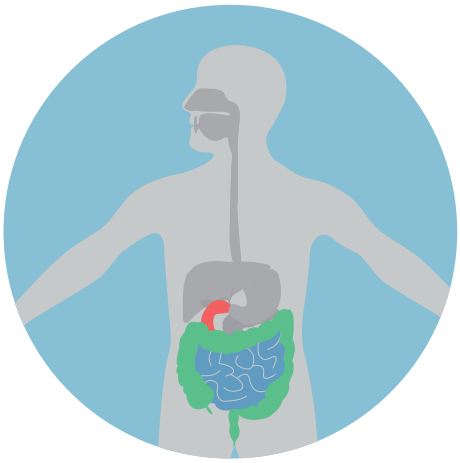
May be linked to a reduced risk of chronic constipation[18]

Coffee and gut microbiota — an emerging area of research

A growing area of research in nutrition and health is the role of gut microbiota in health, and the dietary habits that support a healthy microflora. Research has suggested that the population of Bifidobacterium spp. is seen to increase in the intestine following coffee consumption without any major impact on the dominant microbiota[21,52].

Dietary fibre found in coffee may be metabolised into short chain fatty acids helping to increase the presence of two species of dominant bacteria in the intestinal flora[19]. The polyphenols in coffee, including chlorogenic acid, may also be important in supporting the microflora[20,21].

The impact of food and drink consumption on the gut microflora is a growing area of research and, as more studies explore the complex interplay between coffee consumption and gut microflora, further conclusions may be reached.



"Populations of the beneficial gut bacteria Bifidobacterium spp., increase after drinking coffee[21,52]."

About Carlo La Vecchia

Dr. Carlo is recognised worldwide as a leading authority in cancer aetiology and epidemiology. Presently, he is Professor of Epidemiology and Biostatistics at the School of Medicine at the University of Milan. Dr. La Vecchia serves as an editor for numerous clinical and epidemiologic journals. He is among the most renowned and productive epidemiologists in the field.

Dr. La Vecchia's main fields of interest include cancer epidemiology and the risk related to diet, tobacco, hormone use and occupational or environmental exposure to toxic substances; and analysis of temporal trends and geographical distribution of mortality from cancer, cardiovascular diseases, perinatal and other selected conditions.

About ISIC

The Institute for Scientific Information on Coffee (ISIC) is a not-for-profit organization, established in 1990 and devoted to the study and disclosure of science related to "coffee and health." Since 2003 ISIC also supports a pan-European education programme, working in partnership with national coffee associations in nine countries to convey current scientific knowledge on "coffee and health" to health care professionals.

ISIC's activities are focused on:

- the study of scientific matters related to "coffee and health"
- the collection and evaluation of studies and scientific information about "coffee and health"
- the support of independent scientific research on "coffee and health"
- active dissemination of balanced "coffee and health" scientific research and knowledge to a broad range of stakeholders.

ISIC respects scientific research ethics in all its activities. ISIC's communications are based on sound science and rely on scientific studies derived from peer-reviewed scientific journals and other publications.

ISIC members are six of the major European coffee companies: illycaffè, Jacobs Douwe Egberts, Lavazza, Nestlé, Paulig, and Tchibo.

About coffeeandhealth.org

The website www.coffeeandhealth.org is a science-based resource developed for health care and other professional audiences and provides the latest information and research into coffee, caffeine and health.

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References

1 Boekema P.J. et al. (1999) Coffee and gastrointestinal function: facts and fiction. *Scand J Gastroenterol,* 99:35-9.

2 Papakonstantinou E, et al. (2016) Acute effects of coffee consumption on self-reported gastrointestinal symptoms, blood pressure and stress indices in healthy individuals. *Nutr J,* 15:26.

3 Rubach M. et al. (2014) A dark brown roast coffee blend is less effective at stimulating gastric acid secretion in healthy volunteers compared to a medium roast market blend. *Mol Nutr Food Res,* 58:1370-3.

4 Arin R.M. et al. (2017) Adenosine: Direct and Indirect Actions on Gastric Acid Secretion. *Front Physiol,* 8:737.

5 Yip L. et al. (2004) Role of adenosine A1 receptor in the regulation of gastrin release. *J Pharmacol Exp Ther,* 310:477-87.

6 Douglas B.R. et al. (1990) Coffee stimulation of cholecystokinin release and gallbladder contraction in humans. *Am J Clin Nutr,* 52:553–6.

