

# Why Coffee Affects Metabolism

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✓ Fact Checked

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## STORY AT-A-GLANCE

- › Researchers found the caffeine in one standard cup of coffee stimulated brown fat activity, burning more energy and potentially improving insulin sensitivity. These activities may help improve weight management
- › Daily coffee drinkers also enjoy greater metabolism of fatty acids and a downregulation of the endocannabinoid system, which regulates cognition, immunity, sleep and appetite, having the opposite effect in the body than the ingestion of cannabis
- › Your body has white fat and brown fat cells; the white cells may be programmed to brown cells when the programming is not naturally suppressed by a special protein. Conversion of white to brown fat is known as "beige" or "brite" fat
- › The location of fat is important, since subcutaneous fat just under the skin is not as dangerous as visceral fat found deep in your abdomen around your organs. You may increase the activity of the brown fat you already have through exercise, exposure to cold and sleeping in a cool environment

Many people struggle with obesity and being overweight. According to the CDC,<sup>1</sup> the prevalence of both conditions was measured nationally in 2015-2016, finding 71.6% of the U.S. population were either overweight or obese. By 2022 that number had escalated to 74%.<sup>2</sup> Although some corporations, like Coca-Cola<sup>3</sup> propose you may out-exercise a poor diet, research has found it is a combination of a healthy diet and exercise that has the greatest benefit.<sup>4</sup>

In mid-2015 The New York Times<sup>5</sup> reported on the activities of Global Energy Balance Network, a nonprofit organization funded by Coca-Cola to promote the argument that exercise is more important than diet. The organization disbanded by the end of the year.<sup>6</sup>

In 2017, weight loss and weight management was worth \$66 billion each year according to a market research firm Marketdata, LLC.<sup>7</sup> In their press release<sup>8</sup> they reported that the number of active dieters had fallen by 10% since 2015.

The market — which can include diet pills, shakes and supplements, medical weight loss clinics, frozen entrees and online services — declined during the pandemic to a record low of \$58 billion, but quickly rose to \$72.6 billion in 2021.<sup>9</sup>

There are several factors contributing to your ability to lose weight, including getting enough quality sleep each night,<sup>10</sup> supporting a healthy gut microbiome<sup>11</sup> and choosing to eat more whole food and less processed food.<sup>12</sup> A recent study published in Scientific Reports<sup>13</sup> has demonstrated coffee may affect your metabolism and mobilize metabolically active brown fat.

## **Study Shows Coffee Stimulates Brown Fat**

Brown adipose tissue (BAT) may generate heat (thermogenesis)<sup>14</sup> and burn glucose and fats through a mitochondrial reaction mediated by mitochondrial uncoupling protein 1 (UCP1).<sup>15</sup> Energy balance prevents the development of obesity, and while physical activity may dissipate some energy, the body also uses a system of thermogenesis, or the production of heat through the burning of energy.

Upregulation of UCP1 may reduce the potential for obesity and improve insulin sensitivity as it is one of the systems of thermogenesis in brown fat.<sup>16</sup> In the Scientific Reports study, researchers looked at the effect of caffeine on BAT both in the test tube and in humans.

They wrote that past studies demonstrated the activation of BAT through nutrients or cold exposure. Caffeine demonstrated an upregulation of UCP1 in obese mice but the

extent that it directly affected BAT in humans was not known. The researchers first used cells from mice and human bone marrow stem cells cultured in a test tube and then introduced caffeine.

Their analysis was performed using several tests, including mitochondrial staining, transmission electron microscopy and gene expression analysis. Next, nine healthy human volunteers with a mean body mass index of 23,<sup>17</sup> within normal range,<sup>18</sup> were engaged to participate. They either drank a caffeinated beverage or water and then remained sitting for 30 minutes.

The researchers found treatment of the cell cultures with caffeine increased the expression of UCP1. They also analyzed and compared the thermal imaging done 30 minutes after drinking the beverages against those done before.<sup>19</sup>

The images showed an increased temperature of BAT in the subclavicular area in adults after drinking coffee. This reflected an increase in heat production in BAT not demonstrated after drinking water.

