
Published January 9, 2026 by Dr. Daniel Thomas, DO, MS

# Myokines: How Exercise Fights Cancer

For decades, researchers have observed that physically active individuals experience lower rates of cancer and better outcomes when diagnosed with the disease. While many theories have attempted to explain this relationship, emerging evidence indicates that muscles are not merely engines for movement but are active endocrine organs that release potent anti-cancer molecules during exercise. These molecules, called *myokines*, represent a promising frontier in understanding how physical activity protects against cancer and supports those fighting the disease.

**Muscles as Medicine-Producing Organs**

The traditional view of muscles focused exclusively on their mechanical function, namely, contracting to produce movement. However, research conducted over the past two decades has fundamentally changed this understanding. Scientists now recognize that skeletal muscle is the largest endocrine organ in the human body, secreting hundreds of signaling molecules that influence virtually every organ system.

When muscle fibers contract during physical activity, they release myokines into the bloodstream. These hormone-like molecules travel throughout the body, communicating with distant tissues and triggering a cascade of beneficial effects. Among the most studied myokines with documented anti-cancer properties are IL-6 (the exercise-induced, anti-inflammatory form), irisin, SPARC, and oncostatin M. Each plays a distinct role in the body's defense against malignant disease.

**How Myokines Combat Cancer**

The anticancer effects of exercise-induced myokines are mediated by multiple mechanisms.

Laboratory studies have demonstrated that these molecules can directly reduce cancer cell proliferation, essentially slowing the rate at which malignant cells divide and multiply. Perhaps more significantly, certain myokines induce apoptosis (programmed cell death) in cancer cells while sparing healthy cells. This selective targeting represents a form of natural chemotherapy produced by the body itself.

Beyond their direct effects on cancer cells, myokines enhance immune surveillance. The immune system continuously monitors for abnormal cells, and myokines appear to improve the efficiency of this surveillance, helping immune cells identify and eliminate nascent tumors before they can establish themselves. Research has also shown that myokines alter the tumor microenvironment (the complex ecosystem surrounding cancer cells), making it less supportive of tumor growth and more hostile to metastatic spread.

**The Immediate and Cumulative Benefits**

One of the most encouraging findings from recent research is that the anti-cancer effects of exercise begin almost immediately. Studies have demonstrated that even brief bouts of vigorous physical activity alter the molecular composition of blood in ways that suppress genes implicated in cancer growth, activate DNA repair pathways, and improve metabolic signaling. When researchers exposed cancer cells to post-exercise blood in the laboratory, the cells showed reduced growth rates and improved DNA stability.

The benefits also accumulate over time. In a study of breast cancer survivors, twelve weeks of structured exercise training increased circulating myokine levels by up to fifteen percent. More importantly, when researchers applied blood serum from these exercising individuals to metastatic breast cancer cells in laboratory models, the cells showed twenty-two to twenty-five percent reductions in growth compared to controls. This finding suggests that regular exercise creates a sustained anti-cancer environment within the body.

**Exercise and Cancer Prevention**

For individuals seeking to reduce their cancer risk, the myokine pathway offers a compelling biological rationale for regular physical activity. Many cancers develop and thrive in metabolic environments characterized by elevated blood glucose, high insulin levels, chronic systemic inflammation, and compromised mitochondrial function. Exercise-induced myokines directly counteract each of these conditions.

Regular physical activity improves insulin sensitivity, reducing the elevated insulin levels that have been linked to increased cancer risk. Myokines enhance mitochondrial metabolism, improving the cellular energy production that supports healthy tissue function. They reduce systemic inflammation, which is increasingly recognized as a driver of cancer development and progression. They also support DNA repair mechanisms, helping the body correct genetic damage before it can lead to malignant transformation. Collectively, these effects create an internal metabolic landscape that is fundamentally hostile to cancer initiation and growth.

**Supporting Cancer Treatment and Survivorship**

For those already diagnosed with cancer, exercise-induced myokines offer additional benefits that complement conventional treatment. Research has demonstrated that physical activity during cancer treatment can improve treatment tolerance, helping patients complete their prescribed regimens with fewer dose reductions or delays. The mechanisms underlying this benefit likely involve myokine-mediated improvements in immune function, tissue repair, and metabolic health.

Cancer survivors face an elevated risk of recurrence, and maintaining regular physical activity

appears to reduce this risk substantially. Reviews examining the role of myokines in cancer outcomes have highlighted their influence on immune cell infiltration into residual tumor sites, blood vessel formation, local inflammation, and cancer cell migration. By maintaining elevated myokine levels through regular exercise, survivors may be able to suppress the growth of any remaining cancer cells and reduce the likelihood of metastatic spread.

Exercise also helps counteract sarcopenia, the progressive loss of muscle mass that commonly accompanies cancer and its treatment. Because muscles produce myokines, preserving muscle mass maintains the body's capacity to generate these protective molecules. This creates a positive feedback loop in which exercise preserves muscle, muscle produces myokines, and myokines support better outcomes.

**The Role of Resistance Training**

While all forms of physical activity stimulate myokine release, research suggests that resistance-type movements may be particularly effective. Studies have found that resistance training activates certain myokines more robustly than aerobic exercise alone. This finding has important implications for exercise prescription, particularly for older adults, who appear to respond especially well to resistance-type movements for myokine production.

Resistance training does not require specialized equipment or gym memberships. Any movement that challenges muscles against resistance, including the resistance provided by one's own body weight, triggers the contraction-dependent release of myokines. This makes resistance-based exercise accessible to individuals across a wide range of fitness levels, health conditions, and resource constraints.

**A Practical Strategy: Bodyweight Squats Throughout the Day**

Understanding the science of myokines opens the door to practical strategies for maintaining elevated levels of these protective molecules. One of the most effective approaches involves distributing short bouts of resistance exercise throughout the day rather than concentrating all activity into a single session. This method, sometimes referred to as exercise snacking, maintains elevated myokine signaling throughout the waking hours.

The bodyweight squat represents an ideal movement for this purpose. A single squat engages a substantial amount of muscle mass simultaneously, activating the quadriceps, hamstrings, gluteal muscles, adductors, calves, and core stabilizers. This large-scale muscle recruitment provides exactly the stimulus needed for robust myokine secretion. Because the movement requires no equipment and minimal space, it can be performed virtually anywhere: at home, in an office, during breaks, or while traveling.

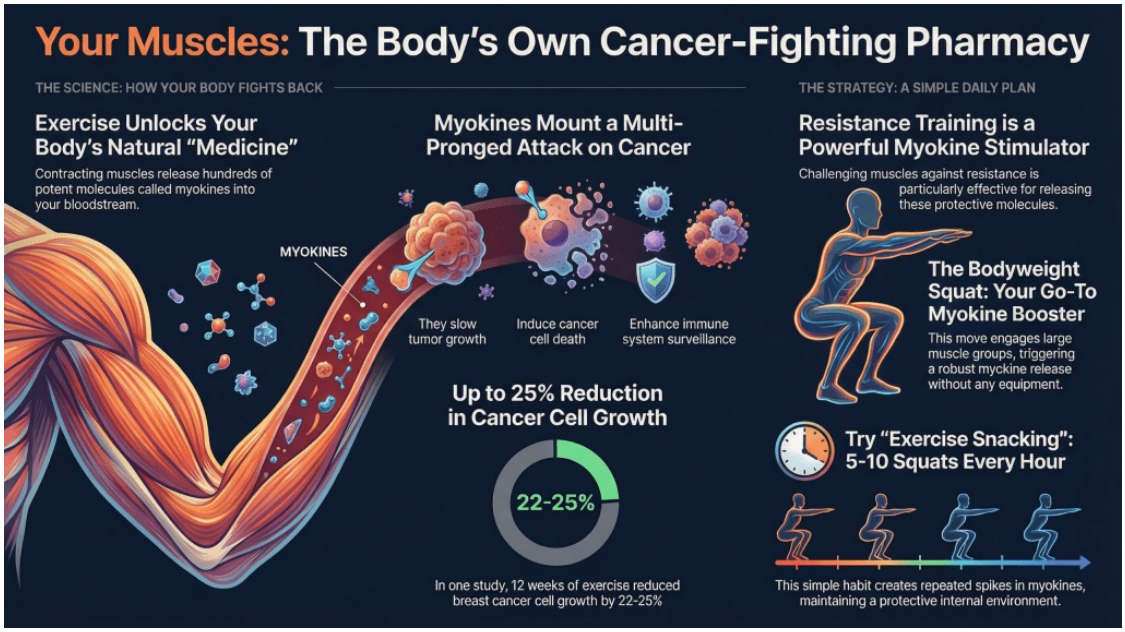
Research indicates that performing just five to ten bodyweight squats every hour throughout the day can meaningfully increase myokine signaling. This approach offers several advantages over traditional exercise prescriptions. It does not require dedicated workout time, making it easier to maintain consistently. It avoids the fatigue associated with longer sessions, which is particularly valuable for individuals undergoing cancer treatment. It provides repeated spikes in myokine release throughout the day, potentially maintaining a more consistently anti-cancer intracellular environment.

For individuals with mobility limitations or those new to exercise, modifications such as chair-assisted squats or partial-range movements can still elicit sufficient muscle activation to trigger myokine release. The key principle is muscle contraction against resistance, which remains present even in adapted versions of the movement. As strength and confidence improve, the depth and intensity of squats can be progressively increased.

**Conclusion**

The discovery that muscles function as endocrine organs that produce anticancer molecules has transformed our understanding of why exercise protects against malignant disease. Myokines represent a direct biological link between physical activity and cancer prevention, treatment support, and survivorship. They work immediately, accumulate with consistent training, and can be stimulated through accessible movements that require no special equipment or facilities.

Simple strategies, such as performing bodyweight squats throughout the day, provide a practical method for maintaining elevated myokine levels. Whether the goal is to reduce cancer risk, support treatment, or prevent recurrence, regular muscle contraction provides one of the most powerful and accessible tools available. The evidence is clear: when muscles contract, they produce medicine. Making that contraction a regular part of daily life may be one of the most important health decisions a person can make.

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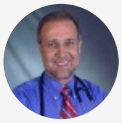

## Dr. Daniel Thomas, DO, MS

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Published January 8, 2026 by Dr. Daniel Thomas, DO, MS

# Common Food Preservatives Linked to Higher Risk of Type 2 Diabetes in Large French Study

**A Closer Look at What's in Our Food**

When you pick up a package of bread, a jar of jam, or a bottle of wine at the grocery store, you probably don't give much thought to the preservatives listed in the ingredients. These substances help keep foods fresh longer by preventing spoilage from bacteria and oxidation. But a major new study suggests that these widely used additives may come with an unexpected health cost: an increased risk of developing type 2 diabetes.

The research, published in Nature Communications, followed more than 108,000 French adults over an average of eight years and found that higher consumption of several common preservatives was associated with a greater likelihood of developing type 2 diabetes. The findings contribute to growing concerns about the long-term health effects of food additives consumed daily by millions worldwide.

**What the Research Found**

The study examined 58 food preservatives and tracked participants' dietary intake using detailed dietary records that recorded specific brand names and product formulations. This level of detail allowed researchers to quantify actual preservative exposure rather than relying on rough estimates.

During the study period, 1,131 participants developed type 2 diabetes. After adjusting for factors such as age, weight, physical activity, smoking status, and overall diet quality, the researchers

identified 13 individual preservatives associated with a higher incidence of the disease. These included potassium sorbate (commonly found in cheese, baked goods, and wine), sodium nitrite (used extensively in processed meats like bacon and ham), citric acid (found in everything from beverages to fruit products), phosphoric acid (a key ingredient in many soft drinks), and several antioxidant preservatives, including sodium ascorbate and alpha-tocopherol.

Participants with the highest intake of total preservatives had a 47 percent greater risk of developing type 2 diabetes compared to those with the lowest intake. For some individual additives, the associations were even stronger. Those consuming the most potassium sorbate, for instance, had more than double the risk of diabetes compared to the lowest consumers.

**How Preservatives May Affect Metabolism**

The researchers noted that their findings align with experimental studies suggesting that preservatives may influence metabolic health. Laboratory research has shown that some of these additives can affect pancreatic tissue, disrupt insulin signaling, promote inflammation, and interfere with the body's energy production cycle. Potassium sorbate, for example, has been found to activate compounds called advanced glycation end products, which are linked to diabetes development. Sodium nitrite and related compounds have been shown in animal studies to contribute to insulin resistance and pancreatic cell dysfunction.

For preservatives that are chemically similar to naturally occurring substances in food, such as citric acid or vitamin-based antioxidants, the researchers emphasized that the health effects may differ depending on the form consumed. A vitamin found naturally in an orange may behave differently in the body than the same vitamin added as an industrial preservative to a processed food product.

**Preservatives Are Everywhere**

One striking finding from the study was just how pervasive these additives are in the modern food supply. Nearly all participants consumed at least one preservative: citric acid in 92% of diets, sulfites in 84%, and ascorbic acid in 84%. Sodium nitrite, primarily from processed meats, was consumed by nearly three-quarters of participants.

The researchers found that approximately 35% of preservative intake came from ultra-processed foods, but many preservatives were present across a wide variety of food categories. Potassium sorbate, for example, was found in fruits and vegetables, fats and sauces, baked goods, and alcoholic beverages. This widespread use makes it difficult for consumers to avoid these substances by eliminating one or two food categories.

**What This Means for Consumers**

While the study cannot prove that preservatives directly cause diabetes, the researchers note that the associations remained consistent across numerous sensitivity analyses designed to rule out alternative explanations. The findings suggest that reducing exposure to preservative food additives could potentially benefit metabolic health.

For consumers, the practical implications favor fresh and minimally processed foods when possible. Cooking at home with whole ingredients and choosing preservative-free alternatives when available could help reduce exposure to preservatives. However, the researchers acknowledge that individual action alone may not be sufficient. They call for regulatory re-evaluation of these additives and policy measures to transform the food supply more broadly.

**Study Limitations and Next Steps**

The researchers acknowledged several limitations of their work. As an observational study, it cannot definitively establish that preservatives cause diabetes. The study population included more women and more health-conscious individuals than the general French population, which may affect how broadly the results apply. Additionally, while the dietary assessment methods were highly detailed, some measurement uncertainty is inevitable.

