

THE TELOMERE EFFECT

A Revolutionary Approach to
Living Younger, Healthier, Longer



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Elissa Epel, PhD



GRAND CENTRAL
PUBLISHING

NEW YORK BOSTON

This book is designed to help you understand the new science of telomeres and to help you make informed lifestyle choices; it is not meant to replace formal medical treatment by a physician or other licensed health care provider. You should regularly consult a physician in matters relating to your health and particularly with respect to any symptoms that may require diagnosis or medical attention.

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Grand Central Publishing

Hachette Book Group

1290 Avenue of the Americas, New York, NY 10104

grandcentralpublishing.com

twitter.com/grandcentralpub

First Edition: January 2017

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Illustrations by Colleen Patterson of Colleen Patterson Design

Library of Congress Cataloging-in-Publication Data

Names: Blackburn, Elizabeth H. (Elizabeth Helen), 1948– author. | Epel, Elissa S. (Elissa Sarah), 1968– author.

Title: The telomere effect : the new science of living younger / by Elizabeth Blackburn, Elissa Epel.

Description: New York : Grand Central Publishing, [2017] | Includes bibliographical references and index.

Identifiers: LCCN 2016028884 | ISBN 9781455587971 (hardcover) | ISBN 9781455541713 (hardcover large-print) | ISBN 9781478940425 (audio cd) | ISBN 9781478940432 (audio download) | ISBN 9781455587964 (ebook)

Subjects: | MESH: Telomere—physiology | Aging—genetics

Classification: LCC QH600.3 | NLM QU 470 | DDC 572.8/7—dc23 LC record available at <https://lccn.loc.gov/2016028884>

ISBNs: 978-1-4555-8797-1 (hardcover), 978-1-4555-4171-3 (large print), 978-1-4555-8796-4 (ebook)

Printed in the United States of America

RRD-C

10 9 8 7 6 5 4 3 2 1

We thank the many authors and publications that allowed us permissions to reprint scales and figures.

For figures, this includes:

Blackburn, Elizabeth H., Elissa S. Epel, and Jue Lin. "Human Telomere Biology: A Contributory and Interactive Factor in Aging, Disease Risks, and Protection." *Science* (New York, N.Y.) 350, no. 6265 (December 4, 2015): 1193–98. **Permissions granted by the American Association for the Advancement of Science.**

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I dedicate this book to John and Ben,
the lights of my life, who simply make everything
for me worthwhile. —EHB

I dedicate this book to my parents, David and Lois,
who are an inspiration in how they live fully
and vibrantly, in their almost ninth decade of life,
and to Jack and Danny, who make my cells happy. —ESE

A Tale of Two Telomeres

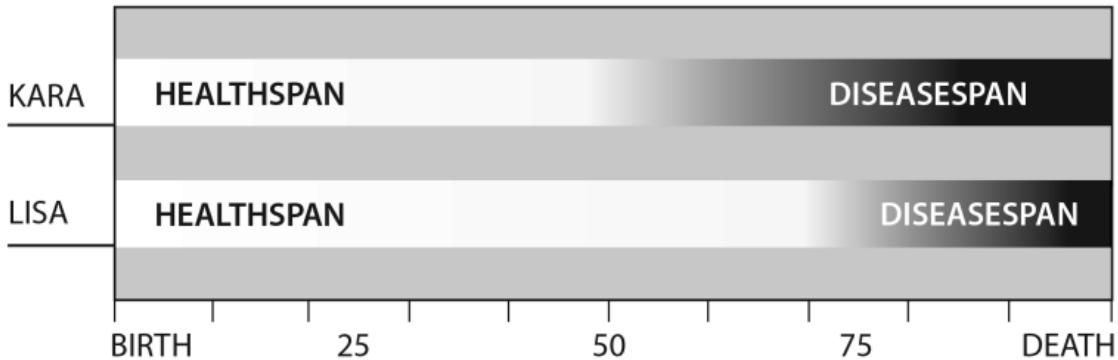


Figure 1: Healthspan versus Diseasespan. Our healthspan is the number of years of our healthy life. Our diseasespan is the years we live with noticeable disease that interferes with our quality of living. Lisa and Kara may both live to one hundred, but each has a dramatically different quality of life in the second half of her life.

A Tale of Two Telomeres

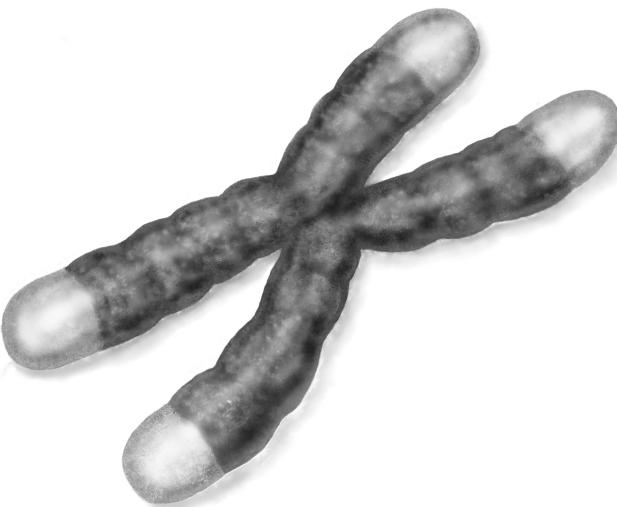


Figure 2: Telomeres at the Tips of Chromosomes. The DNA of every chromosome has end regions consisting of DNA strands coated by a dedicated protective sheath of proteins. These are shown here as the lighter regions at the end of the chromosome—the telomeres. In this picture the telomeres are not drawn to scale, because they make up less than one-ten-thousandth of the total DNA of our cells. They are a small but vitally important part of the chromosome.

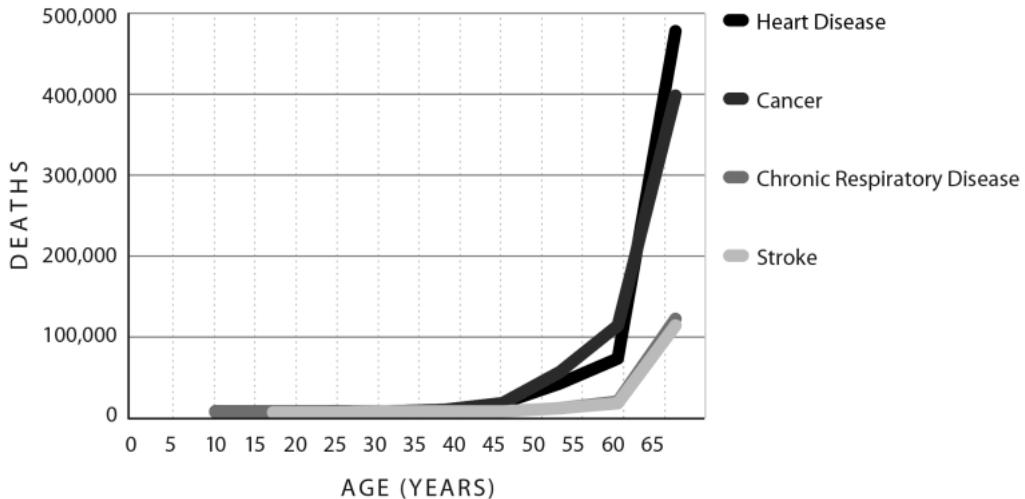


Figure 3: Aging and Disease. Age is by far the largest determinant of chronic diseases. This graph shows the frequency of death by age, up to age sixty-five and older, for the top four causes of death by disease (heart disease, cancer, respiratory disease, and stroke and other cerebrovascular diseases). The death rate due to chronic diseases starts to increase after age forty and goes up dramatically after age sixty. Adapted from U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, “Ten Leading Causes of Death and Injury,” <http://www.cdc.gov/injury/wisqars/leadingCauses.html>.

Here's a typical trajectory for the life of a human's telomere:

Age	Telomere Length (in base pairs)
Newborn baby	10,000 base pairs
35 years old	7,500 base pairs
65 years old	4,800 base pairs

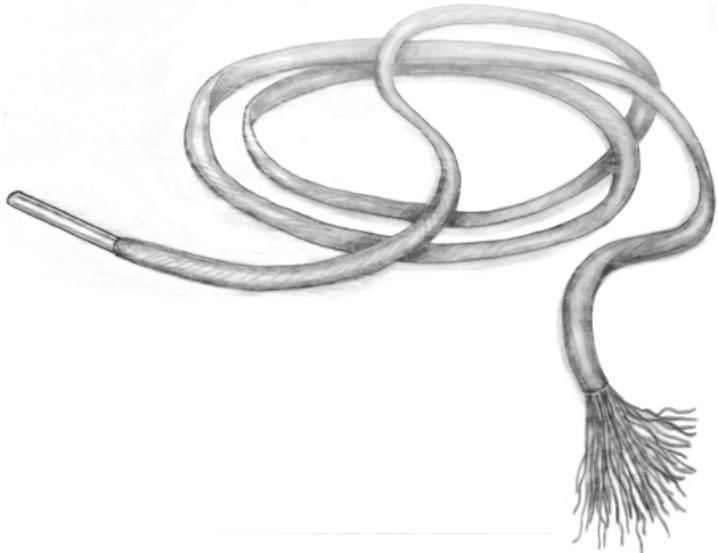


Figure 4: Think of Your Shoelaces. Shoelace tips are a metaphor for telomeres. The longer the protective aglets at the ends of the laces, the less likely the shoelace will fray. In terms of chromosomes, the longer the telomeres, the less likely there will be any alarms going off in cells or fusions of chromosomes. Fusions trigger chromosome instability and DNA breakage, which are catastrophic events for the cell.

PART I

TELOMERES: A PATHWAY TO LIVING YOUNGER

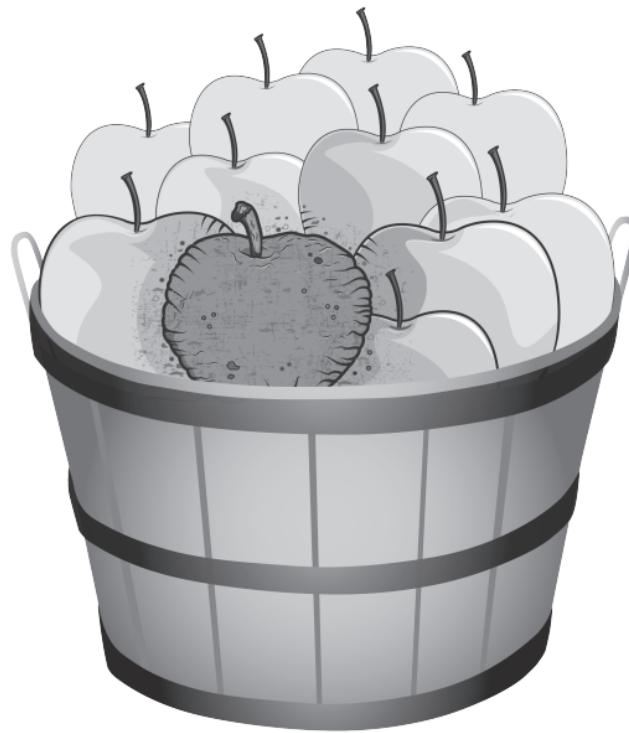


Figure 5: A Rotten Apple in an Apple Barrel. Think of a barrel of apples. An apple barrel's health depends on each apple. One rotten apple sends out gases that rot the other apples. One senescent cell sends signals to surrounding cells, promoting inflammation and factors that promote what we might call "cell rot."