## **Standard Cup of Coffee May Help Weight Management**

The Scientific Reports researchers said this is the first study to demonstrate caffeine's stimulation on UCP1 in vitro that could be projected to the ingestion of caffeine by humans through a standard sized cup of coffee. Michael Symonds, Ph.D., from the school of medicine at the University of Nottingham, co-directed the study. As reported in a press release from the university, he commented:<sup>20</sup>

*"From our previous work, we knew that brown fat is mainly located in the neck region, so we were able to image someone straight after they had a drink to see if the brown fat got hotter. The results were positive and we now need to ascertain that caffeine as one of the ingredients in the coffee is acting as the stimulus or if there's another component helping with the activation of brown fat."*

The researchers believe this suggested that caffeine in a standard cup of coffee could increase the metabolic rate and enhance BAT function. They theorize this activity has the potential to contribute to weight loss. They wrote:<sup>21</sup>

*"In conclusion, these results provide new complementary in vitro and in vivo evidence that caffeine (and a coffee beverage) can promote BAT function at doses compatible with human use."*

## **Daily Coffee Affects Metabolism in Multiple Ways**

New discoveries about coffee and the impact it has on health are reported frequently. Some reports state that caffeine helps you live longer,<sup>22</sup> while others associate caffeine with increasing your potential risk to danger.<sup>23</sup> It can be difficult to know what to believe.

In a study published by Northwestern Medicine,<sup>24</sup> scientists discovered coffee changed significantly more metabolites in the body than had been known. After eating or drinking, your body produces metabolites, or chemicals. A higher number of affected metabolites may explain, in part, the number of effects coffee has on the body.

The researchers gathered 47 habitual coffee drinkers and ask them to stop drinking coffee for one month.<sup>25</sup> In the following month the participants drank four cups of coffee each day and in the last month they drank eight cups of coffee each day. During the study, the researchers collected samples of their blood, evaluating for the number and type of metabolites.

They found that the levels of 115 metabolites were altered by drinking coffee, 82 of which were known to affect 33 biological pathways. They also discovered three novel links to coffee including steroid metabolites, fatty acid metabolism and the effect it had on the endocannabinoid system.<sup>26</sup>

Your body normally has cannabinoid receptors in the neurological system.<sup>27</sup> The researchers found the neurotransmitters related to this system were reduced after drinking four to eight cups of coffee each day. The effect is opposite of what would be expected when cannabis is ingested.

The researchers point out the body's endocannabinoid system regulates cognition, immunity, sleep, appetite and energy functions to name a few.<sup>28</sup> Additionally, they found the metabolites related to the androsteroid system, suggesting to the researchers coffee may help eliminate steroids from the body.

This may help in cancers significantly affected by steroid levels. Lead author Marilyn Cornelis, Ph.D., assistant professor of preventive medicine, commented:<sup>29</sup>

*"These are entirely new pathways by which coffee might affect health. Now we want to delve deeper and study how these changes affect the body. The increased coffee consumption over the two-month span of the trial may have created enough stress to trigger a decrease in metabolites in this system. It could be our bodies' adaptation to try to get stress levels back to equilibrium."*

Regarding the association among coffee, weight loss and a reduced risk of Type 2 diabetes, she said:<sup>30</sup>

*"This is often thought to be due to caffeine's ability to boost fat metabolism or the glucose-regulating effects of polyphenols (plant-derived chemicals). Our new findings linking coffee to endocannabinoids offer alternative explanations worthy of further study."*

## **Brown, Beige or White?**

Three different types of fat perform different functions in your body. Researchers in the featured study were interested in the effect caffeine would have on activating BAT, and thus increase thermogenesis and energy metabolism. Symonds commented:<sup>31</sup>

*"Brown fat works in a different way to other fat in your body and produces heat by burning sugar and fat, often in response to cold. Increasing its activity improves blood sugar control as well as improving blood lipid levels and the extra calories burnt help with weight loss. However, until now, no one has found an acceptable way to stimulate its activity in humans."*