The authors emphasize that their findings require confirmation by other epidemiological studies and further investigation through experimental research to elucidate the biological mechanisms involved. Nevertheless, given the ubiquitous presence of preservatives in processed foods worldwide, they argue that the potential public health implications are significant and warrant serious attention from regulators and policymakers.


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Published January 7, 2026 by Dr. Daniel Thomas, DO, MS

# What Brazilian Supercentenarians Can Teach Us About Living Longer and Healthier

Imagine living to 110 years old or beyond. These extraordinary individuals, known as supercentenarians, represent some of the rarest humans on Earth. While reaching 100 is itself exceptional, living past 110 places a person in an elite category that scientists are increasingly eager to study. A new article published in Genomic Psychiatry highlights groundbreaking research on Brazilian supercentenarians that could reshape our understanding of healthy aging.

Brazil has emerged as an unexpected hotspot for research on extreme longevity. Three of the ten longest-lived validated male supercentenarians in the world are Brazilian, including the current oldest living man, born on October 5, 1912. This is particularly striking because extreme longevity in men is far less common than in women, making these individuals especially valuable for scientific investigation.

**Why Brazil Offers Unique Scientific Opportunities**

Brazil's population carries what researchers describe as the world's richest genetic diversity, the result of centuries of mixing among different population groups. Beginning with Portuguese colonization in 1500, contact with Native American populations who had inhabited the territory for thousands of years initiated a complex blending of ancestries. Between the 17th and 19th centuries, approximately four million enslaved Africans were brought primarily from West Africa. Later waves of European immigrants from Italy, Germany, and Portugal arrived in the late 19th and early 20th centuries, followed by significant Japanese immigration beginning in 1908.

This complex history has produced a population with unique genomic patterns that may influence

traits such as biological resilience and longevity. Recent studies have identified more than eight million previously undescribed genomic variants in Brazilians, along with thousands of potentially significant genetic differences absent from global databases. These rare variants, overlooked in most international research, may hold keys to understanding how some people resist the diseases and deterioration typically associated with aging.

**The Science of Exceptional Aging**

What makes supercentenarians different at the cellular level? Research reveals that these individuals maintain remarkably youthful characteristics in their cells and immune systems, displaying a constellation of protective features that collectively resist the typical age-related deterioration. The key characteristics identified in supercentenarians include:

- **Preserved proteostasis:** Their blood cells exhibit proteasomal activity, including catalytic subunits and protein-degradation functions, comparable to those of much younger individuals. This protein-recycling system, which clears damaged or misfolded proteins that would otherwise accumulate and cause problems, typically declines significantly with age but remains robust in supercentenarians.
- **Functional autophagy:** Beyond proteasomal activity, their broader protein clearance mechanisms remain functional and upregulated, enabling efficient removal of cellular debris and damaged components.
- **Cytotoxic CD4+ T cell expansion:** Single-cell analyses have revealed a striking expansion of CD4+ T cells that adopt transcriptional programs typically associated with CD8+ cytotoxic lymphocytes. This cytotoxic CD4+ profile is virtually absent in younger controls, representing an unconventional but effective immunological strategy.
- **Adaptive immune cell reconfiguration:** Supercentenarians exhibit increased numbers of terminally differentiated effector memory T cells, including γδ and CD8+ subsets, as well as elevated natural killer cell counts. These changes enable effective responses to chronic antigenic stimulation.
- **Preserved naïve T-cell repertoire:** Variations in the IL7R gene, involved in T-cell development and homeostasis, have been implicated in maintaining functional naïve T cells in older age, a feature observed in long-lived populations with low inflammatory markers.
- **Robust antibody response:** Three Brazilian supercentenarians who survived COVID-19 without vaccination exhibited high IgG and neutralizing antibodies against SARS-CoV-2, along with plasma proteins and metabolites associated with the innate immune response and host defense.
- **Rare protective genetic variants:** Studies of an American-Spanish supercentenarian known as M116 revealed exclusive or rare variants in immune-related genes (HLA-DQB1, HLA-DRB5, IL7R), autophagy genes (ATG2A), mitochondrial electron transport genes (NDUFA9, COX7A2), chromatin remodeling genes (CHD7, ARID1A), and DNA damage response genes (ATM, BRCA1).
- **Functional independence:** Notably, some Brazilian supercentenarians remained lucid and independent in basic daily activities such as feeding themselves at the time of researcher contact, indicating preserved cognitive and physical function.

This constellation of protective features suggests that exceptional longevity may require a coordinated system of defenses working together across multiple biological pathways, positioning the immune system and genomic maintenance as converging pillars of long-term health.

**Brazil’s Living Laboratory of Longevity**

The research team from the University of São Paulo’s Human Genome and Stem Cell Research Center has assembled a remarkable cohort for study. They have collected clinical data and biological samples from over 100 centenarians, including 20 supercentenarians, distributed across

multiple regions of Brazil with diverse social, cultural, and environmental backgrounds.

Among their participants was Sister Inah, who was recognized as the oldest person in the world until her death on April 30, 2025, at age 116. The cohort also includes the two oldest living men in the world, both aged 112. Notably, when researchers made contact, some of these supercentenarians remained lucid and independent in basic daily activities such as feeding themselves.

The researchers have also documented exceptional familial cases that suggest longevity may run in families. One striking example involves a 109-year-old woman whose nieces are aged 100, 104, and 106 years, representing one of Brazil's longest-lived families ever documented. Previous research has shown that siblings of centenarians are 5 to 17 times more likely to reach centenarian status themselves, reinforcing the idea that genetics plays a vital role in extreme longevity.

**Surviving COVID Without Vaccines**

One particularly compelling finding involved three Brazilian supercentenarians who survived COVID-19 in 2020, before vaccines became available. Immunology tests showed that these individuals had robust antibody levels against the virus, along with blood proteins and metabolites associated with the innate immune response and host defense. This natural resilience to a novel pathogen at such an advanced age suggests their immune systems possess remarkable adaptive capabilities.

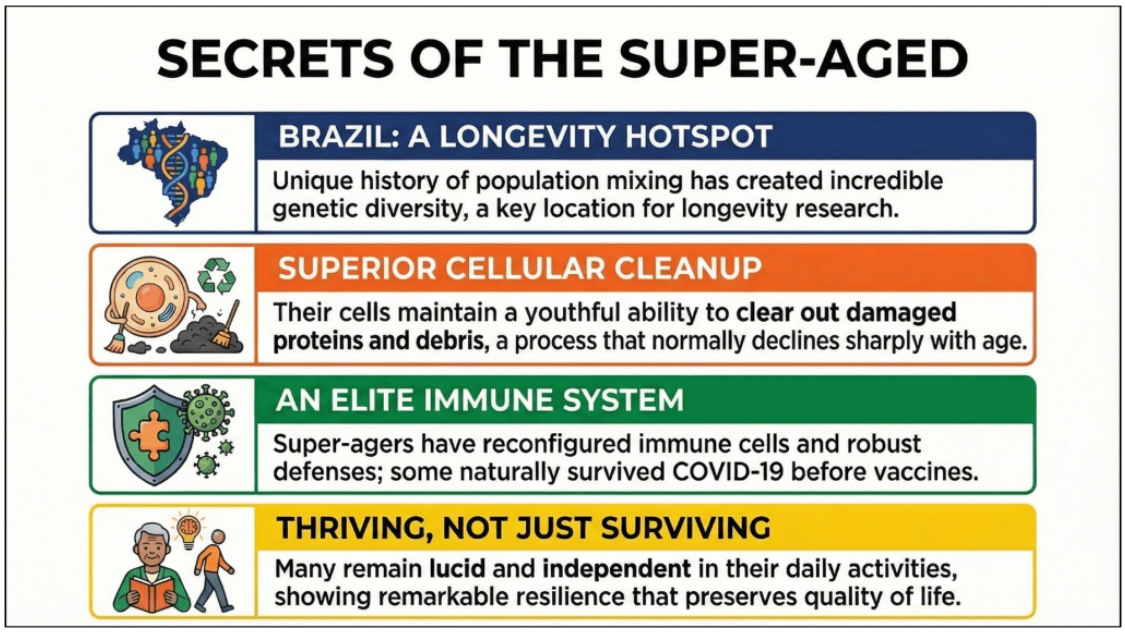
Many participants in the Brazilian study come from underserved regions with limited access to modern health care throughout their lives. This provides researchers with a rare opportunity to investigate resilience mechanisms that operate independently of medical intervention. In other words, these individuals have reached extreme old age not because of sophisticated health care, but despite its absence.

**What This Means for the Rest of Us**

The convergence of robust immune function, preserved protein maintenance systems, and overall physiological integrity makes supercentenarians an exceptional model for studying biological resilience. Rather than merely surviving to extreme old age, these individuals actively resist the hallmarks of aging. Understanding their protective mechanisms could unlock new therapeutic targets for age-related conditions and inspire strategies to promote healthy aging in the general population.

The researchers emphasize that supercentenarians represent far more than examples of extended biological survival. They embody principles of resistance, adaptability, and resilience that biomedical research must seek to understand if the goal is not only to extend lifespan but to enhance quality of life in aging populations.

The authors call for international longevity and genomics research consortia to expand recruitment to include ancestrally diverse and admixed populations, such as Brazil's. Such inclusion would not only deepen scientific understanding but also enhance equity in global health research. The secrets of exceptional aging, it appears, may be found in some of the most genetically diverse populations on Earth.

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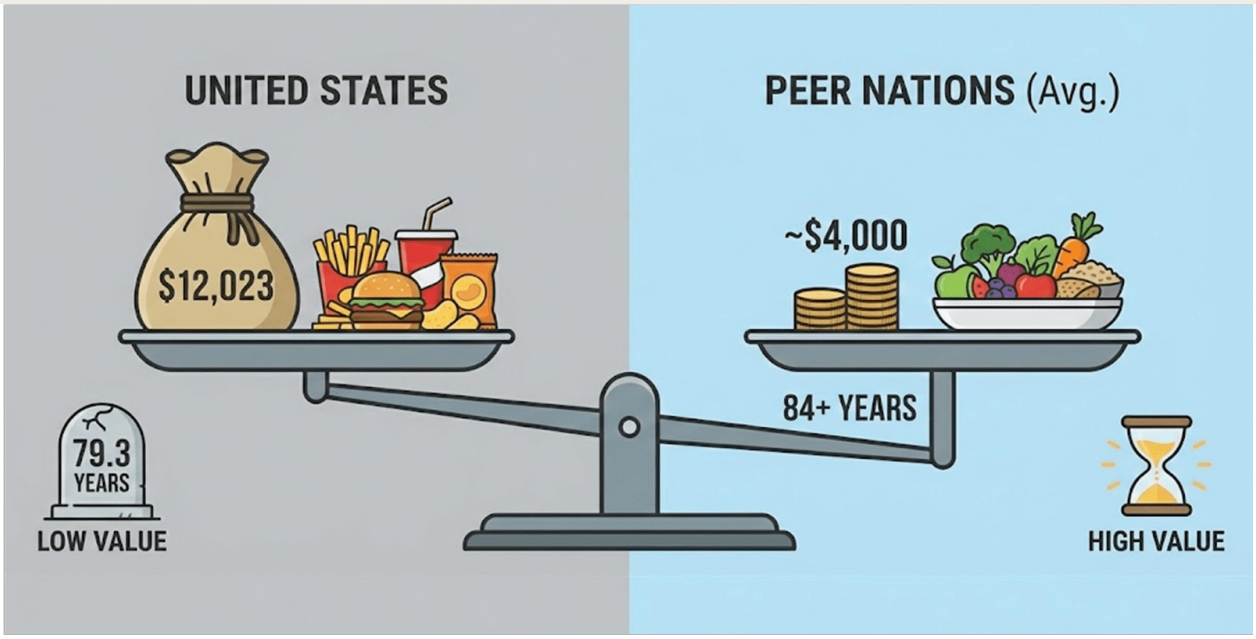



Published January 6, 2026 by Dr. Daniel Thomas, DO, MS

# The American Paradox: High Costs, Short Lives, and the Hidden Price of Diet

*“Price is what you pay, value is what you get.”*

This famous Warren Buffett quote typically applies to finance, but a new analysis from Visual Capitalist reveals it is equally relevant to national health. In a comparison of 51 countries from 1970 to 2023, one trend stands out: the United States has diverged dramatically from its peers, paying the highest price in the world for health outcomes that fall well below the average of developed nations.

While the United States pours trillions into its healthcare system, a closer look suggests that the country is not suffering from a lack of medicine, but from a toxic nutritional foundation that no amount of spending can fully fix.

**A Global Outlier**

The core of the analysis highlights a stark disconnect between expenditure and longevity. Most high-income nations follow a predictable trajectory, spending moderately more over time to achieve steady gains in life expectancy. The United States, however, is a statistical anomaly. It spends nearly three times the average of other Organisation for Economic Co-operation and Development (OECD) nations, yet its citizens live shorter lives than the group average.

Consider the numbers. Japan leads the world in life expectancy at 84.7 years, while spending $4,806 per capita on healthcare. South Korea follows closely, with a life expectancy of 84.3 years and expenditures of $4,055 per person. Switzerland, known for its high cost of living, has an

average life expectancy of 84.0 years at a per capita income of $7,930. The OECD average is 79.7 years, with per-person spending of $3,986.

Then there is the United States. Americans live an average of 79.3 years, below the group average, while spending a staggering $12,023 per capita. Even Switzerland, one of the most expensive countries in the world, spends roughly $4,000 less per person than the United States while achieving nearly five additional years of life expectancy.

**The Root Cause: What Americans Eat**

Why does pouring money into the system fail to extend life? The answer lies largely outside the hospital walls. The American healthcare system is tasked with managing a population that is becoming structurally unhealthier due to what researchers call the Standard American Diet. This dietary pattern acts as a substantial barrier to longevity, characterized by three critical imbalances that work together to undermine population health.

**The Dominance of Ultraprocessed Foods**

The most defining characteristic of the modern American diet is the dominance of ultraprocessed foods. These industrial formulations now account for roughly 60-70 % of total caloric intake in the United States, compared with 14-44% in many European nations.

These products are engineered for what food scientists call hyper-palatability, meaning they are designed to taste so appealing that they often bypass the body's natural satiety signals. The result is that people eat more than they need without feeling full. Ultraprocessed foods are calorically dense but nutritionally bankrupt, driving the metabolic dysfunction that leads to obesity and type 2 diabetes at alarming rates.