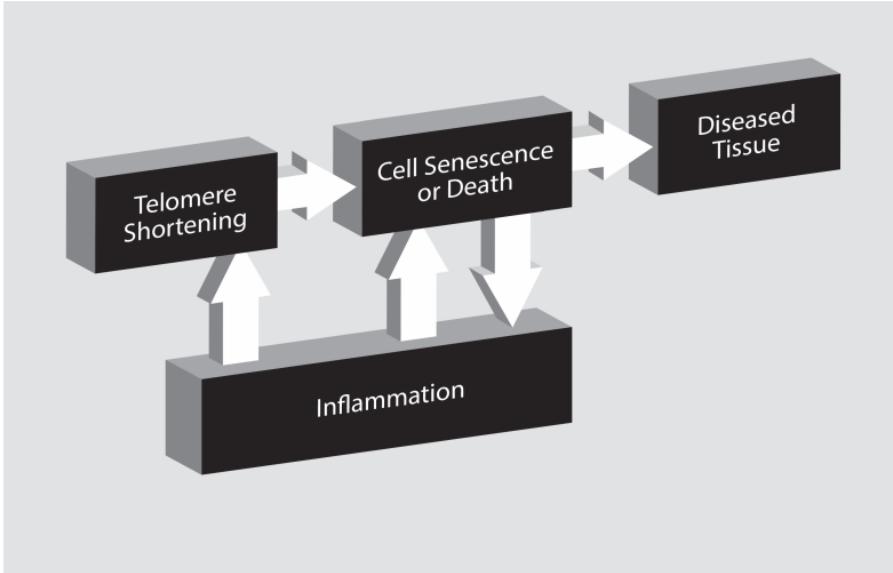


Figure 6: A Path from Short Telomeres to Disease. One early pathway to disease is telomere shortening. Shortened telomeres lead to senescent cells that either stick around or—if we are lucky—are removed from the scene early. While there are many factors that can cause senescence, telomere damage is a common one in humans. When the old senescent cells build up over decades to a critical mass, they become the foundation for diseased tissue. Inflammation is a cause of both telomere shortening and senescent cells, and senescent cells in turn create more inflammation.

How Prematurely Aging Cells Make You Look, Feel, and Act Old

What's Your Image of Aging?	
grumpy	optimistic
dependent	capable
slow	full of vitality
frail	self-reliant
lonely	strong will to live
confused	wise
nostalgic	emotionally complex
distrustful	close relationships
bitter	loving

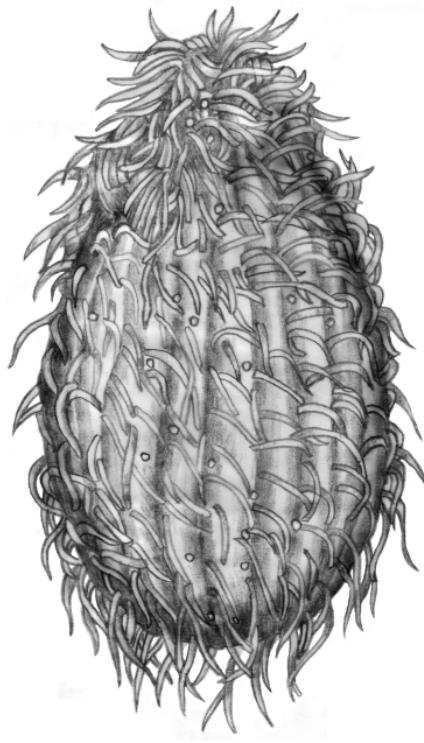


Figure 7: *Tetrahymena*. This tiny one-celled creature, which Liz studied to decode the DNA structure of telomeres and to discover telomerase, provided the first precious information about telomeres, telomerase, and a cell's life span. This foreshadowed what was later learned in humans.



Figure 8: Telomere Strands Up Close. At the tips of the chromosome are the telomeres. The telomere strand is made up of repeating sequences of TTAGGG that sit across from their base pair partners, AATCCC. The more of these sequences we have, the longer our telomeres. In this diagram we depict just the DNA of telomeres, but it is not bare like this—it is covered by a protective sheath of proteins.

TELOMERES: A PATHWAY TO LIVING YOUNGER



Figure 9: Telomeres Shorten with Age. Telomere length declines with age, on average. It declines fastest during early childhood and then has a slower average rate of decline with age. Interestingly, many studies find telomere length is not shorter in those who live to be a lot older than seventy years. This is thought to be due to “survival bias,” meaning that those still alive at this age tended to have been those people with longer telomeres. Their telomeres probably had been longer all along, starting from birth.

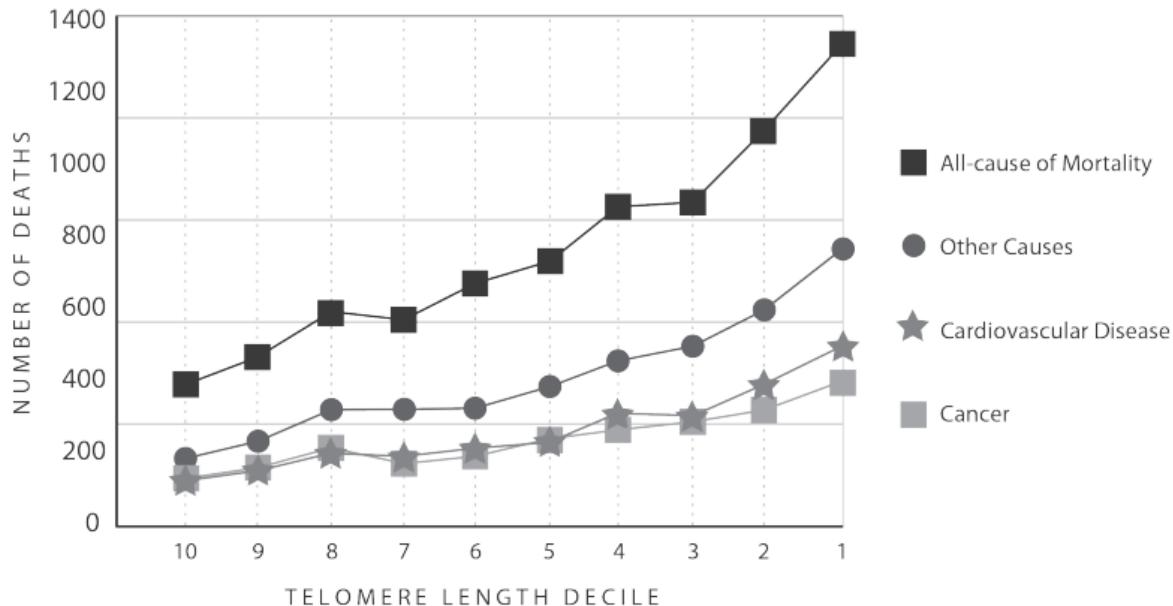
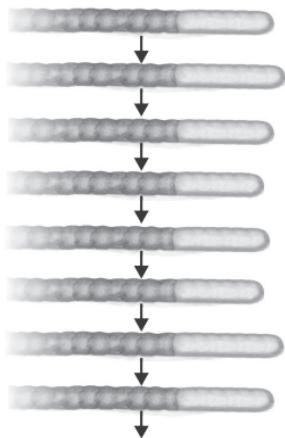


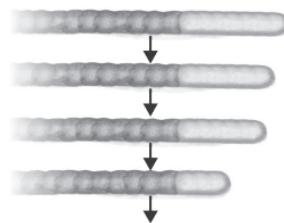
Figure 10: Telomeres and Death. Telomere length predicts mortality overall, and from different diseases. Those with the longest telomeres (90th percentile) have the lowest rate of death from cancers, heart disease, and all causes added up. (Figure is from the data in Rode et al., 2015.³)

Abundant Telomerase as Cell Divides



Cells Keep Dividing

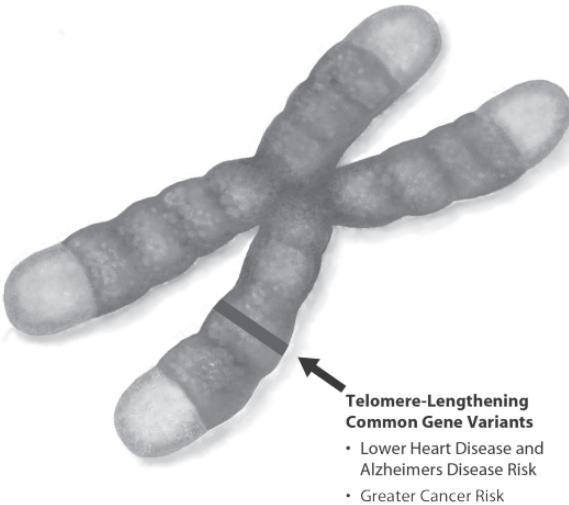
Insufficient Telomerase as Cell Divides



Cell Division Stops Prematurely

Figure 11: Consequences of Enough, or Not Enough, Telomerase Action.

Telomere DNA shortens because the enzymes to duplicate the DNA don't work at the telomere ends (incomplete DNA replication). Telomerase elongates telomeres and thus counterbalances the inexorable attrition of telomeric DNA. With abundant telomerase, telomeres are maintained and cells can keep dividing. With insufficient telomerase (due to genetics, lifestyle, or other causes) telomeres shorten rapidly, cells stop dividing, and senescence soon follows.



**Telomere-Lengthening
Common Gene Variants**

- Lower Heart Disease and Alzheimers Disease Risk
- Greater Cancer Risk

Figure 12: Telomere-Related Genes and Disease. Telomere maintenance genes can protect us from common diseases, but can put us at risk for some cancers. Having gene variants for more telomerase and telomere proteins means longer telomeres. This natural genetic way of making telomeres longer lowers risks for most diseases of aging, including heart disease and Alzheimer's disease, but the high telomerase also means that cells that are prone to become cancerous can keep dividing unchecked, causing a greater risk for certain types of cancer (brain cancers, melanoma, and lung cancers). Bigger isn't always better!

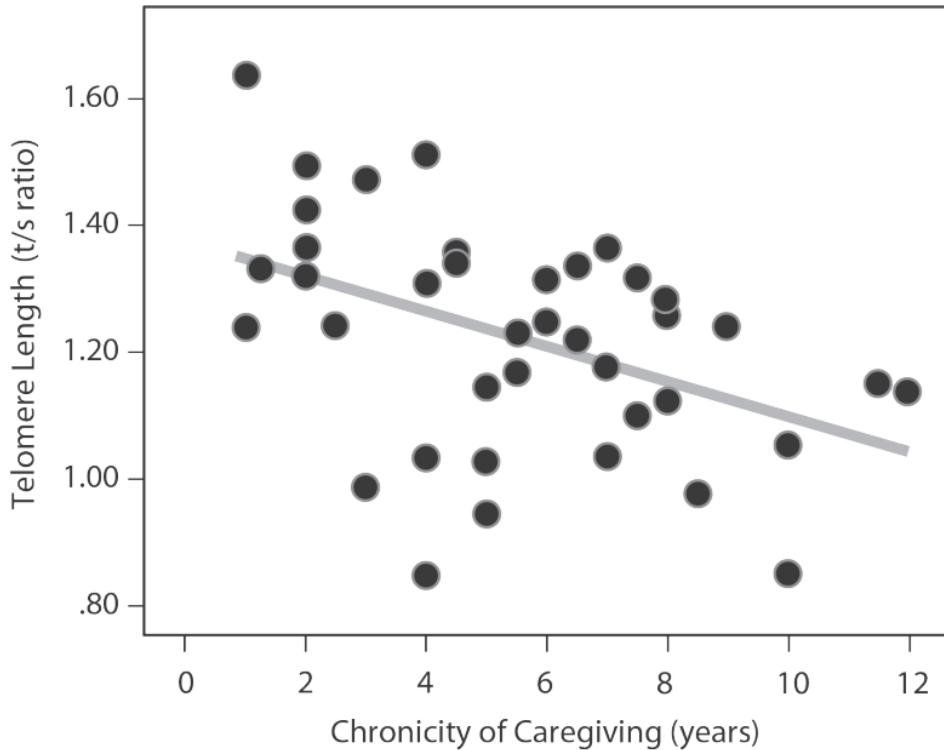


Figure 13: Telomere Length and Chronic Stress. The more years since the child had been diagnosed (thus the more years of chronic stress), the shorter the telomeres.²

PART II

YOUR CELLS ARE
LISTENING TO YOUR
THOUGHTS

ASSESSMENT: Your Stress Response Style Revealed

Part Two, “Your Cells Are Listening to Your Thoughts,” offers insights into how you experience stress and how you can shift that experience to be healthier for your telomeres and more beneficial in your daily life. To get you started, here’s a quick self-test. It assesses your underlying sources of stress reactivity and stress resilience, some of which have been linked to telomere length.