7 Chang C.S. et al. (1997) The incidence of reflux esophagitis among the Chinese. *Am J Gastroenterol,* 92:668-71.

8 Nilsson M. et al. (2004) Lifestyle related risk factors in the aetiology of gastro-oesophageal reflux. *Gut,* 53:1730-5.

9 Dore M.P. et al. (2008) Diet, lifestyle and gender in gastro-esophageal reflux disease. *Dig Dis Sci,* 53:2027-32.

10 El-Serag H.B. et al. (2007) Determinants of gastroesophageal reflux disease in adults with a history of childhood gastroesophageal reflux disease. *Clin Gastroenterol Hepatol,* 5:696-701.

11 Ercelep O.B. et al. (2014) The prevalence of gastroesophageal reflux disease among hospital employees. *Dis Esophagus,* 27:403-8.

12 Shimamoto T. et al. (2013) No association of coffee consumption with gastric ulcer, duodenal ulcer, reflux esophagitis, and non-erosive reflux disease: a cross-sectional study of 8,013 healthy subjects in Japan. *PLoS One,* 8:e65996.

13 Pandeya N. et al. (2012) Prevalence and determinants of frequent gastroesophageal reflux symptoms in the Australian community. *Dis Esophagus,* 25:573-83.

14 Friedenberg F.K. (2010) Prevalence and risk factors for gastroesophageal reflux disease in an impoverished minority population. *Obes Res Clin Pract,* 4:e261-e269.

15 Rao S.S. et al. (1998) Is coffee a colonic stimulant? *Eur J Gastroenterol Hepatol,* 10, 113-8.

16 Brown S.R. et al. (1990) Effect of coffee on distal colon function. *Gut,* 31:450-53.

17 Scheperjans F. et al. (2015) Linking Smoking, Coffee, Urate, and Parkinson's Disease - A Role for Gut Microbiota? *J Parkinsons Dis,* 5:255-62.

18 Murakami K. et al. (2006) Dietary intake in relation to self-reported constipation among Japanese women aged 18–20 years. *Eur J Clin Nutr,* 60:650-7.

19 Gniechwitz D. et al. (2007) Dietary fiber from coffee beverage: degradation by human fecal microbiota. *J Agric Food Chem,* 55:6989-96.

20 Moco S. et al. (2012) Metabolomics view on gut microbiome modulation by polyphenol-rich foods. *J Proteome Res,* 11:4781-4790.

21 Mills C.E. et al. (2015) In vitro colonic metabolism of coffee and chlorogenic acid results in selective changes in human faecal microbiota growth. *Br J Nutr,* 113:1220-7.

22 De Melo Pereira G.V. et al. (2020) Chemical composition and health properties of coffee and coffee by-products. *Ad Food Nutr Res,* 91:65-96.

23 EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA) (2011) Scientific Opinion on the substantiation of health claims related to caffeine and increased fat oxidation leading to a reduction in body fat mass (ID 735, 1484), increased energy expenditure leading to a reduction in body weight (ID 1487), increased alertness (ID 736, 1101, 1187, 1485, 1491, 2063, 2103) and increased attention (ID 736, 1485, 1491, 2375) pursuant to Article 13(1) of Regulation (EC) No 1924/20061. *EFSA Journal,* 9(4):2054.

24 Nehlig A. (2016) Effects of coffee/caffeine on brain health and disease: What should I tell my patients? *Pract Neurol,* 16(2):89-95.

25 Pray L. et al. (2014) Caffeine in Food and Dietary Supplements: Examining Safety: Workshop Summary. Available at: https://www.nap.edu/catalog/18607/caffeine-in-food-and-dietary-supplements-examining-safety-workshop-summary.

26 EFSA (2015) Scientific Opinion on the Safety of Caffeine, *EFSA Journal,* 13(5):4102.

27 Ribeiro J.A., Sebastiao A.M. (2010) Caffeine and adenosine. *J Alz Dis,* 20:S3-S15.

28 Fredholm B.B. et al. (1999) Actions of caffeine in the brain with special reference to factors that contribute to its widespread use. *Pharmacol Rev,* 51:83-133.

29 Lien H.C. et al. (1995) The effect of coffee on gastric emptying. *Nucl Med Commun,* 16: 923-6.

30 Boekema P.J. et al. (2000) The effect of coffee on gastric emptying and oro-caecal transit time. *Eur J Clin Invest,* 30:129-34.