**The Protein Problem**

While protein is essential for health, the American approach is one of excess and imbalance. The average American diet relies heavily on red and processed meats, which have been linked to higher rates of cardiovascular disease and colorectal cancer.

In contrast, regions known for exceptional longevity, sometimes called Blue Zones, and nations like Japan prioritize plant-based proteins and fiber-rich side dishes, using meat sparingly. The American "more is better" mentality regarding animal protein often crowds out the protective nutrients found in plants, vegetables, and legumes.

**The Fiber Gap**

Perhaps the most glaring deficiency is the lack of fiber, a critical nutrient for regulating blood sugar and maintaining gut health. According to the Centers for Disease Control and Prevention, only 12% of American adults meet the daily recommendation for fruit, and only 10% meet it for vegetables.

Without adequate fiber to promote satiety and regulate nutrient absorption, Americans often seek satiety from larger portions of calorie-dense, processed foods. This creates a self-reinforcing cycle of overeating and poor nutrition.

**An Unsustainable Economic Cycle**

This dietary profile creates an unsustainable economic cycle. The $12,023 per person spent in the United States is largely reactive. It is spent treating chronic conditions such as heart disease,

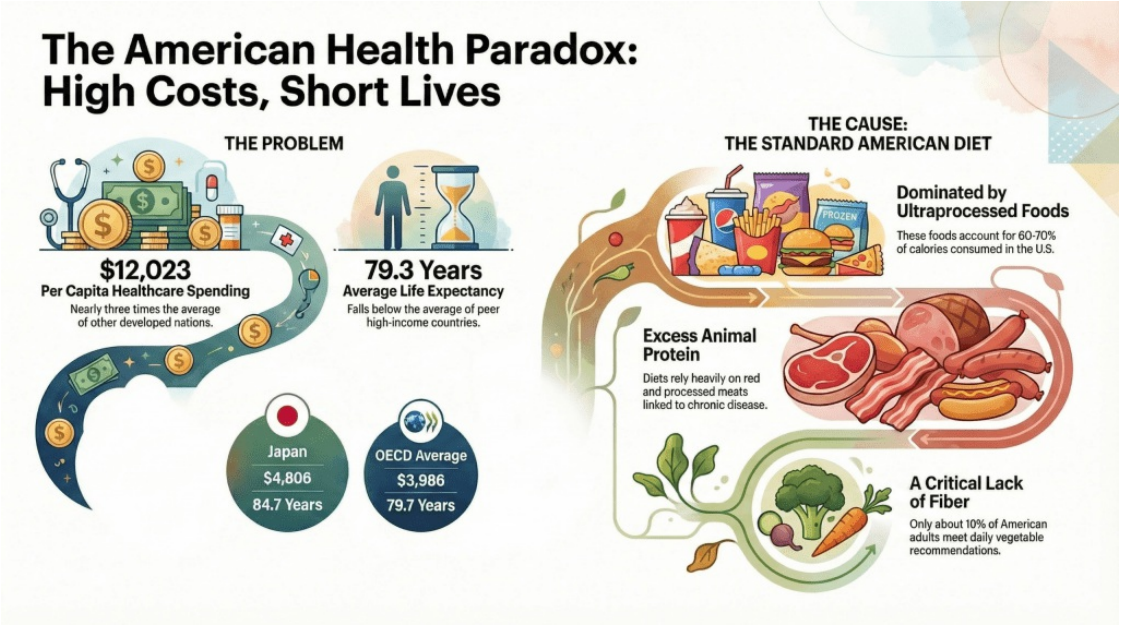
hypertension, and diabetes that are fueled by daily food choices rather than preventing them in the first place.

Advanced medical technology excels at acute care, including trauma treatment and emergency surgery, but it struggles to reverse the cellular damage caused by decades of poor nutrition. High rates of obesity and chronic disease act as a burden on the national average. While the United States offers some of the best cancer treatments and specialized surgeries in the world, these interventions cannot offset the widespread loss of life years caused by metabolic disease affecting millions of people.

**The Path Forward**

The data from 1970 to 2023 tells a clear story: wealth does not equal health. While the rest of the developed world has found a way to efficiently convert capital into longevity, the United States is caught in a trap of high spending and low value.

To close the gap with nations such as Japan or Switzerland, the solution likely does not lie in increasing spending on the next medical breakthrough. Instead, it lies in fixing the food on the American dinner table. Until the Standard American Diet is addressed at its fundamental level, the United States will likely continue to pay a premium for outcomes that lag behind those of the rest of the world. The evidence suggests that the most potent medicine may not come from a pharmacy at all. It may come from the grocery store.

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curiosity, creative and analytical thinking, and practical application of cutting-edge research. Despite the demands of a busy medical practice, to stay at the forefront and continuously improve the care of his patients, Dr. Thomas devotes 20-30 hours a week to reviewing the latest scientific literature and consulting with leading scientists to identify potentially promising treatments. He shares his evidence-based insights at ThomasHealthBlog.com, where complex medical science becomes actionable health information.



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Published January 5, 2026 by Dr. Daniel Thomas, DO, MS

# The Wisdom of Now: What the Eagles Understood About Living in the Moment

Few lyrics capture the essence of present-moment awareness quite like these lines from the Eagles' 1972 classic "Take It Easy": *"We may lose, and we may win, but we will never be here again. Open up, I'm climbin' in to take it easy."*

Written by Jackson Browne and Glenn Frey, these words offer more than laid-back California rock philosophy. They articulate a profound truth that psychologists, philosophers, and spiritual traditions have long recognized: the present moment is the only place where life actually happens, and our tendency to mentally escape it exacts a high cost on our well-being.

**The Psychological Cost of Time Travel**

The human mind possesses a remarkable capacity to travel through time. We can revisit yesterday's conversations, relive last year's failures, and project ourselves into tomorrow's uncertainties. While this ability serves essential functions, such as learning from experience and planning for the future, it becomes problematic when we take up permanent residence outside the present.

Research in clinical psychology has consistently demonstrated the connection between temporal focus and mental health. Rumination, the tendency to repetitively dwell on past events, particularly negative ones, is strongly associated with depression. When we mentally inhabit yesterday's mistakes, missed opportunities, and painful experiences, we carry their emotional weight into today, often amplifying distress that might otherwise naturally diminish.

Conversely, excessive future-focus manifests as anxiety. The mind that constantly projects itself into the future, anticipating threats, rehearsing worst-case scenarios, and attempting to control uncertain outcomes generates a persistent state of unease. We worry about events that may never occur while missing the life unfolding before us.

**The Eagles' Invitation**

"We may lose, and we may win," acknowledges life's fundamental uncertainty. The outcome is not guaranteed, and the song does not pretend otherwise. This acceptance of uncertainty is itself therapeutic. Much of our anxiety stems from the futile attempt to eliminate ambiguity, to know in advance how things will turn out.

The pivotal insight follows: "but we will never be here again." This line delivers a gentle but firm reminder of impermanence. This particular configuration of circumstances, this exact moment in time, this specific opportunity for experience will not repeat. Whether we judge the moment as good or bad, ordinary or extraordinary, it is passing.

"Open up, I'm climbin' in" suggests active engagement rather than passive observation. Present-moment awareness is not merely about being physically located in the current time; it involves opening oneself to experience, climbing into life rather than watching it from a distance.

The conclusion, "to take it easy," might seem like an invitation to passivity, but within this context, it reads differently. Taking it easy means releasing the mental grip on past and future, letting go of the exhausting effort to control what cannot be controlled, and allowing oneself to simply be present.

**Practical Implications**

The song's wisdom aligns with what contemporary mindfulness practices and cognitive behavioral approaches consistently emphasize. When we notice ourselves trapped in regret about the past or worry about the future, we can gently redirect attention to the present experience. What do we see, hear, and feel right now? What is actually happening, as opposed to what we remember or anticipate?

This redirection is not about denying the lessons of the past or abandoning reasonable preparation for the future. Instead, it involves recognizing that excessive mental time travel diminishes our capacity to engage with the only moment we can actually influence.

The Eagles were writing a song about cruising through Arizona, not a clinical intervention for depression and anxiety. Yet they captured something essential about the human condition. We are finite beings moving through time, granted a series of unrepeatable moments. We can spend those moments lost in mental rehearsals of past and future, or we can open up, climb in, and take it easy.

The choice, renewed in each moment, is ours to make.


**Previous Post**
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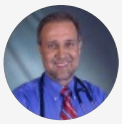
The American Paradox: High Costs, Short Lives, and the Hidden Price of Diet



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Published January 1, 2026 by Dr. Daniel Thomas, DO, MS

# Why Your New Year's Resolutions Fail and What Science Says You Should Do Differently

**The Resolution Paradox**

Every January, millions of people set ambitious goals for the year ahead. They resolve to exercise more, eat healthier, save money, or advance their careers. These resolutions reflect genuine desires for self-improvement, supported by compelling reasons: improved health, financial security, and professional success. Yet by mid-February, most have abandoned these well-intentioned plans.

A new study published in *Psychological Science* offers a surprising explanation for this widespread failure. The research, led by Kaitlin Woolley of Cornell University along with colleagues Laura Giurge of the London School of Economics and Ayelet Fishbach of the University of Chicago, followed people pursuing New Year's resolutions for an entire year. Their findings challenge conventional wisdom about what sustains people's commitment to their goals.

**The Motivation That Matters**

The researchers drew a critical distinction between two types of motivation. Extrinsic motivation refers to pursuing a goal for the outcomes it will produce, such as exercising to improve health or saving money to provide financial security. Intrinsic motivation, by contrast, refers to finding the pursuit itself rewarding, such as exercising because you genuinely enjoy the activity or saving because you see the process satisfying.

The study's central finding was striking: although people overwhelmingly set goals for extrinsic

reasons, their success in maintaining those goals was predicted by intrinsic motivation, not extrinsic motivation. In other words, believing that a goal is essential, helpful, or life-changing did not help people follow through. What mattered was whether they found the pursuit enjoyable, engaging, and personally rewarding in the moment.

**A Year of Following Resolutions**

In the primary study, researchers recruited 2,000 American adults who had set New Year's resolutions. The most common goals involved physical health (nearly 40%), followed by financial goals, healthier consumption habits, professional development, personal growth, and relationship improvements.

At the start of the year, participants rated both their intrinsic motivation (how enjoyable, engaging, and positive the pursuit felt) and their extrinsic motivation (how useful, necessary, and life-changing they believed it to be). The researchers then followed up at four-month intervals throughout the year to assess whether participants were still pursuing their resolutions and how successful they felt.

The results were consistent across all time points. Intrinsic motivation at each measurement predicted success at the subsequent measurement, whereas extrinsic motivation was not significantly associated with adherence. This pattern held whether participants were measured in April, August, or November. Among those who completed all four surveys, 16% had achieved their resolution by year's end, and higher intrinsic motivation at the outset significantly predicted membership in that group.

**The Finding Holds Across Cultures**

To test whether these results were specific to American culture, the researchers conducted a parallel study in China during the Chinese New Year. They recruited 500 participants and followed up one month later. The distribution of goals differed notably from that in the American sample: 45% of Chinese participants set professional, career, or learning objectives, whereas 13% of American participants did.

Despite these differences in goal types and cultural context, the pattern replicated. Chinese participants who found their resolutions more enjoyable and engaging were more likely to adhere to them. In contrast, those who rated their goals as more important or valuable showed no greater adherence. This suggests the power of intrinsic motivation extends beyond Western, individualistic cultures.

**Objective Evidence From Step Counts**

The researchers recognized a potential limitation in their approach: asking people to rate their own success could introduce bias. To address this, they conducted a third study using objective behavioral data.

They recruited 439 participants who aimed to increase their walking and used step-counting apps on their phones. Participants reported their intrinsic and extrinsic motivation for walking, and their actual daily step counts over two weeks.

The results were consistent with previous studies. Participants with higher intrinsic motivation walked significantly more steps on average. Those who were one standard deviation above the mean in intrinsic motivation walked approximately 1,250 more steps per day than those at the mean. Meanwhile, extrinsic motivation was not significantly associated with actual walking behavior.

**Proving Causation Through Experiment**

Correlation does not prove causation. Perhaps people who naturally enjoy activities simply report higher intrinsic motivation, while those who struggle rely on extrinsic justifications. To establish that inherent motivation actually drives behavior, the researchers designed an experiment.

They recruited over 700 participants and had them download Yuka, a health app that allows users to scan product barcodes to learn about their health impact. Participants were randomly assigned to receive one of two descriptions of the app. Half were told it was “a fun new game with surprising product discoveries” that would let them “unravel the mystery” behind their products. The other half were told it would provide “useful and important product information” based on “research-backed” analysis.

Twenty-four hours later, participants reported the number of products they had scanned, as verified by screenshots from the app. Those who had been primed to think of the app as fun scanned 26% more products than those who had been told it was useful and important. This demonstrated that framing an activity in intrinsically motivating terms increases engagement, not merely that intrinsically motivated people engage more.

**Why We Get It Wrong**

If intrinsic motivation is so important, why do people set goals based on extrinsic factors? The researchers explored this question in follow-up studies. They found that 90% of participants reported setting a resolution because it was important for their long-term welfare, rather than because it was enjoyable in the moment.

They also tested whether people understand the factors that motivate goal adherence. Participants were asked to predict whether someone pursuing a healthy-eating goal would be more likely to maintain it if it were important rather than enjoyable, useful rather than providing a positive experience, or life-changing rather than engaging. On average, participants favored the extrinsic options, believing that importance, usefulness, and potential for life change would better predict success.

Interestingly, participants showed slightly greater insight when predicting what would motivate others than when predicting what would motivate themselves. This suggests that people may be particularly prone to underestimating the role of immediate experience in their own motivation.

**The Practical Implications**

These findings have significant implications for anyone trying to change their behavior or help others do so. The traditional approach to goal-setting emphasizes the “why”: articulating compelling reasons for pursuing a goal and keeping those reasons salient. This research suggests that the approach may be incomplete or even counterproductive.

Instead, people may benefit from choosing goals they find inherently enjoyable or finding ways to make necessary goals more intrinsically rewarding. Prior research supports this idea. Studies have shown that cafeteria diners eat more vegetables when signs emphasize their delicious taste rather than their health benefits. Gym-goers return more frequently when they can listen to engaging audiobooks only while exercising. These interventions work by adding intrinsic rewards to extrinsically motivated pursuits.