Think of a situation that bothers you a great deal and that is ongoing in your life. (If you cannot think of a current situation, think of your most recent difficult problem.) Circle your numerical response to each question.

1. When you think about dealing with this situation, how much do you feel hope and confidence vs. feelings of fear and anxiety?	0 hopeful, confident	1 same amount of each	2	3	4 fearful, anxious
2. Do you feel you have whatever it takes to cope effectively with this situation?	4 not at all	3 somewhat	2	1	0 extremely
3. How much are you caught up in repetitive thoughts about this situation?	0 not at all	1 somewhat	2	3	4 extremely
4. How much do you avoid thinking about the situation or try not to express negative emotions?	0 not at all	1 somewhat	2	3	4 extremely
5. How much does this situation make you feel bad about yourself?	0 not at all	1 somewhat	2	3	4 extremely
6. How much do you think about this situation in a positive way, seeing some good that could come from it, or telling yourself statements that feel comforting or helpful, such as that you are doing the best you can?	4 not at all	3 somewhat	2	1	0 extremely
TOTAL SCORE (Add up the numbers; notice questions 2 and 6 are positive responses so the scale is reversed.)					

YOUR CELLS ARE LISTENING TO YOUR THOUGHTS

The point of this informal test is to raise awareness of your own tendencies to respond in a certain way to chronic stress. It is not a diagnostic scale. Also know that if you're dealing with a severe situation, your response style score will naturally shift to be higher. This is not a pure measure of response style, because our situations and our responses inevitably get a bit mixed together.

Total score of 11 or under: Your stress style tends to be healthy. Instead of feeling threatened by stress, you tend to feel challenged by it, and you limit the degree to which the situation spills over into the rest of your life. You recover quickly after an event. This stress resilience is positive news for your telomeres.

Total score of 12 or over: You're like most of us. When you're in a stressful situation, the power of that threat is magnified by your own habits of thinking. Those habits are linked, either directly or indirectly, to shorter telomeres. We'll show you how to change those habits or soften their effects.

★ ★ ★

Here's a closer look at the habits of mind associated with each question:

Questions 1 and 2: These questions gauge how threatened you feel by stress. High fear combined with low coping resources turn on a strong hormonal and inflammatory stress response. **Threat stress** involves a set of mental and physiological responses that can, over time, endanger your telomeres. Fortunately, there are ways to convert threat stress into a feeling of challenge, which is healthier and more productive.

Question 3: This item assesses your level of **rumination**. Rumination is a loop of repetitive, unproductive thoughts about something that's bothering you. If you're not sure how often you ruminate, now you can start to notice. Most stress triggers are short-lived, but we humans have the remarkable ability to give them a vivid and extended life in the mind, letting them fill our headspace

long after the event has passed. Rumination, also known as brooding, can slip into a more serious state known as depressive rumination, which includes negative thoughts about oneself and one's future. Those thoughts can be toxic.

Question 4: This one's about **avoidance and emotion suppression**. Do you avoid thinking about the stressful situation or avoid sharing feelings about it? Is it so emotionally loaded that the thought of it makes your stomach clench? It's natural to try to push difficult feelings away, and although this strategy may work in the short term, it doesn't tend to help when the situation is chronic.

Question 5: This question addresses "**ego threat**." Does it feel as if your pride and personal identity could be damaged if the stressful situation doesn't go well? Does the stress trigger negative thoughts about yourself, even to the extent that you feel worthless? It's normal to have these self-critical thoughts sometimes, but when they are frequent, they throw the body into an overly sensitive, reactive state characterized by high levels of the stress hormone cortisol.

Question 6: This question asks whether you're able to engage in **positive reappraisal**, which is the ability to rethink stressful situations in a positive light. Positive reappraisal lets you take a less than ideal situation and turn it to your benefit or at least take the sting out of it. This question also measures whether you tend to offer yourself some healthy **self-compassion**.

If the assessment revealed that you struggle with your stress responses, take heart. It's not always possible to change your automatic response, but most of us can learn to change our responses *to our responses*—and that's the secret sauce of **stress resilience**. Now let's get to work understanding how stress affects your telomeres and cells, and how you can make changes that will help protect them.

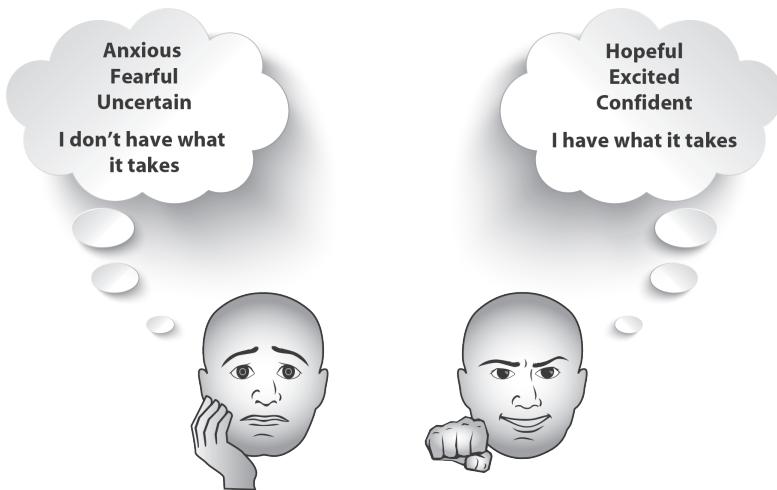


Figure 14: Threat versus Challenge Responses. People tend to have many thoughts and feelings when facing a stressful situation. Here are two different types of responses: One is characterized by feeling threatened, by a fear of losing, or possibly being shamed. The other is characterized by feeling challenged and confident about achieving a positive outcome.

and shame as you anticipate a bad outcome. A predominant habitual threat response can, over time, work itself into your cells and grind down your telomeres. A predominant challenge response, though, may help shield your telomeres from some of the worst effects of chronic stress.

People don't generally show responses that are *all* threat or *all* challenge. Most experience some of both. In one study, we found that it was the proportion of these responses that mattered most for telomere health. The volunteers who felt more threat than challenge had shorter telomeres. Those who saw the stressful task as more of a challenge than a threat had longer telomeres.¹⁰

What does this mean for you? It means you have reason to be hopeful. We do not mean to trivialize or underestimate the potential that very tough, difficult, or intractable situations have for harm

YOUR CELLS ARE LISTENING TO YOUR THOUGHTS

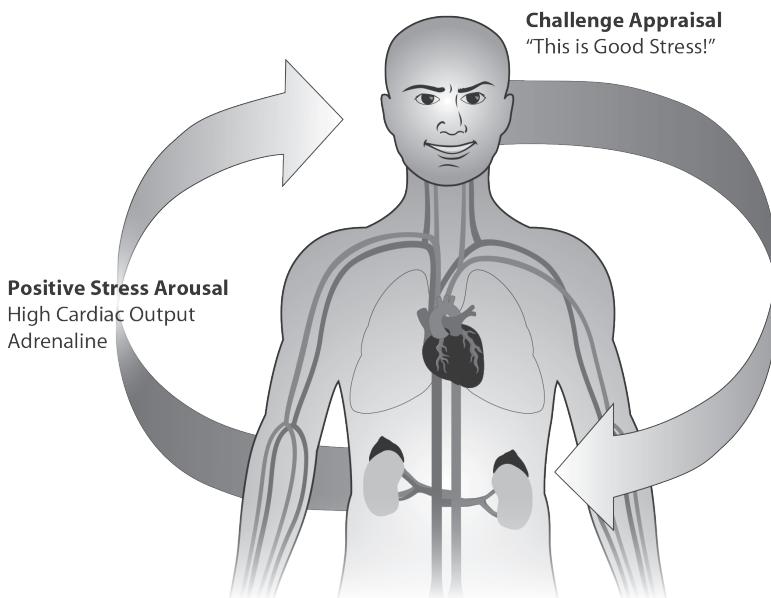


Figure 15: Positive Stress (Challenge Stress) Energizes. Our body automatically reacts to a stressful event within seconds and also reacts to our thoughts about the event. When we start to notice the stress response in our muscle tension, heart rate, and breathing, we can relabel it by saying, “This is good stress, energizing me so I can perform well!” This can help shape the body’s response to be more energizing, bringing more dilation to the vessels and more blood to the brain.

to your telomeres. But when you can’t control the difficult or stressful events in your life, you can still help protect your telomeres by shifting the way you view those events.

WHY DO SOME PEOPLE FEEL MORE THREAT THAN OTHERS?

Reflect on incidents in your life that have been difficult. Ask yourself: Do you tend to respond by feeling more threatened or challenged? Do you borrow trouble, feeling anticipatory threat about events that haven’t happened yet—and that may not ever happen?

ASSESSMENT: How Does Your Personality Influence Your Stress Responses?

Some personality traits can lead to bigger stress responses. To determine whether your personality could affect how your mind responds when stress comes your way, take the assessment below. Whatever you learn about your personality, celebrate it. Personality is the spice of life, and knowledge about it is power. There is no right or wrong way to be. The point is to know yourself and be aware of your tendencies, not to change your personality. In fact, personality cannot change easily. It tends to be stable. Both genetics and life experiences have shaped our temperament. The more we are aware of our general tendencies, the more we can notice and live better with our natural habits of reacting to stress. And that can help us improve our telomere health.

A note to the skeptical: Some magazines or books contain personality assessments that are made up. They're fun, but they're not necessarily accurate. The personality assessments here include the actual measures used in research, reprinted with permission. (The hostility questions are an exception because those questions aren't available for public use. We've done our best to write our own questions that we feel will give you a good sense of your hostility level.) They're validated, meaning that they have been tested to see if they really measure the personality trait in question. (Note: These are shorter versions, but longer versions, those that include more questions, are more reliable.)

Instructions: For each question, circle the number that best

YOUR CELLS ARE LISTENING TO YOUR THOUGHTS

describes how much you agree or disagree with the statement. As you take the assessments, pay attention to the words rather than the numbers. There are no right or wrong answers. Be as honest as you can.

WHAT'S YOUR THINKING STYLE?

How Pessimistic Are You?

1. I hardly ever expect things to go my way.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
2. I rarely count on good things happening to me.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
3. If something can go wrong for me, it will.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
TOTAL SCORE					

Now, calculate your total score by adding up the numbers you circled for each question.

- If you scored between 0 and 3, you are **low** in pessimism.
- If you scored between 4 and 5, you are **average** in pessimism.
- If you scored 6 or above, you are **high** in pessimism.

How Optimistic Are You?

1. In uncertain times, I usually expect the best.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
2. I'm always optimistic about my future.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree

Assessment: How Does Your Personality Influence Your Stress Responses?

3. Overall, I expect more good things to happen to me than bad.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
TOTAL SCORE					

Now, calculate your total score by adding up the numbers you circled for each question.

- If you scored between 0 and 7, you are **low** in optimism.
- If you scored 8, you are **average** in optimism.
- If you scored 9 and above, you are **high** in optimism.

How Hostile Are You?

1. I usually know more than people I have to listen to or follow.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
2. Most people cannot be trusted.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
3. I am easily annoyed or irritated by other people's habits.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
4. I get angry at other people easily.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
5. I can be harsh or rough to people who are disrespectful or annoying.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
TOTAL SCORE					

Now, calculate your total score by adding up the numbers you circled for each question.

YOUR CELLS ARE LISTENING TO YOUR THOUGHTS

- If you scored between 0 and 7, you are **low** in hostility.
- If you scored between 8 and 17, you are **average** in hostility.
- If you scored 18 and above, you are **high** in hostility.

How Much Do You Ruminate?

	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
1. My attention is often focused on aspects of myself I wish I'd stop thinking about.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
2. Sometimes it is hard for me to shut off thoughts about myself.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
3. I tend to ruminate or dwell on things that happen to me for a really long time afterward.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
4. I don't waste time rethinking things that are over and done with.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
5. I never ruminate or dwell on thoughts about myself for very long.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
6. It is hard for me to put unwanted thoughts out of my mind.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
7. I often reflect on episodes in my life that I should no longer concern myself with.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
8. I spend a great deal of time thinking back over my embarrassing or disappointing moments.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
TOTAL SCORE					

Now, calculate your total score by adding up the numbers you circled for each question (be extra careful when adding your scores for questions 4 and 5—the numbers are reversed).