31 Franke A. et al. (2008) Postprandial walking but not consumption of alcoholic digestifs or espresso accelerates gastric emptying in healthy volunteers. *J Gastrointestin Liver Dis,* 17: 27-31.

32 Schubert M.M. et al. (2014) Coffee for morning hunger pangs. An examination of coffee and caffeine on appetite, gastric emptying, and energy intake. *Appetite,* 83:317-26.

33 Schubert M.M. et al. (2017) Caffeine, coffee, and appetite control: a review. *Int J Food Sci Nutr,* 68:901-912.

34 Wei T.Y. et al. (2019) The role of tea and coffee in the development of gastroesophageal reflux disease. *Tzu Chi Med J,* 31:169-176.

35 Wendl B. et al. (1994) Effect of decaffeination of coffee or tea on gastro-oesophageal reflux. *Aliment Pharmacol Ther,* 8:283-7.

36 Arivan R., Deepanjali S. (2018) Prevalence and risk factors of gastro-esophageal reflux disease among undergraduate medical students from a southern Indian medical school: a cross sectional study. *BMC Res Notes,* 11(1):448.

37 Mehta R.S. et al. (2019) Association Between Beverage Intake and Incidence of Gastroesophageal Reflux Symptoms. Cin Gastroenterol Hepatol, S1542-3565(19)31380-1. doi: 10.1016/j.cgh.2019.11.040. [Epub ahead of print]

38 Van Deventer G. et al. (1992) Lower esophageal sphincter pressure, acid secretion, and blood gastrin after coffee consumption. *Dig Dis Sci,* 37:558-69.

39 Surdea-Blaga T. et al. (2019) Food and Gastroesophageal Reflux Disease. *Curr Med Chem.* 26(19):3497-3511.

40 Kaltenbach T. et al. (2006) Are lifestyle measures effective in patients with gastroesophageal reflux disease? An evidence-based approach. *Arch Intern Med,* 166:965-71.

41 Prabhu V., Shivani A. (2014) An Overview of History, Pathogenesis and Treatment of Perforated Peptic Ulcer Disease with Evaluation of Prognostic Scoring in Adults. *Ann Med Health Sci,* 4(1):22–29.

42 Eisig J.N. et al. (1989) Coffee drinking in patients with duodenal ulcer and a control population. *Scand J Gastroenterol,* 24 :796-8.

43 Wijarnpreecha K. et al. (2018) Heavy Coffee Consumption and Risk of Pancreatitis: A Systematic Review and Meta-Analysis. *Dig Dis Sci,* 63(11):3134-3140.

44 Setiawan V.W. et al. (2017) Dietary Factors Reduce Risk of Acute Pancreatitis in a Large Multiethnic Cohort. *Clin Gastro Hepatol,* 15(2):257-265.e.3.

45 Zhang Y.P. et al. (2015) Systematic review with meta-analysis: coffee consumption and the risk of gallstone disease. *Aliment Pharmacol Ther,* 42:637-48.

46 Leitzmann M.F. et al. (1999) A prospective study of coffee consumption and the risk of symptomatic gallstone disease in men. *JAMA,* 281:2106–12.

47 Leitzmann M.F. et al. (2002) Coffee intake is associated with lower risk of symptomatic gallstone disease in women. *Gastroenterol,* 123:1823–30.

48 Chang J.Y. et al. (2007) Risk factors for chronic constipation and a possible role of analgesics. *Neurogastroenterol Motil,* 19(11):905-11.

49 Eamudomkarn N. et al. (2018) Effect of post operative coffee consumption on gastrointestinal function after abdominal surgery: A systematic review and meta-analysis of randomized controlled trials. *Sci Rep,* 8:17349.

50 Gkegkes I.O. et al. (2020) Effect of caffeine intake on postoperative ileus: A systematic review and meta- analysis. *Dig Surg,* 37:22-31.

51 Cornwall H.L. et al. (2019) Coffee to go? The effect of coffee on resolution of ileus following abdominal surgery: A systematic review and meta-analysis of randomised controlled trials. *Clin Nutr,* Jun 13. pii: S0261-5614(19)30258-4. [Epub ahead of print]

52 Jaquet M. et al. (2009) Impact of coffee consumption on the gut microbiota: a human volunteer study. *Int J Food Microbiol,* 130:117-21.