The researchers theorize that intrinsic motivation matters because it captures immediate benefits, while extrinsic motivation captures delayed benefits. Given that humans tend to discount future rewards relative to present ones, the immediate pleasure or engagement of an activity may simply

carry more psychological weight than abstract future outcomes.

**Rethinking Resolution Season**

As another New Year approaches, the findings from this research offer a different way to think about goal-setting. Rather than choosing resolutions based solely on their importance or potential impact, people might consider which goals they would genuinely enjoy pursuing. For goals that seem necessary but are not particularly enjoyable, the path to success may lie in making the pursuit itself more rewarding.

This does not mean abandoning ambitious or challenging goals. Even within the study, resolutions that were rated as more difficult were not inherently less likely to succeed. What mattered was whether people found meaning and enjoyment in the day-to-day work of pursuing them.

The research also suggests that policymakers, employers, and health professionals designing interventions to change behavior might achieve better results by focusing on immediate experience rather than long-term outcomes. Telling people that exercise will extend their lifespan may be less effective than helping them find forms of movement they genuinely enjoy.

**The Bottom Line**

People set goals because they care about their future. They want to be healthier, wealthier, more successful, and more fulfilled. But caring about outcomes is not enough to sustain the effort required to achieve them. What carries people through the daily grind of behavior change is finding something rewarding in the process itself.

The implications extend beyond New Year's resolutions. Whether someone is trying to learn a new skill, build a habit, or make a significant life change, the question worth asking may not be "why is this important?" but rather "how can I make this enjoyable?" The answer to that question may determine whether good intentions translate into lasting change.


**Reference:** Woolley K, Giurge LM, Fishbach A. Adherence to Personal Resolutions Across Time, Culture, and Goal Domains. Psychol Sci. 2025;36(8):607-621.

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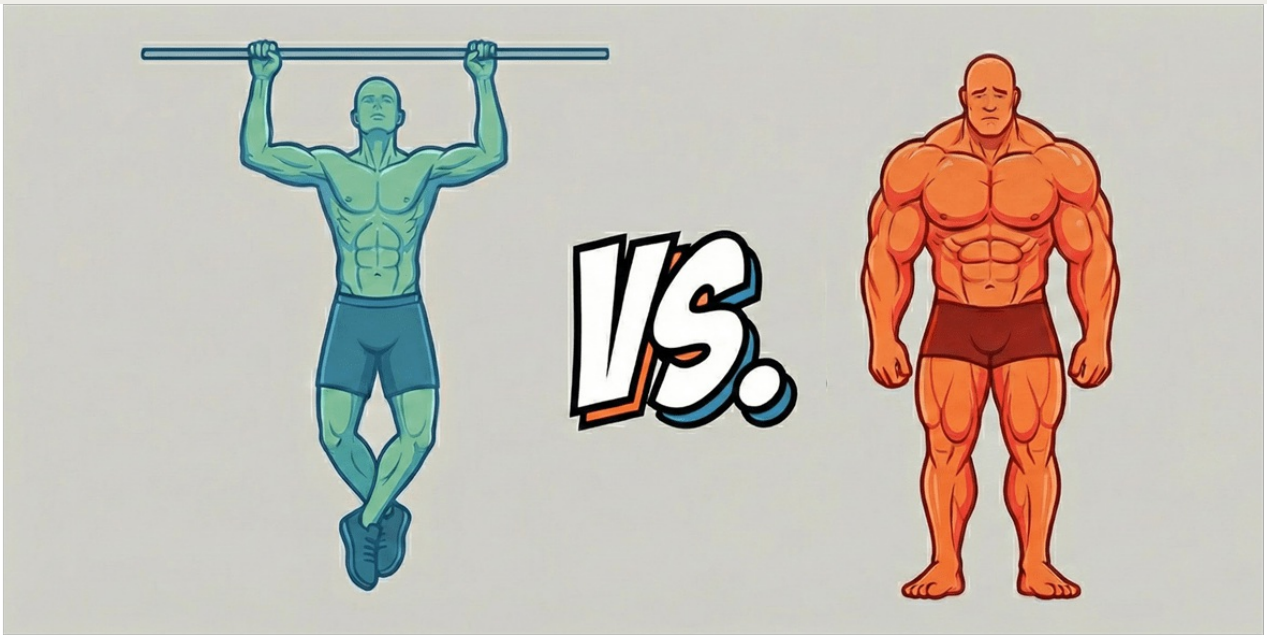



Published December 30, 2025 by Dr. Daniel Thomas, DO, MS

# More Efficient by Design: The Advantages of Strength Without the Bulk

**The Hidden Costs of Muscle Mass**

There's a pervasive belief in fitness culture that bigger muscles are always better. Walk into any gym, and you'll find people chasing size: more mass, more bulk, more visual impressiveness. However, this assumption overlooks a fundamental truth that exercise physiologists and evolutionary biologists have long recognized: muscle tissue is costly. In terms of functional performance, efficiency often trumps size.

Consider two individuals who can each lift 300 pounds from the floor. One weighs 170 pounds with a compact, efficient frame. The other weighs 220 pounds with considerably more muscle mass. On paper, they're equally strong. In practice, they're not even close.

**The Power-to-Weight Equation**

The most significant advantage of compact musculature is its power-to-weight ratio, the relationship between the force you can produce and the mass you must move. This is of considerable importance for nearly every physical activity that involves moving your own body through space.

Running, climbing, swimming, jumping, playing with your children or grandchildren, hiking a mountain trail, and getting off the floor all require you to overcome your body weight. The person who can deadlift their bodyweight twice over with a lighter frame will dramatically outperform the person who can lift the same absolute weight while carrying 50 extra pounds of muscle.

This is why, pound-for-pound, smaller athletes routinely demonstrate remarkable relative strength. It's also why weight classes exist in strength sports: a 150-pound powerlifter moving 400 pounds is performing a more impressive physiological feat than a 275-pound lifter doing the same.

**Why Strength Becomes More Important with Age**

Here's the clean, physiology-driven explanation that most people feel as they age but don't have the language for: strength becomes more important than muscle size because strength is the functional expression of muscle, while size is only a rough proxy for capability.

**Strength Is a Nervous-System Skill; Size Is Just Tissue**

As we age, the nervous system declines faster than muscle mass. Strength depends on motor unit recruitment, firing frequency, synchronization, coordination, and rate of force development. These are neural qualities that deteriorate with age unless trained. Muscle size (hypertrophy), by contrast, is mostly fiber cross-sectional area, sarcoplasmic volume, and stored glycogen. You can have big muscles with poor neural drive, but you cannot be strong without a well-functioning nervous system. Aging affects the nervous system more than muscle fibers, so training strength directly preserves the component that declines fastest.

**Strength Preserves Independence; Size Does Not**

Daily life requires force, not aesthetics. Strength determines whether you can stand up from the floor, climb stairs without fatigue, carry groceries, catch yourself during a fall, lift your bodyweight, and maintain balance. These are all strength tasks, not size tasks. A 70-year-old with modest muscle mass but high strength can live independently. A 70-year-old with large muscles but low strength cannot.

**Strength Protects Fast-Twitch Fibers**

Aging preferentially kills Type II (fast-twitch) fibers and the motor neurons that innervate them. These fibers are responsible for power, balance, reaction time, and fall prevention. Strength training, especially heavy or explosive work, is the only stimulus that preserves these fibers. Hypertrophy training alone often biases toward Type I fibers and sarcoplasmic growth, which is helpful but not protective in the same way.

**Your Heart Doesn't Care How You Look**

Every pound of muscle you carry requires blood supply. Your cardiovascular system must deliver oxygen and nutrients to that tissue around the clock, not just during exercise, but while you're sitting at your desk, sleeping, or watching television.

Larger muscles demand more cardiac output. The heart works harder to perfuse bulky musculature, both at rest and during exertion. Compact muscles that produce equivalent force place considerably less strain on the cardiovascular system, allowing for more efficient oxygen delivery and reducing wear on the heart over decades of life.

For those focused on long-term health rather than aesthetics, this is of considerable importance. Cardiovascular disease remains the leading cause of death in developed nations, and anything that unnecessarily burdens the heart deserves scrutiny.

**Strength Training Improves the Systems That Keep You Alive**

Strength training improves bone density, tendon stiffness, joint stability, insulin sensitivity,

mitochondrial function, hormonal signaling, and cognitive function. Muscle size alone does not guarantee these adaptations. Strength is a whole-system adaptation. Size is a local tissue adaptation.

**The Metabolic Tax of Bulk**

Muscle is a metabolically active tissue. Unlike fat, which is relatively inert, muscle consumes energy continuously. This is often presented as a benefit ("muscle burns more calories!"), but this framing misses the point.

If two people are equally strong, the one carrying more muscle mass is paying a higher metabolic tax for the same functional output. They require more calories just to maintain themselves. They generate more metabolic waste. Their bodies expend more energy to sustain tissue that provides no additional benefit.

From an evolutionary perspective, this inefficiency would have been actively selected against. Our ancestors didn't have the luxury of surplus calories. The body that could accomplish physical tasks with minimal tissue was the body most likely to survive lean times. Modern abundance has allowed us to override this efficiency, but the underlying biology hasn't changed.

**Strength Is the #1 Predictor of Longevity**

Across multiple studies, strength is a stronger predictor of mortality risk than muscle mass, BMI, body fat percentage, and even VO2 max in some cohorts. Grip strength alone predicts cardiovascular mortality, all-cause mortality, disability, and risk of hospitalization. Why? Strength reflects the integrated health of the nervous, muscular, skeletal, and metabolic systems. It's a biomarker of global resilience.

**Sarcopenia: Not Just Muscle Loss**

Clinically, sarcopenia is defined by low muscle mass combined with low strength or low function. But the functional component (strength) is the one that predicts falls, fractures, disability, and mortality. Muscle size without strength is like having a big engine with a broken transmission.

**Muscle Quality Over Quantity**

As we age, muscle becomes infiltrated with fat, fibrous tissue, and fibrosis, and capillary density declines, leading to mitochondrial dysfunction. Strength training reverses these changes. Hypertrophy training alone does not always do so.

Strength training improves fiber recruitment, contractile protein density, neuromuscular junction integrity, and tendon elasticity. This is "muscle quality," and it matters more than size.

**Preventing Falls: The #1 Cause of Injury Death in Older Adults**

Falls are not prevented by big quads, big arms, or big calves. Falls are prevented by rapid force production, balance, reactive strength, tendon stiffness, and coordination. These are all strength qualities, not size qualities.

**Heat, Speed, and Wear**

Several additional factors favor compact musculature. Muscle contraction generates heat as a byproduct of the chemical reactions that produce force. Larger muscles generate more heat during equivalent work, creating thermoregulatory challenges. During sustained activity or in warm

environments, this becomes a significant liability.

Shorter muscle fibers complete their contraction cycles faster than longer ones. This enables more rapid movement and greater force development. The compact individual can often move with greater speed and reactivity than their bulkier counterpart.

More mass means more inertia. Every time you accelerate or decelerate your limbs (which happens with every step, every reach, every athletic movement), you must overcome that inertia. This places additional stress on joints, tendons, and ligaments, potentially increasing the risk of injury and accelerating wear over time.

**What Actually Determines Strength**

Here's what many people don't realize: the size of a muscle is only loosely correlated with its strength. What actually matters is the physiological cross-sectional area of the muscle fibers, their arrangement (pennation angle), the efficiency of neural recruitment, and the density of contractile proteins within each fiber.

Muscles can be architecturally optimized for force production through fiber arrangement rather than simply adding more tissue. Training methods, genetic factors, and hormonal environment all influence whether additional muscle mass translates into proportional strength gains or simply adds bulk without corresponding function.

This is why appearance is a poor proxy for capability. The most impressive-looking physiques in a gym are rarely attached to the strongest or most athletically capable individuals.

**Training for Strength vs. Training for Size**

If the goal is compact, efficient strength rather than maximum bulk, training must be structured accordingly. The difference between strength-focused and hypertrophy-focused programming is substantial.

**Strength-Focused Training**

The primary driver of strength adaptation is mechanical tension under heavy load. This means working with weights that are challenging for relatively few repetitions, typically 3-6 per set. The load should be heavy enough that completing more repetitions would be impossible or nearly so.

Rest periods between sets are long, often 3-5 minutes. This allows the nervous system to recover fully, which is essential because strength is as much a neurological phenomenon as a muscular one. The brain must learn to recruit more motor units simultaneously and fire them at higher frequencies. This neural adaptation accounts for a significant portion of early strength gains and continues to improve with focused training.

Exercise selection emphasizes compound movements that involve multiple joints and large muscle groups working in coordination, such as squats, deadlifts, presses, rows, and their variations. These movements train the body as an integrated system rather than isolating individual muscles. Total training volume tends to be moderate, with a focus on the quality of effort under maximal or near-maximal loads.

**Hypertrophy-Focused Training**

Muscle growth, by contrast, responds primarily to metabolic stress and time under tension. This shifts the programming toward moderate loads performed for higher repetitions, typically 8-15 reps

per set, sometimes more.

Rest periods are shorter, often sixty to ninety seconds. This maintains elevated metabolic stress and keeps blood pooled in the working muscles, creating the “pump” that bodybuilders pursue. Exercise selection often includes more isolation movements targeting individual muscles from multiple angles. Total volume is high, as muscle growth correlates strongly with the total amount of work performed.

**The Practical Difference**

Consider two people following these different approaches for a year. The strength-focused trainee might add 100 pounds to their squat while gaining only five or ten pounds of bodyweight. The hypertrophy-focused trainee might add only 50 pounds to their squat while gaining twenty or more pounds of muscle mass.

Both have made progress. But their bodies have adapted differently. The strength-focused trainee now has a substantially improved power-to-weight ratio, greater neural efficiency, and denser, more efficient muscle tissue. The hypertrophy-focused trainee has greater visual mass but carries tissue that doesn’t proportionally contribute to force production.