Assessment: How Does Your Personality Influence Your Stress Responses?

- If you scored between 0 and 24, you are **low** in rumination.
- If you scored between 25 and 29, you are **average** in rumination.
- If you scored 30 and above, you are **high** in rumination.

How Conscientious Are You?

I see myself as someone who . . .

1. Does a thorough job.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
2. Can be somewhat careless.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
3. Is a reliable worker.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
4. Tends to be disorganized.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
5. Tends to be lazy.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
6. Perseveres until the task is finished.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
7. Does things efficiently.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
8. Makes plans and follows through with them.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
9. Is easily distracted.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
TOTAL SCORE					

YOUR CELLS ARE LISTENING TO YOUR THOUGHTS

Now, calculate your total score by adding up the numbers you circled for each question (be extra careful when adding your scores for questions 2, 4, 5, and 9—the numbers are reversed).

- If you scored between 0 and 28, you are **low** in conscientiousness.
- If you scored between 29 and 34, you are **average** in conscientiousness.
- If you scored 35 and above, you are **high** in conscientiousness.

How Much Purpose in Life Do You Feel?

1. There is not enough purpose in my life.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
2. To me, the things I do are all worthwhile.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
3. Most of what I do seems trivial and unimportant to me.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
4. I value my activities a lot.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
5. I don't care very much about the things I do.	0 Strongly Agree	1 Agree	2 Neutral	3 Disagree	4 Strongly Disagree
6. I have lots of reasons for living.	4 Strongly Agree	3 Agree	2 Neutral	1 Disagree	0 Strongly Disagree
TOTAL SCORE					

Now, calculate your total score by adding up the numbers you circled for each question (be extra careful when adding your scores for questions 1, 3, and 5—the numbers are reversed).

- If you scored between 0 and 16, you are **low** in life purpose.

- If you scored between 17 and 20, you are **average** in life purpose.
- If you scored 21 and above, you are **high** in life purpose.

SELF-ASSESSMENT SCORING AND INTERPRETATION

This assessment is simply meant to raise your awareness of your personal style. It is not meant to diagnose you or make you feel bad about being a certain way. Self-awareness of tendencies that make us more vulnerable to stress reactivity (and possibly telomere shortening, in several studies) is valuable! Awareness can help us notice unhealthy thought patterns and choose different responses. It can also help us know and accept our tendencies. As Aristotle reportedly said, “Knowing yourself is the beginning of all wisdom.”

Dimensions that make us more vulnerable to stress	Score (Circle)		
	High	Medium	Low
Pessimism	High	Medium	Low
Hostility	High	Medium	Low
Rumination	High	Medium	Low

Dimensions that may help us be more stress resilient	Score (Circle)		
	High	Medium	Low
Optimism	High	Medium	Low
Conscientiousness	High	Medium	Low
Purpose in Life	High	Medium	Low

HOW DID WE DECIDE WHAT DETERMINES HIGH OR LOW SCORES?

In general, we determined the high, medium, and low score categories by looking at the data from large representative samples of people who have taken the test. We divided the population into thirds based on their scores. If you are in the top third (33 percent)

YOUR CELLS ARE LISTENING TO YOUR THOUGHTS

of scores, you scored “high.” If you are in the bottom third (33 percent) of scores, you scored “low.” If you are in the middle, you scored “average.” The actual studies used are described below.

The cutoff points should not be taken too literally. First of all, the comparisons are made to some large samples, but any one sample is never representative of everyone. There are always differences in how people score based on their race/ethnicity, sex, culture, and even age, that we could not take into account. Second, we assumed that there is a statistically “normal distribution” for scores for each measure, which means the same number of people score high as low, in the same symmetrical distribution pattern. In reality, few measures have scores that are perfectly normally distributed. Therefore, our cutoff points are not statistically perfect, nor are they perfectly accurate when applied to individuals.

THE PERSONALITY TYPES AND SCALES USED IN THIS ASSESSMENT

Optimism/Pessimism

Optimism is the tendency to expect or anticipate positive events and outcomes rather than negative ones. Optimism is characterized by a sense of hope and positivity about the future. **Pessimism** is the tendency to expect or anticipate negative events and outcomes rather than positive ones. Pessimism is characterized by a lack of hope and positivity about the future.

We used the “Life Orientation Test—Revised” (LOT-R) developed by Professors Charles Carver and Michael Scheier.⁴² Optimism and pessimism are strongly related, but not totally overlapping, which means they are different aspects of personality. So it is helpful to examine them separately.⁴³ Two studies assessed the relationship with telomere length,

and both found correlations with pessimism but not optimism.⁴⁴ That is not to say that optimism doesn't matter for health. It absolutely does, especially for mental health. It's just that with stress-related health outcomes, negative traits are often stronger predictors than positive traits, and they are more directly tied to stress physiology. Positive traits can buffer you from stress, and are weakly related to positive restorative physiology.

For scoring, we used the average levels on each LOT-R subscale from a study that tested over two thousand men and women who varied in age, gender, race, ethnicity, level of education, and socio-economic class.⁴⁵

Hostility

Hostility is thought to have cognitive, emotional, and behavioral manifestations.⁴⁶ The cognitive component, possibly the most important part of hostility, is characterized by negative attitudes toward others, colored by cynicism and mistrust. The emotional component ranges from irritation to anger to rage. The behavioral component is the tendency to act out verbally or physically in ways that could hurt others.

Hostility scales are not free to the public, so this scale includes items we created that should roughly measure hostility in the same way as the standardized research scales, particularly the most common one, the Cook-Medley Hostility Questionnaire, which is part of the MMPI Personality measure. We estimated the cutoffs based on the mean scores from a study of men from the Whitehall study, which used a short version of the Cook-Medley Hostility Questionnaire. This study found high hostility is related to shorter telomeres in men.⁴⁷

Rumination

Rumination is “self-attentiveness motivated by perceived threats, losses, or injustices to the self.”⁴⁸ In other words, rumination is one’s

YOUR CELLS ARE LISTENING TO YOUR THOUGHTS

tendency to spend a significant amount of time thinking about and perseverating on past negative events in one's life and one's role.

We used the eight-item rumination subscale from the “Rumination-Reflection Questionnaire,” developed by Professor Paul Trapnell.⁴⁹ To determine cutoffs, we used the item mean for the eight-item version.⁵⁰ While no studies have directly linked rumination to telomere length, we think it is an important part of the stress process. That’s because it keeps stress alive in the mind and body long after the event has passed. In our daily diary study of caregivers, we have found that daily rumination is associated with lower telomerase.

Conscientiousness

Conscientiousness is the measure of the degree to which a person is organized, how careful a person is in certain situations, and how disciplined he or she tends to be.

We used the conscientiousness subscale from the “Big Five Inventory” developed by Professors Oliver John and Sanjay Srivastava.⁵¹ This scale was used in a study that found a positive correlation between higher conscientiousness and longer telomeres.⁵² For scoring, we used means from a large study that examined conscientiousness scores across ages.⁵³

Purpose in Life

Purpose in life is not a typical personality dimension, but rather how much we are aware of having some explicit purpose or goal for our life. It is something that can change based on life experiences and personal growth. An individual who scores high on the **Purpose in Life** scale is characterized as having a strong sense of meaning in life, having aims and engaging in activities one strongly values, or having an outlook that gives life meaning.⁵⁴

We used the “Life Engagement Test,” a six-item scale developed by Professor Michael Scheier and colleagues.⁵⁵ For scoring, we used normative data from a study of 545 older adults (adjusted to a 0-to-3

Assessment: How Does Your Personality Influence Your Stress Responses?

scale).⁵⁶ No studies have directly linked purpose in life to telomere length. However, in a meditation retreat study, increased purpose in life was associated with higher telomerase. As reviewed in the previous chapter, purpose in life is linked to better health behaviors, physiological health, and stress resiliency.

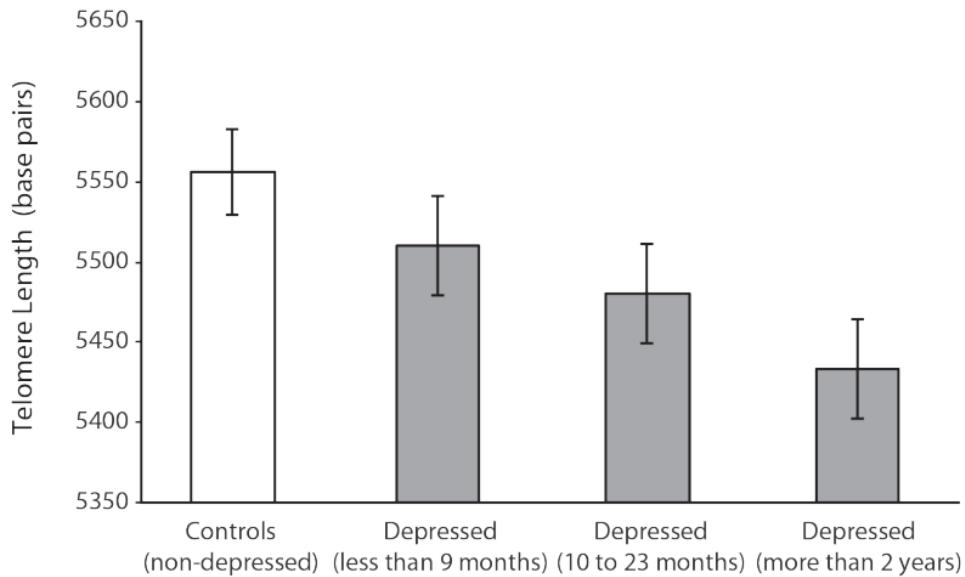


Figure 16: Duration of Depression Matters. The Netherlands Study of Depression and Anxiety has followed almost three thousand people, including those with depression and nondepressed controls. Josine Verhoeven and Brenda Penninx found those with current depression lasting less than ten months did not have significantly shorter telomeres than controls, but those with depression for more than ten months did.

Doing Mode Versus Being Mode¹⁶

	Doing Mode (Automatic)	Being Mode
Where is your attention?	Not noticing what you are doing.	Paying attention to the moment.
What time period are you living in?	Past or future	Now
What are you thinking about?	Absorbed in stressful ideas Thinking about where I wish I was, not where I am right now. Nothing feels satisfactory.	Absorbed in current experience Able to fully taste, smell, touch, and feel. Able to fully connect with others. Radical acceptance of self, unconditional kindness.
Level of metacognition (thoughts about thoughts)	Believe thoughts are true Cannot observe the mind's workings. Mood is controlled by thoughts.	Freedom from believing the thoughts Understand the transient nature of thoughts, can observe thoughts as they come and go. Can tolerate unpleasantness.

PART III

HELP YOUR BODY PROTECT ITS CELLS

ASSESSMENT: What's Your Telomere Trajectory? Protective and Risky Factors

Next we are going to focus on the body—activity, sleep, eating. But before reading further, you are probably wondering how your telomeres are doing, and how you can find out. We pause here for a mini-assessment. We have telomeres in every cell of our body, in our different tissues, organs, and blood. They are correlated loosely—if we have short telomeres in our blood, we tend to have short telomeres in other tissues. A few commercial labs offer tests that measure the length of telomeres in your blood, but for individuals the usefulness of this is limited (see “Information about Commercial Telomere Tests” on page 333 and our website for a discussion of blood measures). It is more useful to assess the factors that are known to protect or damage telomeres and then, with the results of the assessment in mind, try to shift aspects of our daily lives so that our telomeres are more protected. That leads us to the Telomere Trajectory Assessment.

TELOMERE TRAJECTORY ASSESSMENT

You can assess the personal wellbeing and lifestyle factors that we know are related to telomere length. This assessment takes around ten minutes to complete and will help you identify the main areas you may want to improve.

When possible, we reprinted the actual scales used in the research

HELP YOUR BODY PROTECT ITS CELLS

described in this book. Research details for each scale are described after each section.

You will be asked about these areas:

Your Wellbeing

- current major stressful exposures
- clinical levels of emotional distress (depression or anxiety)
- social support

Your Lifestyle

- exercise and sleep
- nutrition
- chemical exposures

Do You Have Any Severe Stress Exposures?