*This is the first study in humans to show that something like a cup of coffee can have a direct effect on our brown fat functions. The potential implications of our results are pretty big, as obesity is a major health concern for society and we also have a growing diabetes epidemic and brown fat could potentially be part of the solution in tackling them."*

The most common type of fat cells are white adipocytes, where excess energy is stored, increasing the risk of obesity. Overloading these cells leads to related conditions, such as Type 2 diabetes and cardiovascular disease.<sup>32</sup> On the other side of the spectrum are brown adipocytes, which are thermogenically active<sup>33</sup> and more prevalent in children than adults.<sup>34</sup>

Researchers have discovered white fat cells may be programmed to turn brown, but this programming is suppressed by the FLCN protein. The function to suppress brown fat programming is performed in cooperation with another pathway,<sup>35</sup> which is active during cell processes, including tumor formation, insulin resistance and fat cell growth.<sup>36</sup>

That particular pathway, called mTOR, is activated by amino acids and insulin,<sup>37</sup> as well as growth factors, which in turn help suppress brown fat programming.<sup>38</sup> The conversion of white fat to BAT cells is known as "brite" or "beige" fat cells.

The body's sympathetic nervous system is capable of doing this on a small scale but since white fat cells are connected to other organ systems, on a large scale within the body it is not possible.<sup>39</sup> Scientists are experimenting with conversion of white fat outside the body to beige fat and then reintroducing to help fight obesity.<sup>40</sup>

## **Fat Location Makes a Difference**

Where fat is located on your body makes a difference to your health. White fat performs two important functions: It stores excess calories and releases hormones that control metabolism.<sup>41</sup> Fat may be stored directly under the skin, called subcutaneous fat, or deep in the abdomen around your organs, called visceral fat.<sup>42</sup>

Subcutaneous fat is often found on the thighs and buttocks and does not usually cause as many problems as visceral. According to Harvard Health, 90% of body fat in most individuals is subcutaneous,<sup>43</sup> which might be described as the fat you can pinch. It accumulates in the lower body, creating a pear shape.<sup>44</sup>

The remaining 10% is intra-abdominal or visceral fat, beneath the abdominal wall and surrounding your organs.<sup>45</sup> This type of fat is strongly associated with metabolic syndrome and insulin resistance.<sup>46</sup> In a study<sup>47</sup> from the University of Illinois, researchers found a regulatory molecule produced a bodily response leading to higher amounts of visceral fat with increased caloric intake.<sup>48</sup>

## Activate Your Brown Fat Stores

One way the mTOR pathway is stimulated is through excessive protein intake. This stimulation helps suppress white fat to BAT programming. There are additional ways of activating your brown fat to burn more energy and convert some of your white fat to beige, also increasing thermogenesis, without drugs or surgery. Here are five strategies you may consider:

- **Exercise** — In a study from The Ohio State University Wexner Medical Center,<sup>49</sup> researchers found one reason exercise may boost metabolism is through increasing levels of a lipokine molecule that had been linked to cold temperatures in the past.<sup>50</sup>
  - The researchers found the function of brown fat during exercise was to tell the muscle to use more fatty acids as fuel. They confirmed their results in an animal study during which they found lipokines after the mice exercised, but once BAT was removed from the mice there was no evidence of exercise-induced increase.
- **Cold** — Several studies have demonstrated that exposure to cold temperatures increases glucose burning in brown fat and upregulates UCP1 proteins.<sup>51</sup> It also increases BAT activation, reduces fat<sup>52</sup> and changes mitochondria in skeletal

muscle and BAT.<sup>53</sup> Daily exposure increases the volume of BAT and the oxidative capacity.<sup>54</sup>

- **Sleep** — One method<sup>55</sup> studied to expose participants to a cool environment was to reduce the ambient temperature during sleep. Researchers engaged five men over four months. The participants did their regular activities during the day and then returned to their rooms each evening.
  - The temperature in the room was set to 75 degrees Fahrenheit (F) during the first month, 66 F in the following two months, and 81 F in the final month. After one month of exposure to mild cold temperatures the researchers measured a 42% increase in BAT volume and 10% rise in metabolic activity in the participants.<sup>56</sup>

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