**Practical Implications**

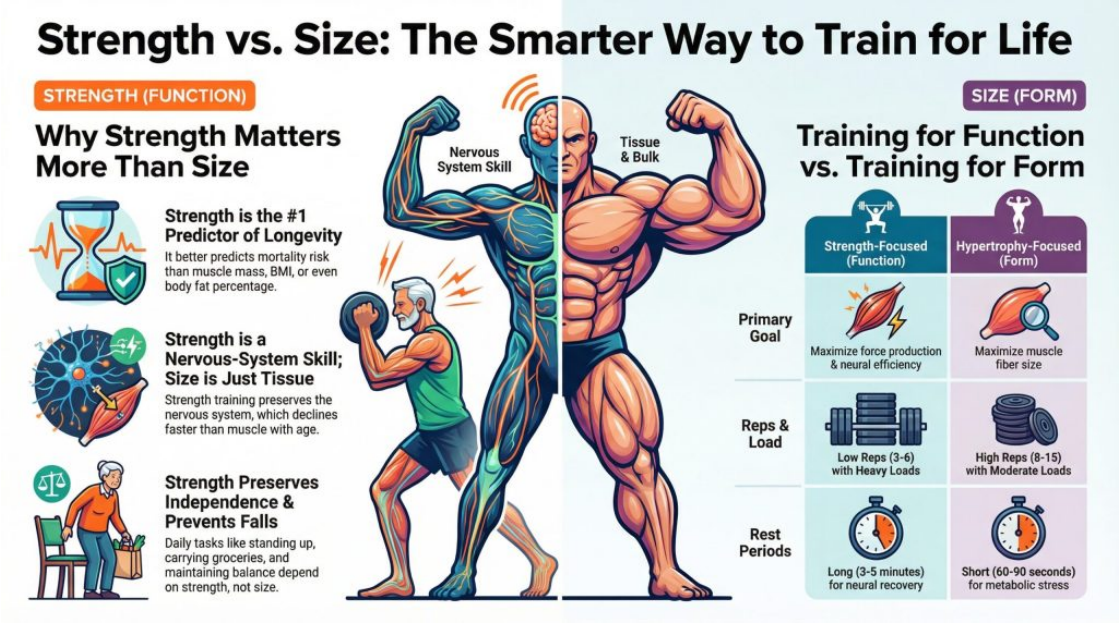
None of this suggests you should avoid building muscle or developing strength. Both are profoundly beneficial for metabolic health, bone density, functional independence as you age, and quality of life. The point is that chasing size for its own sake, or assuming that more mass automatically means better performance, reflects a misunderstanding of how the body actually works.

The goal should be optimal strength and capability with appropriate mass: building the muscle you need without accumulating tissue that doesn’t serve you. Train for function. Eat to fuel performance and recovery. Allow your body to develop the physique that supports your activities rather than treating physique as the end in itself.

**The Bottom Line**

As we age, strength becomes more important than muscle size because strength is a nervous-system skill that declines faster than muscle mass; strength determines independence and fall prevention; strength preserves fast-twitch fibers; strength improves bone, tendon, and metabolic health; strength predicts longevity better than size; and strength reflects muscle quality, not just quantity. Muscle size still matters. It’s a reservoir of amino acids, a site of glucose disposal, and a determinant of metabolic health. But strength is the functional currency of aging.

The strongest pound-for-pound athletes in the world understand this intuitively. They’re not trying to get as big as possible. They’re trying to get as capable as possible within their frame. That distinction makes all the difference. The body, like any well-designed system, tends toward efficiency. Respecting that efficiency, rather than overriding it in pursuit of aesthetics, may be one of the wisest things you can do for long-term health and performance.

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Dr. Thomas is a highly sought-after physician whose medical expertise has been forged through extensive education and refined over nearly 40 years of clinical practice. He has helped people worldwide by providing innovative solutions that not only address their immediate health concerns, but also lay lasting foundations for optimal wellness. His strength lies in his scientific curiosity, creative and analytical thinking, and practical application of cutting-edge research. Despite the demands of a busy medical practice, to stay at the forefront and continuously improve the care of his patients, Dr. Thomas

devotes 20-30 hours a week to reviewing the latest scientific literature and consulting with leading scientists to identify potentially promising treatments. He shares his evidence-based insights at ThomasHealthBlog.com, where complex medical science becomes actionable health information.



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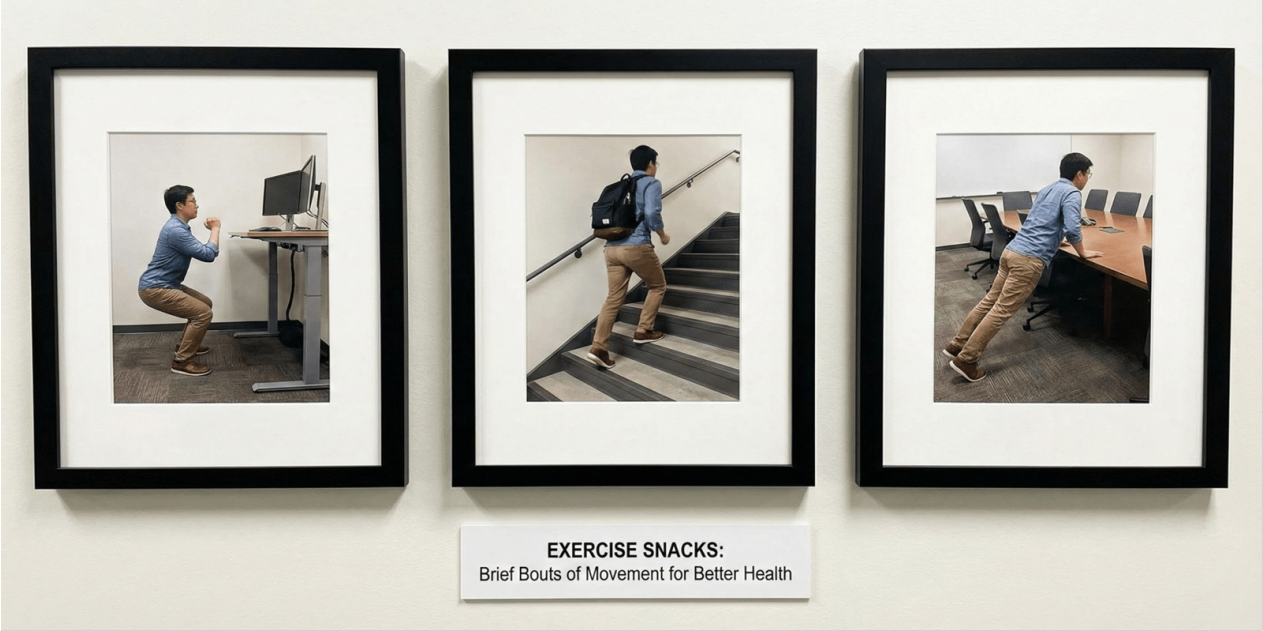



Published December 25, 2025 by Dr. Daniel Thomas, DO, MS

# Exercise Snacks: How Brief Movement Breaks Help Control Blood Sugar

Brief bouts of bodyweight squats distributed throughout the day can reduce postprandial (after-meal) glucose levels by 21-52% through insulin-independent mechanisms that remain fully functional even in people with type 2 diabetes. This approach, often called “exercise snacking,” leverages the body’s contraction-mediated glucose uptake pathway, bypassing the insulin resistance that defines metabolic dysfunction. The effectiveness of this strategy reflects a fundamental truth: the human body was designed to be in motion. Our metabolic machinery was created for frequent movement—walking, squatting, climbing, carrying—and it still requires that input to function optimally. Prolonged sitting is a modern phenomenon that our physiology simply isn’t equipped to handle well. Research now shows that frequent short bouts of lower-body exercise outperform single continuous exercise sessions for glycemic control, offering a practical, equipment-free strategy for managing blood glucose in both healthy and metabolically impaired individuals.

**Understanding blood sugar control: Appearance versus disposal**

To understand why exercise snacking works so powerfully, you first need to understand what actually determines your blood sugar after a meal. Each postprandial glucose curve is shaped by two opposing forces acting in concert. The first is glucose appearance, the rate at which glucose enters your bloodstream from digestion and absorption. The second is glucose disposal, the rate at which your tissues pull glucose out of circulation for use or storage.

Most dietary advice focuses almost exclusively on slowing the appearance of glucose, such as eating more slowly, avoiding sugary foods, choosing whole grains over refined ones, and

consuming protein and fat before carbohydrates (click here). These strategies work by slowing digestion or absorption, reducing the rate at which glucose floods into your bloodstream. However, metabolic research has established that, in most people, particularly those with blood glucose disorders, impaired glucose disposal is the primary driver of elevated postprandial glucose, not excessive glucose appearance.

In landmark research employing a triple-tracer methodology, scientists compared individuals with normal glucose tolerance to those with type 2 diabetes. They found that the rate at which meal glucose appeared in the bloodstream was essentially identical between groups. What differed dramatically was the rate of glucose disposal. The increase in glucose clearance during the first three hours after a meal was 7.9 mmol/kg in healthy subjects, compared with only 4.8 mmol/kg in those with diabetes. This 40% reduction in disposal capacity accounted for the higher blood sugar peaks, not faster meal absorption.

This finding has profound implications. Dietary strategies can slow glucose appearance, but they cannot overcome the disposal process, which operates at half the normal rate. The bottleneck is not the rate at which glucose enters the bloodstream but the rate at which tissues clear it. This is precisely why exercise snacking represents such a powerful intervention: it directly targets the disposal side of the equation.

**The muscle contraction pathway bypasses insulin entirely**

When skeletal muscle contracts, it triggers glucose uptake through molecular machinery completely distinct from insulin signaling. This insulin-independent pathway centers on GLUT4 translocation, the movement of glucose transporter proteins from intracellular storage vesicles to the cell surface, where they facilitate glucose entry into muscle cells.

During exercise, muscle contraction activates three parallel signaling cascades that converge on GLUT4 mobilization. AMPK (AMP-activated protein kinase) senses the drop in ATP during muscle work and phosphorylates downstream targets. Calcium/calmodulin-dependent kinase II, activated by calcium release during contraction, accounts for approximately 30% of contraction-stimulated glucose uptake. Most powerfully, Rac1 GTPase activation (which increases 40-100% during exercise) is essential for glucose disposal, with muscle-specific Rac1 knockout reducing contraction-stimulated uptake by 55-80% depending on muscle type.

These pathways converge on AS160/TBC1D4 and TBC1D1, Rab-GTPase-activating proteins that normally retain GLUT4 in intracellular storage. Phosphorylation by exercise-activated kinases inactivates these “brakes,” allowing GLUT4 vesicles to fuse with the plasma membrane and T-tubules. The result: exercise increases muscle glucose uptake by up to 100-fold relative to rest, and, crucially, this pathway remains fully intact in insulin-resistant individuals.

Insulin and contraction recruit GLUT4 from different intracellular pools, creating additive effects when both stimuli are present. Studies show that combined insulin and contraction produce 44% more GLUT4 at the cell surface than either stimulus alone, explaining why post-meal exercise (when both insulin and muscle contraction are active) produces potent glucose-lowering effects. This dual activation dramatically accelerates glucose disposal, addressing the primary bottleneck in postprandial glucose control.

**How glycogen depletion creates a sustained “glucose sink”**

Beyond acute GLUT4 translocation, exercise creates prolonged metabolic benefits through glycogen dynamics. A typical resistance exercise session depletes 24-40% of muscle glycogen in working muscles, with type II fast-twitch fibers showing particularly pronounced depletion during high-intensity movements like squats.

This glycogen deficit transforms muscle into a powerful “glucose sink” during recovery. Glycogen-depleted muscle shows enhanced GLUT4 translocation, activated glycogen synthase, and dramatically improved insulin sensitivity. Under optimal conditions, glycogen resynthesis proceeds at 5-10 mmol/kg/h, actively drawing glucose from the bloodstream for hours after exercise concludes.

The inverse relationship between glycogen content and glucose uptake creates sustained blood glucose-lowering effects. In studies in which post-exercise carbohydrate was withheld, elevated glucose uptake persisted for 18 or more hours as muscles slowly rebuilt glycogen stores through gluconeogenesis. When carbohydrates were consumed, glycogen uptake remained elevated, whereas glycogen normalized more quickly. Post-exercise improvements in insulin sensitivity persist for 16 to 72 hours after a single exercise bout, depending on exercise intensity, duration, and dietary factors. This “prolonged acute effect” explains why regular exercisers maintain better glucose control: each session provides days of enhanced disposal capacity, creating overlapping windows of metabolic benefit.

**Distributed exercise outperforms traditional workout sessions**

The emerging science of “exercise snacking” challenges conventional exercise prescription. Formally defined as isolated bouts of one minute or less of vigorous exercise performed periodically throughout the day, exercise snacks provide repeated stimuli for GLUT4 translocation rather than a single activation event. From a glucose disposal perspective, this is critical. Each bout elicits a fresh wave of GLUT4 translocation to the cell surface, maintaining elevated disposal capacity throughout the day rather than allowing it to decay after a single morning workout.

The landmark 2012 Dunstan study established the paradigm: interrupting prolonged sitting with just 2 minutes of light walking every 20 minutes reduced postprandial glucose by 24-30% and insulin by 23% compared to uninterrupted sitting. Remarkably, light-intensity walking produced identical benefits to moderate-intensity walking; intensity mattered less than frequency.

More strikingly, the 2017 Duvivier study in patients with type 2 diabetes found that replacing sitting with light standing and walking throughout the day improved insulin sensitivity compared with structured cycling exercise, despite matched energy expenditure. The “sit less” condition reduced HOMA-IR (a fasting insulin resistance marker) by 12%, while the structured exercise condition showed no improvement over sitting. The authors concluded that breaking up sedentary time was metabolically distinct from, and potentially superior to, traditional exercise.

A meta-analysis confirmed that light-intensity walking breaks significantly reduced postprandial glucose (standardized mean difference, -0.72) and insulin (standardized mean difference, -0.83), whereas standing alone provided modest glucose benefits but no insulin benefits. Individuals with higher BMI showed greater benefits from interrupting sitting, suggesting particular value for metabolically at-risk populations, precisely those with the greatest impairment in glucose disposal.

**Optimal dosing: Frequency matters more than volume**

The relationship between squat frequency and glucose reduction is nonlinear, with interruption frequency mattering more than total exercise volume. When Gao and colleagues compared four conditions in overweight men over 8.5 hours, they found that 10 bouts of brief activity produced substantially greater benefit than a single 30-minute walk. Uninterrupted sitting produced a glucose net incremental area under the curve of 10.2 mmol/L/h. A single 30-minute walk reduced this to 9.2 mmol/L/h, representing approximately 10% reduction. Three-minute walks every 45 minutes achieved a 7.9 mmol/L/h reduction, representing a 23% reduction. Ten squats every 45 minutes matched this exactly at 7.9 mmol/L/h, a 21% reduction.