Enter “1” next to any statements that apply to you and “0” next to any statements that don’t apply. The situations must be ongoing for at least several months for a score of 1.

Are you experiencing severe ongoing job stress, where you feel emotionally exhausted, burned out, cynical about your work, and fatigued, even when you wake up?	
Are you serving as a full-time caregiver for an ill or disabled family member and feeling overwhelmed by it?	
Do you live in a dangerous neighborhood and regularly feel unsafe?	
Are you experiencing severe extreme stress almost every day due to some chronic situation or a recent traumatic event?	
TOTAL SCORE	

Calculate your score by adding up your TOTAL SCORE (sum of items 1–4): _____

Circle the telomere points below that relate to your score.

Severe Stress Exposure Score	Telomere points (Circle)
If you scored 0, you have low risk .	2
If you scored 1, you have some risk .	1
If you scored 2 or higher, you have high risk .	0

Explanation: This Severe Stress Exposure Checklist is not a standardized scale. Instead, it measures whether you are experiencing an extreme situation that has been linked to shorter telomeres. For example, work-related emotional exhaustion,¹ being a caregiver for a family member with dementia,² and regularly feeling unsafe where you live³ are related to shorter telomeres in at least one study, after controlling for factors such as BMI, smoking, and age. Any severe event has the potential to contribute to telomere shortening, if it occurs over years. Exposure alone is not a determinant—your response is important, too, as we discuss in chapter 4. Last, having one situation may be manageable, but having more than one severe chronic situation is more likely to exhaust one's coping resources. Multiple severe chronic situations are categorized here as a higher risk.

Any Mood Disorders?

Have you been currently diagnosed with depression or an anxiety disorder (such as posttraumatic stress disorder or generalized anxiety)?

Circle the telomere points below that relate to your score:

Clinical Distress Score	Telomere Score (Circle)
If you do not have a diagnosable condition, you are at low risk .	2
If you have been diagnosed with a severe condition, you are at high risk .	0

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Explanation: From various studies, it appears the symptoms of moderate distress alone are not related to shorter telomeres, but actual diagnoses—which means symptoms that are severe enough to interfere with your daily life—are related.⁴

How Much Social Support Do You Have?

Answer the following questions about social support you typically receive from significant others, family, friends, and community members.

1. Is there someone available to give you good advice about a problem?	1 None of the time	2 A little of the time	3 Some of the time	4 Most of the time	5 All of the time
2. Is there someone available whom you can count on to listen to you when you need to talk?	1 None of the time	2 A little of the time	3 Some of the time	4 Most of the time	5 All of the time
3. Is there someone available to you who shows you love and affection ?	1 None of the time	2 A little of the time	3 Some of the time	4 Most of the time	5 All of the time
4. Can you count on anyone to provide you with emotional support (talking over problems or helping you make a difficult decision)?	1 None of the time	2 A little of the time	3 Some of the time	4 Most of the time	5 All of the time
5. Do you have as much contact as you would like with someone you feel close to, someone in whom you can trust and confide in?	1 None of the time	2 A little of the time	3 Some of the time	4 Most of the time	5 All of the time
TOTAL SCORE					

Calculate your score by adding up the numbers you circled for each question.

TOTAL SCORE (sum of items 1–5): _____

Circle the telomere points below that relate to your score.

Social Support Score	Telomere Points (Circle)
If you scored 24 or 25, you are high in social support.	2
If you scored between 19 and 23, you are average in social support.	1
If you scored between 5 and 18, you are low in social support.	0

Explanation: This questionnaire is the five-question version of the ENRICHD Social Support Inventory (ESSI), originally created to assess social support of post-heart attack patients and used in epidemiological studies.⁵ Versions of this questionnaire have been used in studies relating telomere length to social support.⁶

Cutoffs for the social support categories are approximations from data from a large study, and the effects in this study were found in the oldest age group only.⁷ The ENRICHD trial used the score of 18 as a lower cut point to define people who were low on social support.

How Much Physical Activity Do You Do?

During the past month, which statement best describes the kinds of physical activity you usually did?

1. I did not do much physical activity. I mostly did things like watching television, reading, playing cards, or playing computer games, and I took one or two walks.

2. Once or twice a week, I did **light activities** such as getting outdoors on the weekends for an easy walk or stroll.

3. About three times a week, I did **moderate activities** such as brisk walking, swimming, or riding a bike **for about 15–20 minutes each time.**

4. Almost daily (five or more times a week), I did **moderate activities** such as brisk walking, swimming, or riding a bike **for 30 minutes or more each time.**

HELP YOUR BODY PROTECT ITS CELLS

5. About three times a week, I did **vigorous activities** such as running or riding hard on a bike **for 30 minutes or more each time**.

6. Almost daily (five or more times a week), I did **vigorous activities** such as running or riding hard on a bike **for 30 minutes or more each time**.

Circle the telomere points that relate to your score.

Exercise Score	Telomere points (Circle)
If you chose options 4, 5, or 6, you are at low risk .	2
If you chose option 3, you are at average risk .	1
If you chose option 1 or 2, you are at high risk .	0

Explanation: This questionnaire is the Stanford Leisure-Time Activity Categorical Item (L-CAT).⁸ The L-CAT assesses six different levels of physical activity. Scores of 4, 5, or 6 meet the CDC recommendations for aerobic activity (150 minutes of moderate exercise, like brisk walking, or 75 minutes of vigorous exercise like jogging; note the CDC also recommends muscle-strengthening activities at least two days a week). As we explain in chapter 7 (“Training Your Telomeres”), if you are fit and do regular exercise, there doesn’t appear to be an upper limit to its benefits as long as you don’t overdo it during workouts and you give yourself recovery time after big workouts. Think “regular exerciser,” not “weekend warrior.”

People who are more physically active appear to be better buffered from the telomere shortening that occurs due to extreme stress than people who are less active.⁹ Additionally, an intervention showed that exercising forty-five minutes three times a week led to increases in telomerase.¹⁰

What Are Your Sleep Patterns?

During the past month, how would you rate your sleep quality overall?	0 Very good	1 Fairly good	2 Fairly bad	3 Very bad
How many hours of sleep do you get on average each night (not including lying in bed awake)?	0 7 hours or more	1 6 hours	2 5 hours	3 Less than 5 hours

Circle the telomere points that relate to your score.

Sleep Score	Telomere points (Circle)
If you scored a 0 or 1 on both questions, you're at low risk .	2
If you scored a 2 or 3 on one question, you're at some risk .	1
If you scored 2 or 3 on both questions, or you have poorly treated sleep apnea, you have high risk .	0

Explanation: The item on sleep quality is from the Pittsburgh Sleep Quality Index (PSQI), which assesses quality and disturbances of sleep.¹¹ Several studies relating telomere length to sleep have used the PSQI to measure sleep quality.¹² Duration of sleep is also important. If you report sleeping at least six hours per night and describe your sleep as good or very good, you're at low risk. If you report either poor sleep quality or shorter sleep durations, this adds risk. And if you report both poor sleep quality and shorter sleep durations, this is categorized as high risk. Since studies have not tested for an additive effect of both short and poor sleep, we are making an assumption that having both is worse.

If you have sleep apnea and do not treat it nightly, you are also at risk.

HELP YOUR BODY PROTECT ITS CELLS

What Are Your Nutrition Habits?

How often do you have the following? Circle 1 or 0 for each question.

1. Omega-3 supplements, seaweed, or fish that contains high omega-3 oils:	
3 servings or more a week of these products?	1
Less than 3 times a week	0
2. Fruits and vegetables:	
At least daily?	1
Not every day	0
3. Sugared sodas or sweetened beverages (not including when you add your own sugar to coffees or teas, which typically adds up to substantially less sugar than in commercially sweetened drinks):	
At least one 12-ounce drink on most days	0
Not regularly	1
4. Processed meat (sausage, lunch meats, hot dogs, ham, bacon, organ meats):	
Once a week or more	0
Less than once a week	1
5. How much of your diet is whole foods (whole grains, vegetables, eggs, unprocessed meats) versus processed food (packaged or processed with salts and preservatives)?	
Mostly eat whole foods	1
Mostly eat processed foods	0

Add your total points from all five nutrition questions, creating a score between 0 and 5.

TOTAL SCORE (sum of items 1–5): _____

Circle the telomere points that relate to your score.

Telomere Nutrition Score	Telomere points (Circle)
If you scored a 4 or 5, you have excellent protection from diet.	2
If you scored a 2 or 3, you have average risk from diet.	1
If you scored 0 or 1, you have high risk from diet.	0

Explanation: The frequencies were extrapolated from telomere studies.

For omega-3s, food sources are best. If you rely on supplements, try algae-based products instead of fish for sustainability reasons. People with higher blood levels of omega 3 fatty acids (DHA, or docosahexaenoic acid, and EPA, or eicosapentaenoic acid) have slower attrition over time.¹³ Those who ate a half serving of seaweed each day had longer telomeres later in life.¹⁴ An omega-3 supplement study found that dose didn't matter as much as what's absorbed in your blood: Taking either a 1.25 gram or 2.5 gram omega-3 supplement decreased the ratio of omega-6s to omega-3s in the blood at least to some extent for most people, which in turn was associated with an increase in telomere length.¹⁵ It's hard to know how much your body will absorb, but it should be sufficient to have fish several times a week, or take a gram of omega-3 oils a day.

While supplements are also associated with longer telomere length, real foods with antioxidants and vitamins are superior if available (i.e., lots of vegetables and some fruit).

Sugar carbonated beverages are linked to shorter telomeres in three studies,¹⁶ and it is prudent to assume that daily consumption would be a sufficient dose to have an effect, as suggested in one of these studies. Most sweetened beverages have over 10 grams of sugar, typically 20 to 40 grams.

For processed meat, one study showed that those in the highest quartile of the sample—those who ate processed meats once a week (or roughly a small .15 serving a day) had shorter telomeres.¹⁷

How Often Are You Exposed to Chemicals?

Circle either “Yes” or “No” for the following questions.

Do you regularly smoke cigarettes or cigars?	Yes	No
Do you do regular agricultural work with pesticides or herbicides?	Yes	No

HELP YOUR BODY PROTECT ITS CELLS

Do you live in a city with very heavy traffic-related pollution?	Yes	No
Do you work in a job with heavy exposure to chemicals listed on the Telomere Toxins table (see page 266), such as hair dyes, household cleaners, lead or other heavy metal exposure (for example, in a car mechanic's shop)?	Yes	No

If you answered “yes” to one or more of these questions, your score is 2. Circle the telomere points that relate to your score.

Telomere Chemical Exposure Score	Telomere points (Circle)
If you answered all “Nos,” you have low risk from chemical exposures.	2
If you answered “yes” to one of these questions, you have average risk .	1
If you answered “Yes” to two or more, you have high risk .	0

Explanation: Here we listed exposures that have been linked to telomere shortness in at least one study. The exposures include smoking,¹⁸ pesticide exposure,¹⁹ chemical exposures in dyes and cleaners,²⁰ pollution,²¹ lead exposure,²² and exposures in a car mechanic shop.²³

How Did You Score Overall?

Area	Telomere points (Circle)		
WELLBEING:	high risk	average	low risk
Stress Exposures	0	1	2
Clinical emotional distress	0	1	2
Social support	0	1	2
LIFESTYLE:			
Exercise	0	1	2
Sleep	0	1	2
Nutrition	0	1	2
Chemical Exposures	0	1	2
Total Score (range 0 to 14) ——			

How to Understand Your Total Telomere Trajectory

The summary score is a way to show overall risk and protection of your telomere rate of decline. If you have a high score, you likely have great telomere maintenance. Keep up the good work! The most useful way to use this assessment is to focus on individual areas rather than your total score. **If you scored a 2 on any area in the summary grid, you are doing a great job at telomere protection. You are doing more than simply dodging risk. Typically, this score means you are performing protective behaviors every day, engaging in the daily work creating the foundation of a good healthspan.**

If you scored a 0 (high-risk category), you are likely to experience the typical age-related telomere decline, made worse by risk factors, but ones that you hopefully can gain more control over.