A 2024 network meta-analysis confirmed these findings, showing that breaks every 30 minutes achieved the highest probability of optimal glucose reduction (SUCRA of 81.8%), with an effect size of -1.18 standard mean difference. Breaking at 20-minute intervals also showed significant benefit (-0.89 SMD), though with diminishing returns compared to the every-30-minute protocol. Ten squats per bout appears to represent the minimum effective threshold validated across multiple studies.

When comparing activity types during sitting interruptions, resistance exercise consistently produces the largest effect sizes. Resistance movements yield a standardized mean difference of -1.23 for glucose reduction, compared with -0.74 for walking, -0.08 for standing (not significant), and +0.17 for cycling (not significant). This advantage stems from greater muscle contractile activity: squats recruit the quadriceps, gluteals, hamstrings, and calves under body-weighted resistance, generating stronger GLUT4 translocation signals than walking at matched durations. In the context of glucose metabolism, resistance exercise elicits greater activation of glucose disposal than other forms of exercise.

**Squats activate the body's largest glucose-disposal muscles**

Lower-body exercises are particularly effective for glucose regulation because they recruit the quadriceps, gluteals, and hamstrings. These muscle groups collectively constitute the body's largest glycogen reservoir and highest glucose disposal capacity. Skeletal muscle accounts for 70-90% of whole-body glucose disposal during insulin stimulation, and the lower limbs comprise the majority of this muscle mass. EMG studies demonstrate that increased activation of these muscles directly correlates with greater glucose reduction: each unit increase in quadriceps EMG amplitude reduces glucose by 0.38 mmol/L/h.

A 2024 study by Gao and colleagues directly compared squats to walking for interrupting prolonged sitting in overweight men. Both 10 bodyweight squats every 45 minutes and 3-minute walking breaks reduced the net incremental area under the glucose curve by 21% compared with continuous sitting, and both outperformed a single 30-minute walk. Electromyographic analysis revealed that only increased quadriceps and gluteal muscle activity predicted glucose reduction; hamstring activation showed no independent association.

Japanese researchers found that 30 bodyweight squats (10 reps times 3 sets) performed 30 minutes after glucose ingestion significantly lowered blood glucose at 30 and 60 minutes post-challenge. Notably, slower-tempo squats (40 beats per minute) produced substantially greater glucose reduction than faster squats (80 beats per minute), despite lower perceived exertion. The slow-tempo condition maintained statistical significance at both 30 and 60 minutes post-glucose load, while the fast-tempo condition lost significance by 60 minutes. The mechanism involves greater time under tension and enhanced lactate production during slow contractions; brief ischemia during slow squats boosts lactate generation, which signals GLUT4 transporter translocation to the muscle surface and can increase glucose uptake threefold. The practical recommendation: perform each squat over approximately 4 seconds, using controlled descent and ascent rather than rapid bouncing.

The soleus muscle, a deep calf muscle comprising just 1% of body weight, has emerged as a uniquely powerful glucose regulator. Hamilton and colleagues demonstrated that "soleus pushups" (raising the heels while seated) performed during an oral glucose tolerance test reduced postprandial glucose excursion by 52% and insulin by 60%. These massive effects were achieved at just 1.3 to 1.7 METs of effort. The soleus is composed of 88% slow-twitch oxidative fibers, with minimal reliance on glycogen, allowing it to sustain elevated glucose oxidation for hours without fatigue. Follow-up studies in prediabetic adults confirmed a 32% reduction in glucose with this simple seated movement.

**Timing around meals maximizes glucose-lowering effects**

When exercise occurs in relation to eating, it dramatically influences glycemic impact. A meta-analysis of randomized trials found that post-meal exercise significantly reduced glucose excursions (standardized mean difference of 0.55). In contrast, pre-meal exercise showed no significant benefit (standardized mean difference of -0.13, not significant) compared with inactive controls. The effect was strongest when exercise occurred within 0-30 minutes after eating.

The mechanism aligns perfectly with the glucose appearance and disposal framework. Postprandial exercise provides both insulin and contraction simultaneously, resulting in additive GLUT4 translocation. It also matches glucose supply (from the meal being digested) with increased glucose demand (from working muscles), thereby preventing postprandial spikes rather than attempting to lower already elevated blood glucose. Peak blood glucose occurs 30 to 60 minutes after eating in healthy people and 60 to 120 minutes in those with type 2 diabetes. Initiating exercise during the ascending phase of the glucose curve allows muscle GLUT4 transporters to intercept meal-derived glucose at its peak concentration, maximizing disposal precisely when appearance is highest.

In individuals with type 2 diabetes, studies comparing exercise timing found that 45 minutes postprandially was more effective than 90 minutes postprandially. The Francois study demonstrated that 6 times 1-minute intervals of intense walking, performed 30 minutes before each meal, reduced 24-hour mean glucose by 12% and post-breakfast glucose by 17%, whereas 30 minutes of continuous moderate walking before dinner alone showed no improvement in glucose control.

Different protocols optimize fasting versus postprandial glucose. For postprandial control, the established protocol is to take squat breaks every 30 to 45 minutes during prolonged sitting, with particular emphasis on postprandial exercise within 30 minutes. For fasting glucose and the dawn phenomenon, more frequent interruptions may be required. A study of patients with type 2 diabetes found that breaks every 15 minutes (versus every 30 or 60 minutes) produced the most significant reduction in fasting glucose (by 1.0 mmol/L) and shortened the duration of the dawn phenomenon by 3.1 hours. The glucose-lowering effect from a single squat bout persists for 24 to 48 hours, with benefits extending into nocturnal glucose levels.

**Clinical applications span from healthy to diabetic populations**

In healthy individuals, exercise snacks provide “metabolic insurance” against the glucose dysregulation that accompanies prolonged sitting. Even 3-10 minutes of stair climbing reduced peak postprandial glucose by 15 to 23 mg/dL in healthy adults, and 10-minute bouts further improved insulin sensitivity. However, healthy young adults may require higher doses or intensities to achieve measurable effects: a study using 5 times 1-minute bodyweight exercise bouts (at 75% of maximum heart rate) in healthy individuals showed no significant 24-hour difference in glucose compared with a sitting control.

For prediabetes and type 2 diabetes, the insulin-independent nature of contraction-mediated glucose uptake makes exercise snacks particularly valuable. The molecular pathway that becomes impaired in insulin resistance (insulin receptor to IRS proteins to PI3K to Akt to GLUT4) is completely bypassed by exercise. This is the key insight: while insulin-mediated disposal is compromised in metabolic dysfunction, contraction-mediated disposal remains intact. Studies confirm that a single bout of resistance exercise reduces blood glucose for up to 24 hours and insulin for up to 18 hours in patients with diabetes. A 10-week trial found that resistance training produced greater reductions in HbA1c than aerobic training in individuals with type 2 diabetes.

Populations with insulin resistance derive the greatest benefit. Meta-analysis confirms that higher

BMI associates with greater glycemic attenuation, and pooled analysis shows that the magnitude of improvement is proportional to baseline fasting glucose, insulin, and HOMA-IR. In patients with type 2 diabetes, 3 minutes of simple resistance exercises (half-squats, calf raises, gluteal contractions, knee raises) performed every 30 minutes reduced the incremental area under the glucose curve by 39% and the insulin curve by 37%. Those who would benefit most from squat breaks are precisely those with the greatest impairment of glucose disposal: the insulin-independent pathway provides an alternative route for glucose clearance when the insulin-dependent pathway has failed.

International guidelines now recommend interrupting sedentary behavior with at least 3 minutes of light activity every 30 minutes for people with diabetes, a direct translation of the exercise snacking research into clinical practice.

**Exercise snacks as an alternative to fasting**

The primary metabolic benefit of fasting is improved insulin sensitivity. By lowering ambient insulin levels, depleting hepatic and muscle glycogen, and allowing insulin receptors to resensitize during periods of low insulin exposure, fasting consistently improves glucose control and shifts the body toward burning stored fat for fuel. This metabolic shift reduces the constant high-insulin state that drives weight gain, inflammation, and metabolic disease. The question naturally arises: can exercise snacks accomplish the same metabolic benefits through a different route?

The convergence is striking when you trace both interventions to their mechanistic endpoints. Fasting improves insulin sensitivity primarily by reducing insulin demand over time. The metabolic benefits people attribute to fasting (reduced inflammation, improved glucose handling, metabolic flexibility) flow downstream from this hormonal reset. Exercise snacks arrive at a remarkably similar destination through a completely different route. Rather than waiting for insulin levels to fall so that insulin-mediated glucose disposal can improve, they activate a parallel disposal system that never broke in the first place. The contraction-mediated GLUT4 pathway remains fully functional even in severe insulin resistance, effectively providing a workaround while the insulin-dependent machinery is impaired.

Critically, exercise snacks do not merely bypass insulin; they actually reduce it. The Dunstan data cited earlier showed a 23% reduction in postprandial insulin, and the soleus push-up study demonstrated a 60% reduction. When muscle is actively clearing glucose through contraction-mediated uptake, the pancreas does not need to secrete as much insulin to maintain glucose homeostasis. Over time, this reduced insulin demand may produce effects similar to those achieved by fasting through caloric restriction.

The glycogen-depletion component strengthens this parallel. Fasting depletes glycogen stores, thereby increasing metabolic demand for glucose, which in turn improves subsequent insulin sensitivity. Exercise snacks do the same thing, with 24-40% glycogen depletion per session creating that sustained “glucose sink” effect. The 16-72 hour window of enhanced insulin sensitivity after exercise mirrors what happens during the refeeding phase after a fast.

There may actually be an argument that exercise snacks are more precisely targeted than fasting for metabolic improvement. Fasting reduces insulin by reducing glucose appearance (no food coming in). Exercise snacks reduce insulin by increasing glucose disposal (muscle actively clearing it). Given that impaired disposal is the primary driver of postprandial hyperglycemia, the exercise approach addresses the underlying bottleneck rather than circumventing it.

The practical implications are substantial. Many patients struggle with fasting protocols, whether due to medication timing, risk of hypoglycemia, or simple adherence challenges. Exercise snacks require only minutes of accumulated activity, can be performed anywhere, and do not conflict with

medication schedules or social eating patterns. For individuals who find fasting difficult or contraindicated, distributed exercise throughout the day may provide a comparable metabolic intervention.

The two approaches may also be synergistic rather than redundant. Fasting during sleep, with exercise snacks during waking hours, would provide continuous metabolic benefit: low overnight insulin exposure, allowing receptor resensitization, followed by enhanced disposal capacity during the day when eating resumes. This combination might produce better results than either intervention alone.

**Why this all matters: Hyperinsulinemia sits at the crossroads of chronic disease**

The discussion of glucose disposal and insulin sensitivity extends far beyond blood sugar management. Hyperinsulinemia, the chronic elevation of insulin levels that accompanies insulin resistance, is increasingly recognized as a central, upstream driver of biological aging and the chronic diseases that dominate American healthcare. The exact mechanisms that accelerate aging also drive the most common diseases in the United States, and elevated insulin sits at the nexus of both.

Chronically elevated insulin damages the body through multiple interconnected pathways. It impairs mitochondrial function, reducing cellular energy production and increasing oxidative stress. It promotes DNA damage and interferes with repair mechanisms. It dysregulates immune function, creating a state of chronic low-grade inflammation. It damages vascular health, promoting atherosclerosis and endothelial dysfunction. These are not separate disease processes but overlapping manifestations of the same underlying metabolic dysfunction.

The diseases that flow from these mechanisms read like a list of America's leading causes of death and disability: obesity, type 2 diabetes, cardiovascular disease, cancer, neurodegeneration, frailty, and immune dysfunction. Each of these conditions has been linked to hyperinsulinemia through epidemiological associations and mechanistic research. Elevated insulin levels promote fat storage and impede weight loss. It drives the progression from prediabetes to frank diabetes. It accelerates arterial plaque formation and increases heart attack and stroke risk. It creates a metabolic environment that favors cancer cell growth and survival. It impairs brain insulin signaling, contributing to cognitive decline and dementia. It accelerates the loss of muscle mass and strength that characterizes aging. It compromises immune surveillance, thereby increasing susceptibility to infections and reducing vaccine efficacy.

This convergence explains why many researchers now view insulin regulation as a foundational pillar of long-term health. Interventions that reduce insulin levels or improve insulin sensitivity do not merely address blood glucose; they may also slow aging and reduce risk across the entire spectrum of chronic diseases. Caloric restriction, the most robust longevity intervention identified in animal research, primarily acts by lowering insulin levels and improving insulin sensitivity. The same is true of intermittent fasting, time-restricted eating, and exercise.

Exercise snacks, by reducing postprandial insulin spikes and improving insulin sensitivity through contraction-mediated glucose disposal, may offer benefits that extend far beyond glycemic control. Every time muscle contraction clears glucose from the bloodstream without requiring insulin, the pancreas secretes less insulin, and the body spends less time in a hyperinsulinemic state. Over weeks and months, this cumulative reduction in insulin exposure may translate into meaningful protection against the cascade of conditions that hyperinsulinemia promotes.

This perspective reframes exercise snacks from a diabetes-management tool to a fundamental health-optimization strategy applicable to virtually everyone. The 60-year-old concerned about cognitive decline, the 45-year-old with a family history of heart disease, the 55-year-old cancer

survivor seeking to reduce recurrence risk, and the 70-year-old working to maintain independence all share a common interest in reducing insulin levels and improving insulin sensitivity. Brief bouts of lower-body exercise distributed throughout the day address this shared objective through a mechanism that remains effective regardless of current metabolic status.

**Practical protocols supported by evidence**

The research supports several evidence-based approaches for using bodyweight squats and lower-body exercise to enhance glucose disposal:

- **For breaking up prolonged sitting,** the Gao protocol (2024) recommends 10 bodyweight squats every 45 minutes for 10 bouts over 8.5 hours of sitting, producing a 21% reduction in postprandial glucose in overweight and obese men. This is consistent with the observed reduction in glucose during equivalent-duration walking breaks. Slower tempo (2 to 3 seconds per repetition, approximately 4 seconds total per squat) enhances the effect compared with rapid movements. The total daily volume (perhaps 50 to 100 squats distributed across the day) matters less than the frequency of metabolic "resets" that maintain elevated disposal capacity.
- **For postprandial glucose control,** 20-30 squats performed within 30 minutes of eating provide both acute glucose disposal via GLUT4 translocation and enhanced insulin action during the absorptive period. This timing aligns disposal activation with peak glucose appearance, addressing both sides of the equation simultaneously. For individuals with type 2 diabetes, the optimal postprandial window extends to 30-45 minutes, allowing time for glucose to enter the circulation before muscle contraction begins to clear it. This can be combined with a brief walk for added benefit.
- **For type 2 diabetes management,** the Baker Institute SRA (simple-resistance activity) protocol uses 3 minutes of half-squats, calf raises, gluteal contractions, or knee raises every 30 minutes, reducing the incremental area under the glucose curve by 39% and the insulin area under the curve by 37% in patients with type 2 diabetes. The Homer frequency protocol (2021) found that 6 minutes of SRAs every 60 minutes produced a 21% reduction in glucose and a 13% reduction in insulin, effects nearly equivalent to those of the more frequent 3-minute-every-30-minute protocol.
- **For sustained glucose management,** soleus pushups offer a unique tool: performing 100 to 300 heel raises while seated during otherwise sedentary activities (desk work, meetings, television watching) can dramatically reduce postprandial glucose without visible exertion or interruption of other activities. The soleus muscle's unique fiber composition allows sustained glucose oxidation without fatigue, providing continuous disposal support.
- **For practical implementation:** Set a timer for 30- to 45-minute intervals, and perform 10 to 15 controlled squats at each prompt. Prioritize breaks within 30 minutes after meals. This protocol requires only 3-5 minutes of accumulated activity per hour yet produces glucose reductions of 20-40% by maintaining elevated disposal capacity throughout the day.

**Conclusion**

Blood sugar control after meals depends on both how quickly glucose enters the bloodstream and how quickly the body clears it. While most popular advice focuses on slowing glucose entry through food choices and eating strategies, research clearly shows that impaired glucose disposal, primarily by skeletal muscle, is the dominant cause of elevated postprandial glucose in most people.

This does not mean dietary strategies are worthless. They provide real, if modest, benefits. But the most powerful interventions target disposal: walking after meals, building and maintaining muscle mass, getting adequate sleep, and managing stress. A comprehensive approach that addresses both sides of the glucose equation will produce better results than focusing on appearance alone.

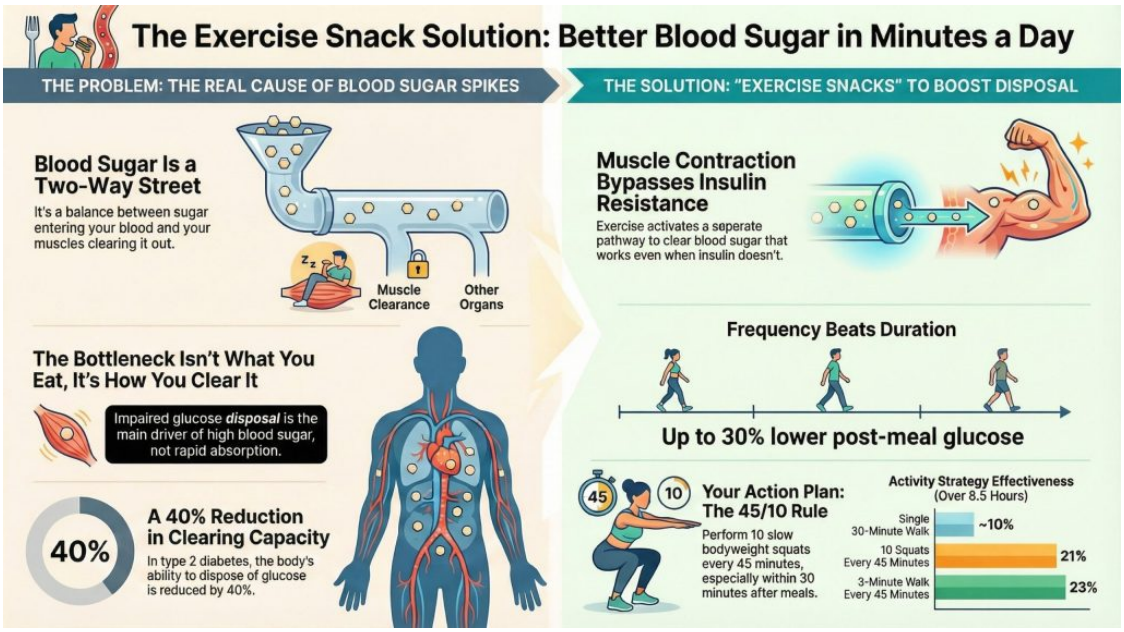
Understanding this distinction empowers you to make more informed choices and helps explain why your glucose responses might vary even when your diet remains constant.

Bodyweight squats engage the body's largest glucose-disposal muscles, trigger insulin-independent GLUT4 translocation that remains intact even when insulin signaling has failed, create glycogen deficits that transform muscle into a sustained glucose sink, and, when distributed throughout the day, may outperform traditional continuous exercise for glycemic control. The practical accessibility of this approach (no equipment, brief duration, flexible timing) removes typical barriers to exercise. The post-meal timing optimization aligns disposal activation with the body's greatest need for glucose clearance, when appearance from digested food peaks.

For those seeking alternatives or complements to fasting protocols, exercise snacks offer a compelling option. Both interventions ultimately reduce insulin demand and improve insulin sensitivity, but they achieve these effects through different mechanisms. Fasting reduces glucose appearance; exercise snacks increase glucose disposal. Given that impaired disposal is the primary metabolic defect in most people with glucose dysregulation, the exercise approach may be more precisely targeted at the underlying problem. For patients who cannot or prefer not to fast, distributed movement throughout the day provides a metabolically equivalent strategy that integrates seamlessly with normal eating patterns.

The implications extend beyond blood sugar management. Hyperinsulinemia stands at the crossroads of America's most prevalent chronic diseases, driving obesity, diabetes, cardiovascular disease, cancer, neurodegeneration, frailty, and immune dysfunction through shared mechanisms that also accelerate biological aging. By reducing insulin demand through enhanced glucose disposal, exercise snacks may offer protection across this entire spectrum of conditions. This reframes what might seem like a narrow intervention for people with diabetes into a foundational health optimization strategy relevant to virtually everyone concerned with long-term health and longevity.

For individuals seeking to manage fasting and postprandial glucose through lifestyle intervention, the evidence strongly supports integrating frequent bodyweight squats and lower-body movements throughout daily activities. This approach addresses the disposal side of the glucose equation—the side that matters most but receives the least attention in popular health advice. More fundamentally, it realigns our modern sedentary lives with the movement patterns for which our bodies are designed. We are not meant to sit motionless for hours. Our metabolic systems were built to expect regular muscle contractions to function properly. Exercise snacking isn't so much an intervention as a return to what our bodies have always needed. By honoring this design, we gain a practical, accessible means of reducing insulin levels and improving metabolic health, with potential benefits that extend far beyond the glucose numbers themselves.

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## Dr. Daniel Thomas, DO, MS

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Published December 19, 2025 by Dr. Daniel Thomas, DO, MS

# Not Overfat, But Undermuscled: Rethinking America's Health Crisis

For decades, public health messaging has focused relentlessly on weight loss and fat reduction. The obesity epidemic dominates headlines, and Body Mass Index remains the default metric for assessing health risk. Yet an accumulating body of scientific evidence suggests we may have been looking at the problem from the wrong angle. What if America's health crisis is not primarily about carrying too much fat, but about carrying too little muscle?

This reframing is not mere semantic wordplay. It represents a fundamental shift in how we understand the relationship between body composition and health outcomes. The evidence indicates that muscle mass is a powerful predictor of longevity, metabolic function, and cognitive health. More striking still, when researchers account for muscle mass, many of the puzzling inconsistencies in obesity research begin to dissolve.

**Muscle Mass Predicts Survival Better Than Body Weight**

The relationship between muscle mass and mortality is remarkably robust across populations and study designs. A 2023 meta-analysis by Wang and colleagues examined 16 prospective cohort studies encompassing more than 81,000 participants and found that individuals with low skeletal muscle mass index faced a 57 percent higher risk of death from all causes compared to those with adequate muscle. Even more revealing, this mortality penalty was amplified in individuals with higher BMI. Among those classified as obese, low muscle mass more than doubled the risk of death.

These findings are not isolated observations. García-Hermoso and colleagues synthesized data

from approximately two million participants across 38 studies and found that higher muscular strength was associated with a 31 percent lower risk of mortality. Meanwhile, analysis of the National Health and Nutrition Examination Survey III demonstrated that older adults in the highest quartile of muscle mass index had 19-20% lower mortality than those in the lowest quartile. Here is the critical point: BMI showed no significant association with mortality in this same population after adjusting for muscle mass.

**The Hidden Epidemic: Sarcopenia Begins Earlier Than You Think**

Many people associate muscle loss with advanced age, viewing it as an inevitable consequence of growing old. While age-related muscle decline is real, the assumption that sarcopenia only affects the elderly is dangerously mistaken. Research by Jung and colleagues established that more than one in ten young adults across most ethnicities now meets criteria for sarcopenia. Even more concerning, data from the National Health and Nutrition Examination Survey showed that the prevalence of pre-sarcopenia in adults aged 18 to 39 increased from 11.3 percent to 14.1 percent between 1999 and 2006, suggesting the problem is worsening.

The trajectory of muscle loss follows a predictable but often underappreciated pattern. Comprehensive reviews document a decline of 3-8% in muscle mass per decade after age 30, with the rate accelerating after age 60. The Health, Aging and Body Composition Study found that leg strength declined at an annual rate of 3-4%, approximately three times the rate of muscle mass loss. This means both the quantity and quality of muscle deteriorate with age, and by the eighth or ninth decade of life, individuals may have lost up to half of their peak muscle mass.

**Muscle: The Body's Primary Metabolic Engine**

The metabolic significance of skeletal muscle cannot be overstated. Foundational research by DeFronzo and Tripathy established that 80-90% of glucose disposal during insulin stimulation occurs in skeletal muscle, making it the primary tissue for glycemic control. This finding has profound implications: muscle insulin resistance, not fat accumulation, is the initiating defect in type 2 diabetes, appearing decades before beta-cell failure becomes evident.

Population studies confirm these mechanistic insights. Srikanthan and Karlamangla's analysis of 13,644 participants found that each 10 percent increase in skeletal muscle mass index was associated with an 11 percent relative reduction in insulin resistance and a 12 percent reduction in prediabetes prevalence. These associations held independent of age, sex, ethnicity, and obesity measures. A large Korean cohort study of more than 200,000 adults demonstrated that higher baseline muscle mass was associated with a lower risk of incident type 2 diabetes, even in apparently healthy, non-diabetic individuals.

Beyond glucose disposal, skeletal muscle functions as an endocrine organ. Pioneering work by Pedersen and Febbraio identified that contracting muscle releases hundreds of signaling molecules, called myokines, that affect the liver, adipose tissue, pancreas, bone, and brain. The first identified myokine, interleukin-6, increases up to 100-fold during exercise and enhances fat oxidation while improving insulin sensitivity. Physical inactivity fundamentally alters this myokine profile, providing a molecular mechanism linking sedentary behavior to metabolic disease.

**The Muscle-Brain Connection**

Perhaps the most compelling argument for prioritizing muscle health comes from research on cognitive function. Peng and colleagues conducted a meta-analysis of 15 observational studies and found sarcopenia significantly associated with cognitive impairment, with more than doubled odds of cognitive dysfunction. A comprehensive 2024 meta-analysis examining 77 studies and more than 92,000 subjects demonstrated that sarcopenia was associated with mild cognitive

impairment, nearly triple the risk of Alzheimer's disease, and increased risk of other dementias.

Grip strength has emerged as a potent biomarker of brain health. The UK Biobank study of more than 190,000 adults found that each 5-kilogram decrement in handgrip strength was associated with 14 to 16 percent higher dementia risk, with powerful associations for vascular dementia. Lower grip strength was also associated with greater white matter hyperintensity volume on brain MRI, suggesting that structural brain changes accompany muscle weakness.

The mechanisms connecting muscle to brain involve myokines that cross the blood-brain barrier. FNDC5 and irisin, released during exercise, induce hippocampal expression of brain-derived neurotrophic factor, a key neurotrophin for learning and memory. Cathepsin B similarly crosses into the central nervous system and promotes neurogenesis. These findings suggest that active muscle directly communicates with and protects the brain through molecular signals.

**Sarcopenic Obesity: The Hidden Condition**

Perhaps the most direct evidence supporting the undermuscled hypothesis comes from research on sarcopenic obesity, the combination of low muscle mass with normal or elevated body weight. A meta-analysis by Gao and colleagues found the global prevalence of sarcopenic obesity in older adults at 11 percent overall, but 19 percent in North Americans and 21 percent in South Americans. Americans appear to have particularly high rates of this hidden condition.

Sarcopenic obesity carries a unique mortality risk. Zhang and colleagues conducted a meta-analysis of 23 studies encompassing more than 50,000 participants and found sarcopenic obesity associated with 21 percent higher all-cause mortality. When defined by visceral fat area, the hazard ratio jumped to 2.54. Critically, data from the National Health and Nutrition Examination Survey show that normal-weight and underweight individuals have higher presarcopenia prevalence, ranging from 50 to 56 percent, than obese individuals. This validates the skinny-fat phenomenon as medically significant and demonstrates that focusing on weight alone misses dangerous body composition patterns.

Brown and colleagues analyzed data on community-dwelling older adults and found a 36.5% prevalence of sarcopenia. Those with sarcopenia had a median survival of 10.3 years compared to 16.3 years for those without. This six-year survival difference underscores the profound health implications of inadequate muscle mass.

**Solving the Obesity Paradox**

The obesity paradox refers to the puzzling finding that in some populations, particularly the elderly and those with chronic diseases, overweight and mildly obese individuals sometimes have better survival than their leaner counterparts. This has long confused researchers and practitioners and has led some to question whether excess weight might be protective.

The answer lies in body composition. Abramowitz and colleagues conducted a landmark study using body composition data from more than 11,000 adults. They found that at any BMI of 22 or higher, participants with low muscle mass had higher body fat, more diabetes, and higher adjusted mortality than other participants. When muscle mass was accounted for, the BMI associated with the lowest mortality shifted downward toward the normal range. The researchers concluded that this provides a concrete explanation for the obesity paradox.