Choose an Area to Work On

The best way to use this chart is to notice the areas in which you scored 0, and then decide which will be the easiest for you to change. If you don't have any 0s, choose a category in which you scored a 1. Wherever you begin, **we suggest you choose only one area to work on at a time.** Make a commitment to improve one small thing in this area. Put a reminder of the change you're trying to make on your bedside table, or set a reminder alarm on your phone to go off at a helpful time of day. At the end of Part Three, you will see some tips to get you started on your new goal.

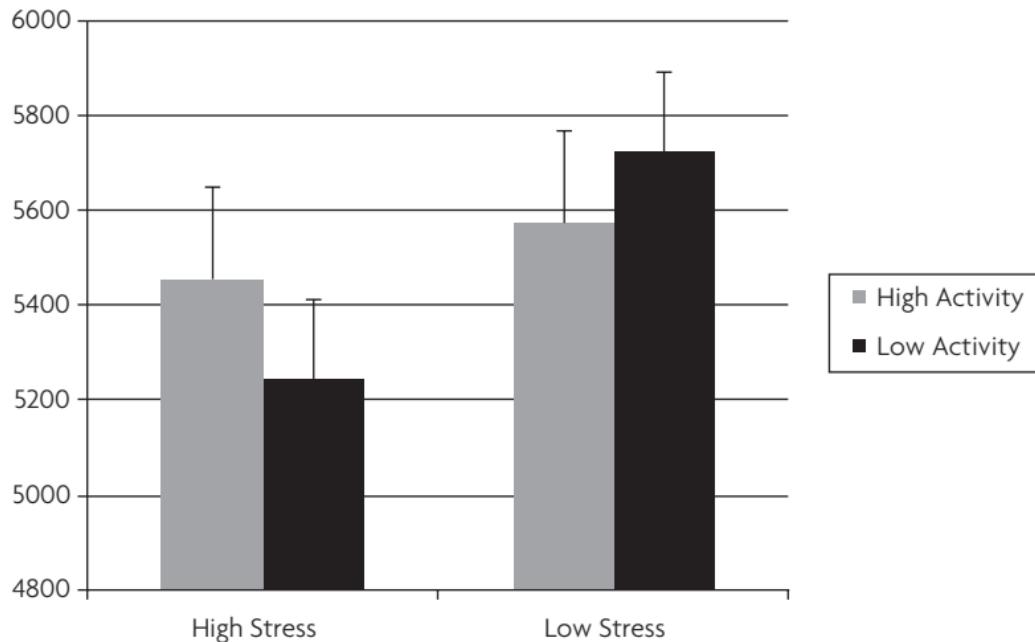


Figure 17: Physical Activity May Buffer Stress-Related Telomere Shortening.

Women high on perceived stress had shorter telomeres, but only if they were relatively sedentary. If they exercised, they did not show the stress-telomere relationship.²² The raw values (unadjusted) for telomere length in base pairs are shown here on the vertical axis.

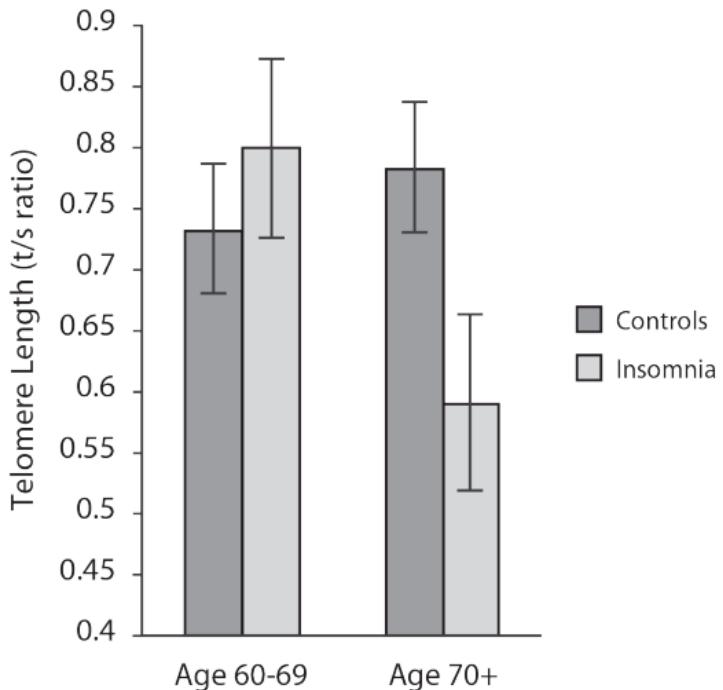


Figure 18: Telomeres and Insomnia. In men and women ages 60 to 88 years old, insomnia was related to shorter telomere length, but only in those 70 years and older. This graph shows the average telomere length from peripheral blood mononuclear cells.

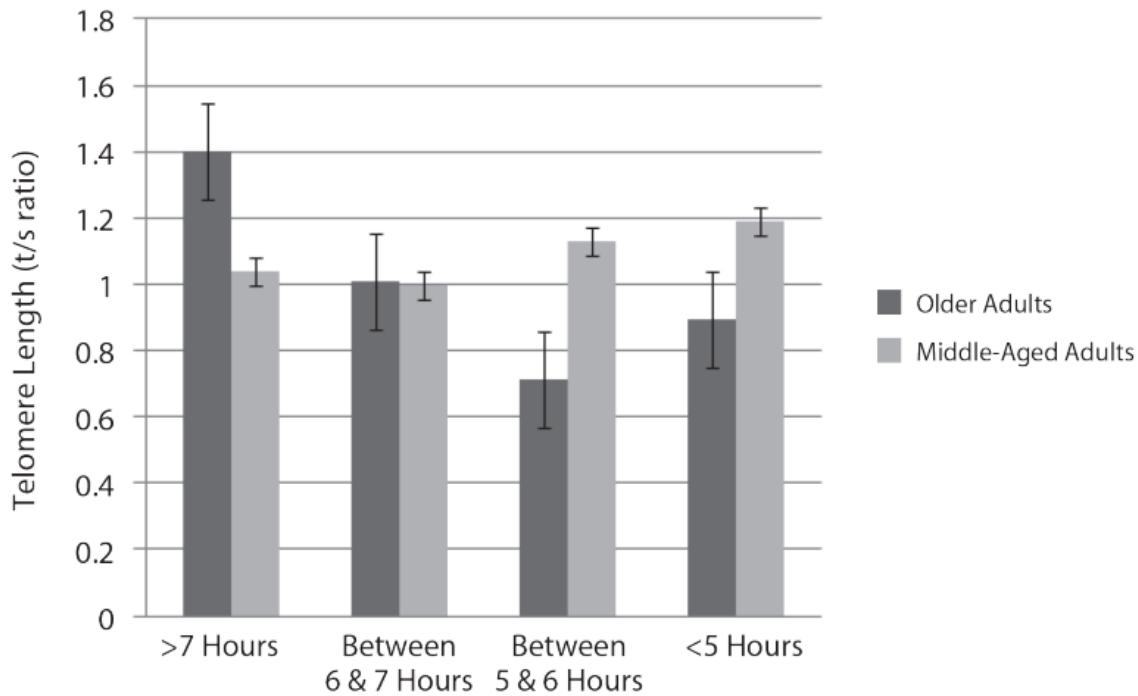
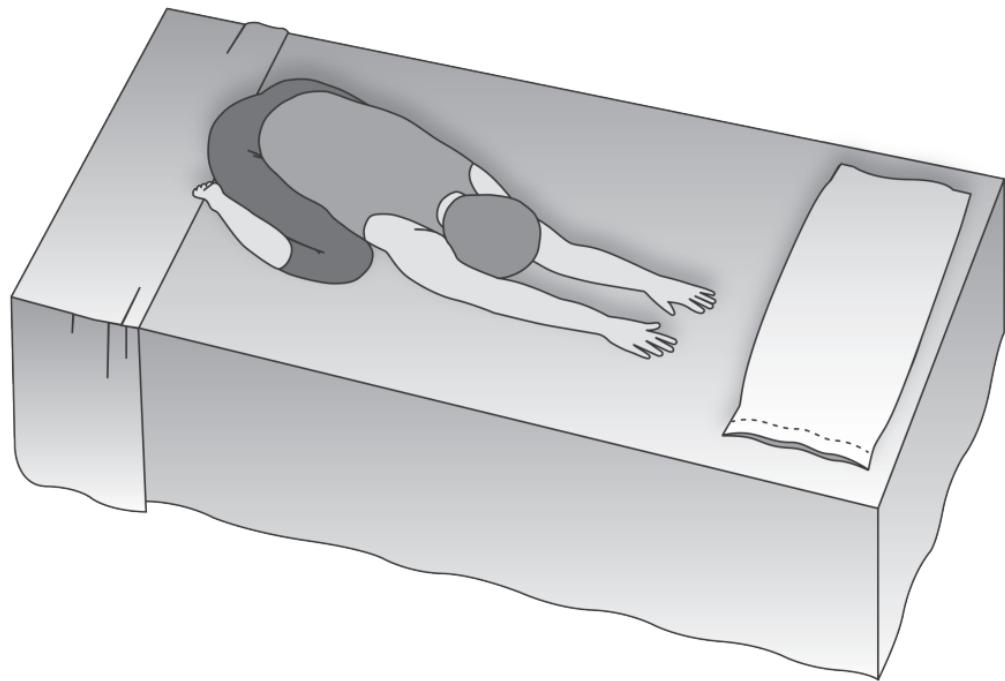
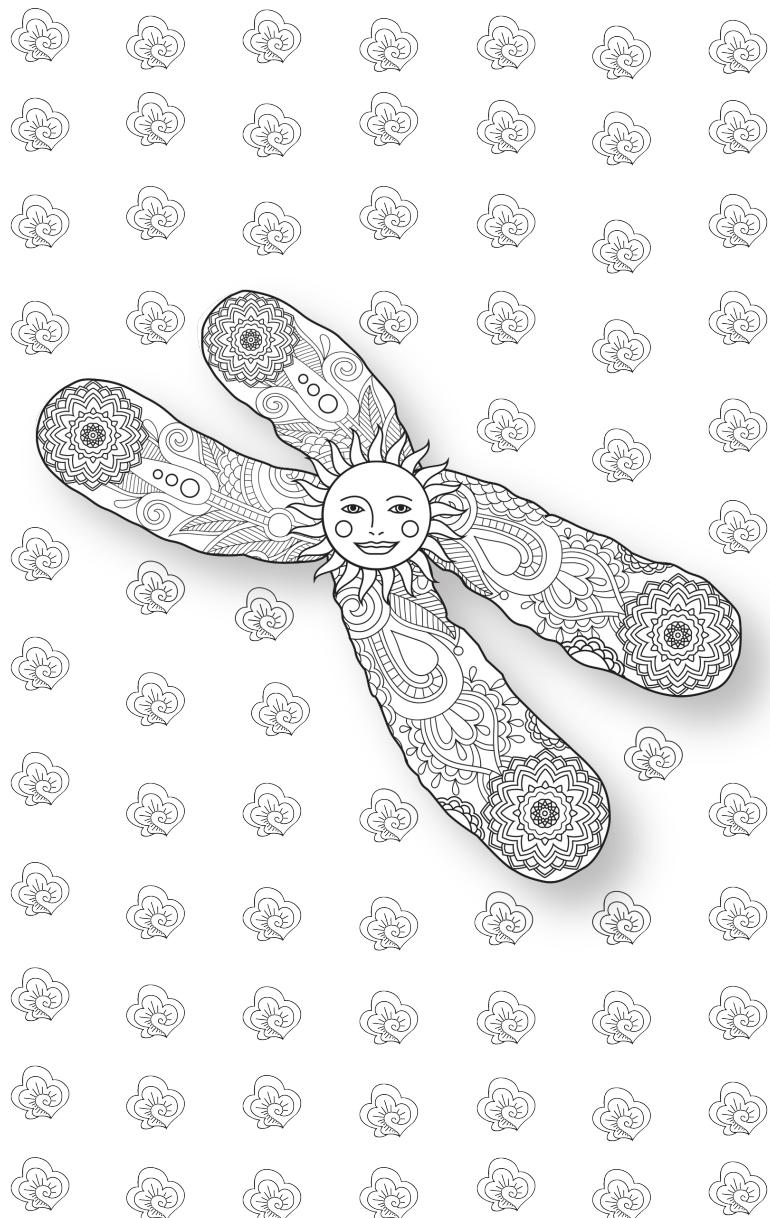


Figure 19: Telomeres and Hours of Sleep. Older adults who only get five or six hours of sleep a night have shorter telomeres. If they get more than seven hours of sleep, their telomere length is similar to younger adults.¹¹



Figures 20–21: Coloring for Adults—A Soothing Transition to Sleep.

HELP YOUR BODY PROTECT ITS CELLS





Apple Shape

Pear Shape

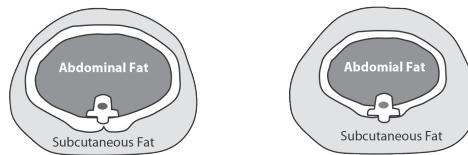


Figure 22: Telomeres and Belly Fat. Here you see what it means to have excessive fat around the waist, an apple shape (reflecting high intra-abdominal fat, measured by a greater waist-to-hip ratio, or WHR), versus more fat in the hips and thighs, a pear shape (smaller WHR). Subcutaneous fat, found under the skin and in limbs, carries fewer health risks. High intra-abdominal fat is metabolically troublesome and indicates some level of poor glucose control or insulin resistance. In one study, greater WHR predicts 40 percent greater risk for telomere shortening over the next five years.³

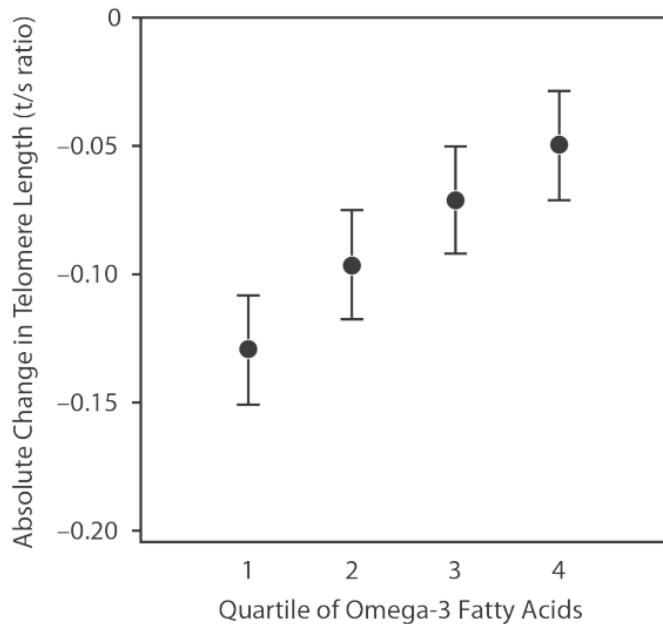


Figure 23: Omega-3 Fatty Acids and Telomere Length over Time. The higher the levels of omega-3s in the blood (EPA and DHA), the less telomere shortening over the next five years. Each one standard deviation above the average omega-3 levels predicted 32 percent lower chances of shortening. This effect was even stronger in those who started off with longer telomeres (since longer telomeres shorten more quickly).⁷



Figure 24: Finding a Balance—as Guided by Telomeres. Choose more foods high in fiber, antioxidants, and flavonoids, like fruits and vegetables. Include foods high in omega-3 oils, like seaweed and fish. Choose less refined sugars and red meat. A healthy dietary balance, like the one pictured above, will lead to healthy shifts in your blood to high nutrients and less oxidative stress, inflammation, and insulin resistance.

NUTRITION AND TELOMERE LENGTH**

Food, Drinks, and Telomere Length	
Associated with Shorter Telomeres	Associated with Longer Telomeres
Red meat, processed meat ²⁹ White bread ³⁰ Sweetened drinks ³¹ Sweetened soda ³² Saturated fat ³³ Omega-6 polyunsaturated fats (linoleic acid) ³⁴ High alcohol consumption (more than 4 drinks per day) ³⁵	Fiber (whole grains) ³⁶ Vegetables ³⁷ Nuts, legumes ³⁸ Seaweed ³⁹ Fruits ⁴⁰ Omega-3s (e.g., salmon, arctic char, mackerel, tuna, or sardines) ⁴¹ Dietary antioxidants, including fruits, vegetables, but also beans, nuts, seeds, whole grains, and green tea ⁴² Coffee ⁴³
Vitamins	
Associated with Shorter Telomeres	Associated with Longer Telomeres
Iron-only supplements ⁴⁴ (probably because they tend to be high doses)	Vitamin D ⁴⁵ (mixed evidence) Vitamin B (folate), C, and E Multivitamin supplements (mixed evidence) ^{46, 47}

***Note that the scientific literature here is growing and changing all the time. Check our website for updates!*

Your Renewed Day

Each day you have an opportunity to forestall, maintain, or accelerate the aging of your cells. You can stay in balance or maybe even forestall unnecessary acceleration of biological aging by eating well, getting enough sleep for restoration, being active and maintaining or building fitness, and sustaining yourself through meaningful work, helping others, and social connection.

Or you can do the opposite—consume junk food or too many sweets, get too little sleep, and stay sedentary or decondition the fitness you have. Throw high stress into the mix of a vulnerable body, and you'd have a day of wear and tear on your cells. It's possible that you might even lose a few base pairs of telomere length. We don't *really* know how responsive telomeres are on a daily basis, but we do know that chronic behavior over time has important effects. We can all strive to have more days of renewal rather than wear and tear. Begin by making small changes. There are suggestions for telomere-healthy change throughout the book, and we've created an example of how you can build some of these behaviors into your day. Circle any you might like to try.

We've also included a blank Renewed Day schedule that you can customize with the telomere-healthy changes you'd like to make. You can copy it, or print it from our website, and stick it to your refrigerator or mirror to help remind you of easy ways to promote healthy cell renewal. Fill in several new behaviors you'd like to add to your day. What do you want to say to yourself when you wake up? Do you want to fit in a few minutes of a morning renewal

Your Renewed Day

Time	Telomere-Shortening Behavior	Telomere-Supporting Behavior
Waking up	Anticipatory stress or dread. Mentally rehearse your to-do list. Check phone immediately.	Reappraise your stress response (page 120). Wake with joy. “I am alive!” Set an intention for the day. Look forward to any positive aspects.
Early morning	Regret that there’s no time for exercise.	Perform a cardio or interval workout (page 187). Or do energizing Qigong (page 157)
Breakfast	Sausage and bagel.	Oatmeal with fruit; fruit smoothie with yogurt and nut butter; vegetable omelet
Morning commute	Rush, hostile thoughts, maybe a little road rage.	Practice the three-minute breathing break (page 149).
Arrival at work	Play catch-up from the moment you arrive. Anticipate, worry about the work day.	Give yourself a 10-minute window of habituation and settling before work begins. Meet situations as they arise.
Workday	Self-critical thoughts. Multitask to deal with work overload.	Notice your thoughts. Take a self-compassion break (page 122) or manage your eager assistant (page 123). Focus on one task at a time. (Can you turn off your e-mail and ringer for an hour?)
Lunch	Eat fast food, deli meats. Eat quickly.	Enjoy a lunch made from fresh, whole foods. Practice mindful eating (page 222). Connect with someone. Have lunch or walk with a partner; text, call, or e-mail someone you have a supportive relationship with.
Afternoon	Give in to cravings for a sugared drink, baked goods, or candy.	Surf the urge (page 220). Have a telomere-friendly snack (page 240). Stretch
Evening Commute	Ruminate. Negative mind wandering.	Mentally distance yourself (page 97). Take a three-minute breathing break (page 149).
Dinner	Eat processed food. Look at screens.	Have a whole-foods dinner (see our website for ideas). Give the gift of focused attention to others.
Evening	Run through your evening activities and chores without a break. Suffer from a head buzzing with the aftereffects of a busy nonstop day.	Exercise , or try a stress-reducing technique (page 153). Ask: <i>Did I live my intentions today?</i> Review your day; try a challenge reappraisal (page 000). Savor the things that made you happy. Engage in a relaxing sleep ritual (page 204).

My Renewed Day

Waking up	
Early morning	
Breakfast	
Morning Commute or Arrival at Work	
Workday	
Lunch	
Afternoon	
Evening Commute or Arrival at Home	
Dinner	
Evening	

HELP YOUR BODY PROTECT ITS CELLS

mind-body activity? Think about transitions in the day when you can build in more physical activity, shift your awareness to the moment to promote stress resilience, connect with other people, and add some telomere-healthy foods to your diet.

Just remember that the path to lasting change is traveled one small step at a time.

PART IV

OUTSIDE IN:
THE SOCIAL WORLD
SHAPES YOUR
TELOMERES

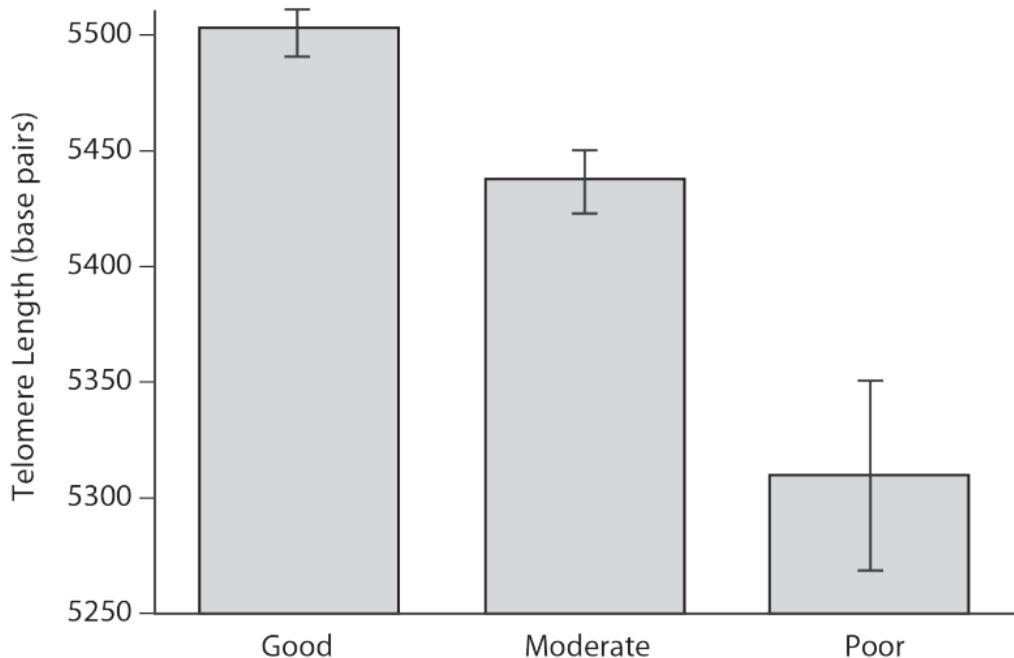


Figure 25: Telomeres and Neighborhood Quality. Here in the NESDA study, residents of neighborhoods with higher quality had significantly longer telomeres than those with moderate or poor quality.³ This is even after adjusting for age, gender, demographic, community, clinical, and lifestyle characteristics.

Telomere Toxins

Chemicals Linked to Shorter Telomeres	Chemicals Linked to Longer Telomeres <i>(Long telomeres in these conditions indicate a possible risk of uncontrolled cell growth and some forms of cancer)</i>
Heavy metals, such as cadmium and lead	Dioxins and furans Arsenic Particulate matter Benzene PCBs
Agricultural pesticides and lawn products: alachlor metolachlor trifluralin 2,4-dichlorophenoxyacetic acid (also known as 2,4-D) permethrin Mostly no longer produced but still present in the environment: toxaphene DDT	
Polycyclic aromatic hydrocarbons (PAHs)	



Figure 26: Aging at Birth? “Mom, what happened to the level playing field?”

Babies are born with short telomeres depending on their mothers' genes but also their mothers' biological health, level of stress, and, possibly, level of education.