The Health Professionals Follow-up Study, which tracked more than 38,000 men for over 21 years, separated the effects of lean mass and fat mass on mortality. Fat mass was strongly associated with mortality, whereas lean body mass showed that individuals in the middle quartiles had 8-10% lower mortality than those in the lowest quartile. The authors concluded that the

obesity paradox controversy may be explained mainly by low lean body mass, rather than low fat mass, in the lower range of BMI.

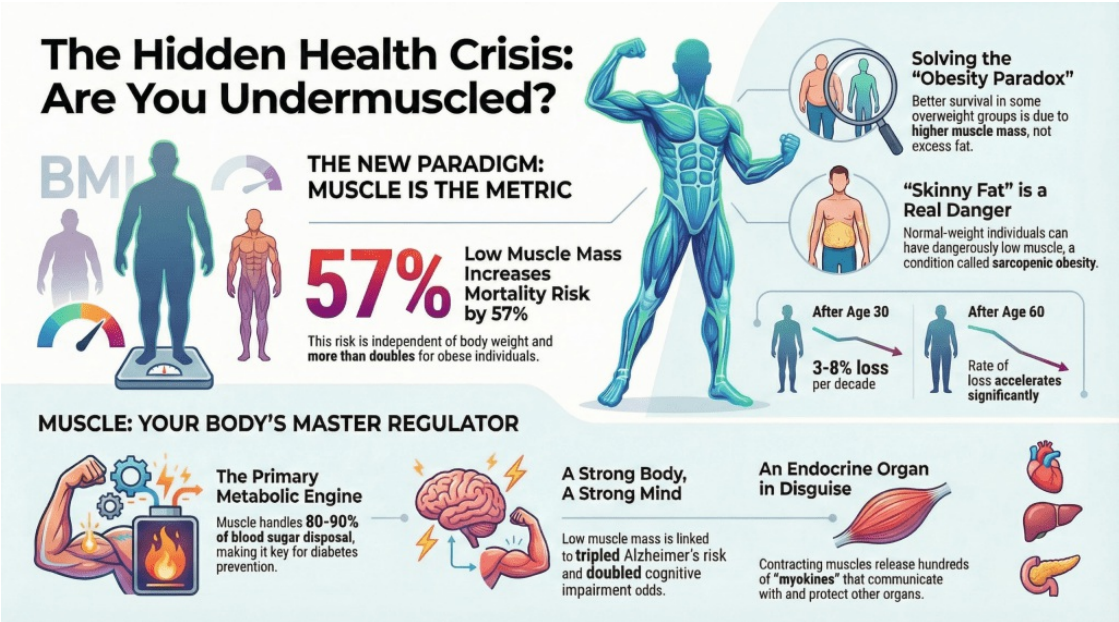
Cancer outcomes tell a similar story. In a colorectal cancer study, 42 percent of patients were sarcopenic at diagnosis, and sarcopenic patients had 27 percent higher mortality. The lowest mortality was observed among patients with a BMI of 25-30, precisely the range with the highest proportion of patients with adequate muscle mass. The apparent overweight advantage was actually a muscle mass advantage.

**A New Paradigm for Health**

The peer-reviewed evidence compellingly supports reframing America's health crisis from excess fat to insufficient muscle. Low muscle mass doubles mortality risk independent of BMI, predicts type 2 diabetes better than adiposity measures, and increases dementia risk by 50-100%. The obesity paradox dissolves when body composition replaces body weight as the metric of interest.

More than one in ten young adults already meet sarcopenia criteria, and this proportion appears to be growing. Skeletal muscle's role as both the body's primary glucose sink and an endocrine organ secreting hundreds of health-regulating myokines positions it as perhaps the most underappreciated vital organ.

Clinical practice and public health messaging may need fundamental revision. Rather than focusing exclusively on weight loss, perhaps we should prioritize muscle preservation and building. The evidence suggests that Americans are not merely overfat. They are critically undermuscled. Addressing that deficit may be key to improving metabolic health, cognitive function, and longevity across the population.

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Published December 15, 2025 by Dr. Daniel Thomas, DO, MS

# The Greatest Want of the World: An Examination of Moral Integrity in Modern Times

Throughout my years of study and professional practice, I have encountered countless philosophical insights and leadership principles. Yet few have resonated with me as profoundly as these words from early-American author Ellen G. White: “The greatest want of the world is the want of men—men who will not be bought or sold, men who in their inmost souls are true and honest, men who do not fear to call sin by its right name, men whose conscience is as true to duty as the needle to the pole, men who will stand for the right though the heavens fall.”

This statement, written over a century ago, speaks to a fundamental human need that transcends time and culture. While the language reflects its historical context, the principle it articulates applies equally to all people, regardless of gender, and remains strikingly relevant to the challenges we face today.

**The Currency of Character**

When White speaks of individuals “who will not be bought or sold,” she addresses the cornerstone of moral integrity: incorruptibility. In our modern context, this principle extends far beyond mere financial bribes. The currencies that can compromise our integrity today are numerous and subtle. They include social approval, career advancement, political advantage, and even the comfort of avoiding difficult conversations.

Consider the corporate whistleblower who risks career and reputation to expose wrongdoing, or the manager who refuses to manipulate financial reports despite pressure from above. These individuals understand that their integrity cannot be valued in monetary terms or traded for

temporary advantages. They recognize that once compromised, moral authority is extraordinarily difficult to restore.

**The Inner Compass**

The phrase “true and honest in their inmost souls” points to authenticity that runs deeper than public persona. In an age of carefully curated social media profiles and corporate messaging, this call for genuine character feels particularly urgent. True integrity requires alignment between our private thoughts, our stated values, and our public actions.

This internal consistency manifests in small, daily decisions as much as in grand moral stands. It appears in the accuracy of expense reports submitted when no one is watching, in the credit given to team members for their contributions, and in the promises kept even when circumstances make them inconvenient.

**The Courage of Clarity**

Perhaps the most challenging aspect of White’s vision is the call for those “who do not fear to call sin by its right name.” In contemporary terms, this translates to moral clarity and the courage to identify wrongdoing without equivocation. This does not mean harsh judgment or self-righteousness, but rather the willingness to acknowledge when actions or systems cause harm, even when such acknowledgment is uncomfortable or unpopular.

In organizational contexts, this might mean addressing systemic discrimination rather than dismissing it as isolated incidents. It could involve questioning environmentally destructive practices despite their profitability. It requires speaking truth to power when that power is being misused, regardless of personal consequences.

**Magnetic North**

White’s metaphor of conscience being “as true to duty as the needle to the pole” offers a powerful image of unwavering moral direction. Just as a compass needle consistently points north regardless of local conditions, a well-developed conscience provides reliable guidance through ethical complexity.

This consistency becomes particularly valuable in times of moral ambiguity. When organizational cultures normalize questionable practices, when peer pressure suggests compromise, or when the path forward seems unclear, this internal compass provides direction. It reminds us that ethical principles are not situational conveniences but fundamental guides for decision-making.

**Standing When Heaven Falls**

The final phrase, “men who will stand for the right though the heavens fall,” represents the ultimate test of character. This hyperbolic image captures the essence of moral courage: the willingness to maintain ethical standards even when the cost appears catastrophic.

History provides powerful examples of such individuals. Nelson Mandela spent twenty-seven years in prison rather than abandoning his fight against apartheid. Dietrich Bonhoeffer, a German theologian, chose execution over silence about Nazi atrocities. Frank Serpico testified against widespread police corruption despite death threats and an assassination attempt that nearly killed him. Sherron Watkins risked her career at Enron to expose accounting fraud that was defrauding thousands of employees and investors. Daniel Ellsberg sacrificed his freedom and reputation to release the Pentagon Papers, revealing governmental deception about the Vietnam War. These figures demonstrate that some principles transcend personal safety, professional success, or even

life itself. Their examples remind us that while compromise is often necessary in practical matters, fundamental ethical principles must remain non-negotiable.

**A Visionary's Broader Wisdom**

Ellen White's moral clarity extended beyond character and ethics into practical matters of human well-being. Her extensive writings on the benefits of a whole-food, plant-based diet were remarkably prescient, articulated more than a century before modern nutritional science would validate many of her recommendations. In an era when meat consumption was considered essential for health and refined foods were symbols of prosperity, White advocated for whole grains, fruits, vegetables, and nuts as the foundation of optimal nutrition. She warned against the excessive use of sugar, refined flour, and processed foods decades before epidemiological studies would link these dietary patterns to chronic disease.

This aspect of her work demonstrates another dimension of the moral courage she described: the willingness to challenge prevailing wisdom when it contradicts observed truth. Her dietary counsel, like her call for principled leadership, required individuals to think independently and act according to evidence rather than cultural convention. Today, as major medical institutions increasingly recognize the health benefits of plant-based diets for preventing and reversing chronic diseases, White's writings stand as testimony to the value of principled observation over popular opinion.

**The Modern Application**

In today's interconnected and rapidly changing world, the need for such individuals has only intensified. We face challenges that require not just technical expertise but moral leadership: artificial intelligence ethics, climate change response, wealth inequality, and global health crises. These issues demand leaders who cannot be swayed by short-term interests, who will speak uncomfortable truths, and who will maintain their ethical bearings despite unprecedented pressures.

Moreover, this call extends beyond formal leadership positions. In every organization, community, and family, there exists a need for individuals who embody these principles. The cumulative effect of many people choosing integrity over expedience, truth over comfort, and principle over profit can transform cultures and institutions.

**The Discipline of Health: Character Expressed Through Daily Choices**

The pursuit of moral integrity that White describes naturally extends to personal health and lifestyle choices. Indeed, the discipline required to maintain a healthy diet and lifestyle serves as both a metaphor for and a practical expression of the character traits she champions. The daily decisions we make about what we consume and how we treat our bodies reflect the same commitment to principle over convenience that defines moral courage in other spheres of life.

Maintaining a healthy lifestyle in modern society requires many of the same qualities White identified as essential to moral character. It demands the ability to resist being "bought or sold" by the persuasive marketing of processed foods, the social pressures of unhealthy eating patterns, and the convenience culture that prioritizes immediate gratification over long-term well-being. Every trip to the grocery store, every meal choice, and every decision to exercise or rest becomes an opportunity to demonstrate the same incorruptibility White valued in ethical matters.

Consider the professional who maintains their exercise routine despite crushing work deadlines, or the parent who takes time to prepare nutritious meals even when fast food would be easier. These individuals understand that their commitment to health cannot be compromised by external pressures or temporary circumstances. They recognize that physical well-being, like moral

integrity, requires consistent dedication rather than sporadic effort.

White's advocacy for plant-based nutrition in the late nineteenth century required tremendous courage to challenge prevailing wisdom. Today, maintaining truly healthy dietary practices still often means swimming against powerful cultural currents. The standard Western diet, with its emphasis on processed foods, excessive sugar, and animal products, has become so normalized that choosing whole, plant-based foods can seem radical or extreme to others. This parallel between dietary choices and moral stands is particularly striking. Just as White called for those who "do not fear to call sin by its right name," maintaining health standards often requires acknowledging uncomfortable truths about common dietary practices.

The commitment to healthy living exemplifies White's metaphor of conscience being "as true to duty as the needle to the pole." A genuine commitment to health does not waver based on circumstances, emotions, or social settings. It remains constant whether we are dining alone or at a celebration, whether we feel motivated or discouraged, whether healthy options are convenient or require extra effort. This consistency in health practices builds the same moral muscle necessary for ethical decision-making in other areas. The person who can resist the immediate pleasure of unhealthy foods for the sake of long-term wellbeing develops the capacity to resist other forms of temptation.

Perhaps most significantly, maintaining a healthy lifestyle despite societal pressures serves as a powerful form of leadership. In a culture where chronic disease has become normalized and preventable illnesses are treated as inevitable, those who demonstrate vibrant health through disciplined lifestyle choices offer living proof that another way is possible. Their example, like that of moral leaders in other spheres, can inspire others to question assumptions and make better choices. This form of leadership requires no formal position or platform. A colleague who consistently brings nutritious lunches to work, a friend who maintains their exercise routine through busy seasons, or a family member who successfully reverses chronic disease through lifestyle changes can have profound influence on those around them.

The intersection of moral integrity and health discipline reveals a fundamental truth about character development. True integrity cannot be compartmentalized. The person who claims to value truth but lies to themselves about the consequences of their lifestyle choices has not fully embraced the principle of honesty. The leader who advocates for sustainable practices while neglecting the environmental impact of their dietary choices demonstrates incomplete commitment to their stated values. White understood this integration intuitively, which is why her writings addressed both spiritual principles and practical health guidance. She recognized that the development of character requires attention to all aspects of human existence.

Maintaining commitment to health requires the same long-term perspective that underlies moral integrity. Just as ethical compromises may offer short-term advantages but ultimately diminish our character, dietary indulgences and sedentary habits may provide immediate pleasure but compromise our future well-being. The person of integrity that White describes understands that some values transcend immediate gratification. This long-term vision becomes particularly important when facing health challenges or setbacks. The commitment to healthy living, like the commitment to ethical principles, will be tested by circumstances that make adherence difficult.

Ultimately, the discipline required for healthy living represents one dimension of the comprehensive integrity White envisioned. It demonstrates that true character manifests not just in dramatic moral stands but in the quiet consistency of daily choices. It shows that the "greatest want of the world" includes not just ethical leaders but individuals who embody wellbeing in all its dimensions, offering hope and inspiration through their very existence. The challenge White presents to us extends beyond professional ethics or public moral stands to encompass the private decisions we make about our own bodies and health.

**Conclusion**

Ellen White's words remind us that the world's greatest need is not for more resources, technology, or even knowledge. It is for people of uncompromising character. While the specific challenges we face have evolved since her time, the fundamental human need for moral leadership remains constant.

As I reflect on this quote, I am reminded that developing such character is not a destination but a daily practice. Each decision we make either strengthens or weakens our moral foundation. Each time we choose integrity over convenience, we contribute to filling this "greatest want of the world."

The question we must ask ourselves is not whether we have already achieved this ideal, since few if any have, but whether we are committed to its pursuit. In a world that often rewards compromise and cynicism, choosing to develop and maintain moral integrity is itself an act of courage. It is also, I believe, our most important contribution to the communities we serve and the legacy we leave behind.


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