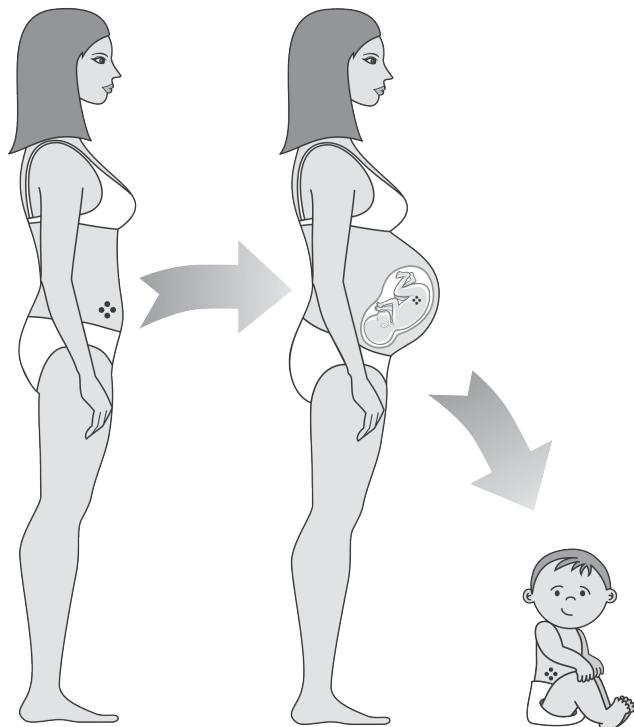


Figure 27: Telomere Transmission. There are at least three paths for telomere transmission from a parent to a grandchild. If a mother has short telomeres in her eggs, those short telomeres can be transmitted directly to the baby (this is known as germline transmission). All the baby's telomeres would then be shorter, including his or her own germline cells (sperm or eggs). During fetal development, maternal stress or poor health can lead to telomere loss in the baby, thanks to excessive cortisol exposure and other biochemical factors. Postnatally, the child's life experiences can shorten his or her telomeres. This child's short telomeres in germline can then be transmitted to his or her future offspring. Mark Haussman and Britt Heidinger have described such transmission pathways in animals and humans.²²

ADD UP YOUR ACES (ADVERSE CHILDHOOD EXPERIENCES)

Here's a version of the ACES test, used to measure the number of adverse childhood experiences. Take it now to evaluate your own adversity in childhood.

When you were a child (up to eighteen years old):

1. Did a parent or other adult in the household often or very often swear at you, insult you, put you down, or humiliate you? Or act in a way that made you afraid that you might be physically hurt?

No ____ If Yes, enter 1 ____

2. Did a parent or other adult in the household often or very often push, grab, slap, or throw something at you? Or ever hit you so hard that you had marks or were injured?

No ____ If Yes, enter 1 ____

3. Did an adult or a person at least five years older than you ever touch or fondle you or have you touch their body in a sexual way? Or attempt or actually have oral, anal, or vaginal intercourse with you?

No ____ If Yes, enter 1 ____

4. Did you often or very often feel that no one in your family loved you or thought you were important or special? Or that your family didn't look out for each other, feel close to each other, or support each other?

No ____ If Yes, enter 1 ____

5. Did you often or very often feel that you didn't have enough to eat, had to wear dirty clothes, and had no one to protect you?

OUTSIDE IN: THE SOCIAL WORLD SHAPES YOUR TELOMERES

Or that your parents were too drunk or high to take care of you or take you to the doctor if you needed it?

No ____ If Yes, enter 1 ____

6. Were your parents ever separated or divorced?

No ____ If Yes, enter 1 ____

7. Was your mother or stepmother often or very often pushed, grabbed, or slapped? Or sometimes, often, or very often kicked, bitten, hit with a fist, hit with something hard, or been the target of a thrown object? Or ever repeatedly hit for at least a few minutes or threatened with a gun or knife?

No ____ If Yes, enter 1 ____

8. Did you live with anyone who was a problem drinker or an alcoholic, or who used street drugs?

No ____ If Yes, enter 1 ____

9. Was a household member depressed or mentally ill, or did a household member attempt suicide?

No ____ If Yes, enter 1 ____

10. Did a household member go to prison?

No ____ If Yes, enter 1 ____

Total score ____

Typically, having one adverse event is not related to health, whereas having three or four events may be. If you've had several adverse childhood events, and you feel lasting imprints on your current "mindstyle" or lifestyle, don't panic. Your childhood does not have to determine your future. If for example, you developed emotional eating as a coping strategy, you can shed that as an adult. It involves

understanding why that pattern developed, and that it doesn't have to be your coping solution going forward. But before you can shed the behavior, it's important to discover alternative coping that works for you, and practice healthier ways to tolerate painful feelings over and over. There are so many ways to buffer residual effects of childhood trauma. If you are still bothered by thoughts about a difficult past, it may warrant seeking help from a professional in mental health.

Remember: You are not powerless, and you not alone. Caring professionals can help you undo some of the damage that you were once powerless to stop. And remember there are positive attributes still with you. For example, severe adversity is related to feeling more compassion and empathy for others.¹⁶

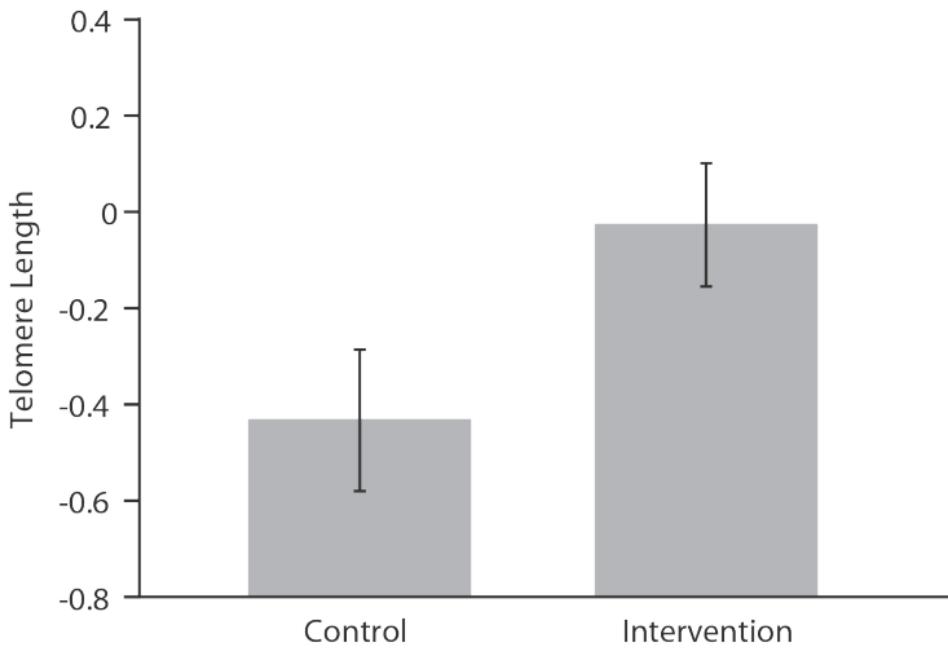


Figure 28: Family Resilience Classes and Telomeres. Among the teenagers whose parents showed very unsupportive parenting, those who were in the supportive intervention group had significantly longer telomeres five years later. (This is after adjusting for factors such as social status, stressful events, smoking, alcohol use, and body mass index.)³⁴

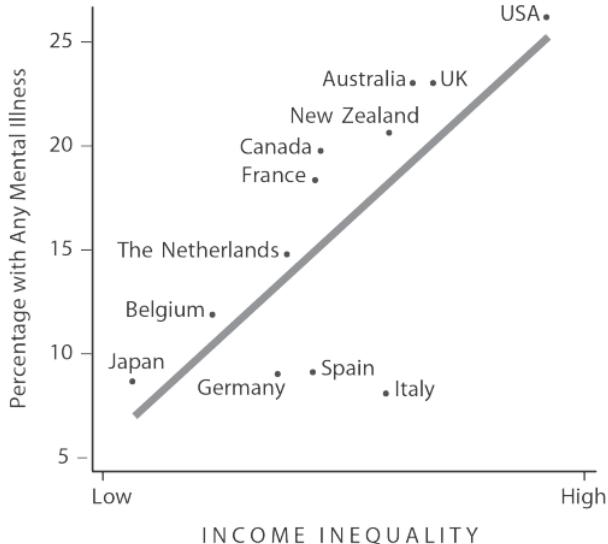


Figure 29: Income Inequality and Mental Health. A large body of research has shown that income inequality in regions and countries is associated with worse behavior (less trust, more violence, drug abuse) and worse health for all, whether it's physical or mental health. Kate Pickett and Richard Wilkinson have summarized this massive set of research findings,² and here they show relations with mental health. In this data set, Japan has the lowest inequality and the lowest rate of mental illness, whereas the United States has the highest of each.

THE TELOMERE MANIFESTO

Your cellular health is reflected in the wellbeing of your mind, body, and community. Here are the elements of telomere maintenance that we believe to be the most crucial for a healthier world:

Mind Your Telomeres

- Evaluate sources of persistent, intense stress. What can you change?
- Transform a threat to a challenge appraisal.
- Become more self-compassionate and compassionate to others.
- Take up a restorative activity.
- *Practice thought awareness and mindful attention. Awareness opens doors to wellbeing.*

Maintain Your Telomeres

- Be active.
- Develop a sleep ritual for more restorative and longer sleep.
- Eat mindfully to reduce overeating and ride out cravings.
- Choose telomere-healthy foods—whole foods, omega-3s, skip the bacon.

Connect Your Telomeres

- Make room for connection: Disconnect from screens for part of the day.
- Cultivate a few good, close relationships.
- Provide children quality attention and the right amount of “good stress.”
- Cultivate your neighborhood social capital. Help strangers.
- Seek green. Spend time in nature.
- *Mindful attention to other people allows connections to bloom. Attention is your gift to give.*

Create Telomere Health in Your Community and the World

- Improve prenatal care.
- Protect children from violence and other traumas that damage telomeres.
- Reduce inequality.
- Clean up local and global toxins.
- Improve food policies so that everyone has access to fresh, healthy, affordable food.

The future health of our society is being shaped right now, and we can measure part of that future in telomere base pairs.

Acknowledgments

We could not have written this book without drawing upon the decades of hard work of many scientists, and we thank them all for their contributions to our understanding of telomeres, human aging, and behavior, even though we couldn't reference each important contribution of our colleagues. We thank the innumerable scientific collaborators and students with whom we have worked during the past few decades; our gratitude to each of you is bottomless. Our research could not have transpired without you. We are both especially indebted to Dr. Jue Lin, PhD, who has worked tirelessly and with great talent for over ten years on all of our human telomere studies. Jue has performed tens of thousands of meticulous telomere-length and telomerase measurements for these studies, and has served as an exemplar of a translational researcher, working at all levels, from lab bench to community.

We would like to acknowledge the following people who have contributed to this book in various important ways, through enlightening discussions, providing perspectives on the book, or serving as an inspiration or support to our work. Any mistakes in the content, however, are entirely our own. We extend our deepest gratitude to: Nancy Adler, Mary Armanios, Ozlum Ayduk, Albert Bandura, James Baraz, Roger Barnett, Peter and Allison Baumann, Petra Boukamp, Gene Brody, Kelly Brownell, Judy Campisi, Laura

Acknowledgments

Carstensen, Mark Coleman, David Creswell, Alexandra Croswell, Steve Cole, Susan Czaikowski, James Doty, Mary Dozier, Rita Effros, Sharon Epel, Michael Fenech, Howard Friedman, Susan Folkman, Julia Getzelman, Roshi Joan Halifax, Rick Hecht, Jeannette Ickovics, Michael Irwin, Roger Janke, Oliver John, Noa Kageyama, Jon Kabat-Zinn, Will and Teresa Kabat-Zinn, Erik Kahn, Alan Kazdin, Lynn Kutler, Barbara Laraia, Cindy Leung, Becca Levy, Andrea Lieberstein, Robert Lustig, Frank Mars, Pamela Mars, Ashley Mason Thea Mauro, Wendy Mendes, Bruce McEwen, Synthia Mellon, Rachel Morello-Frosch, Judy Moskowitz, Belinda Needham, Kristen Neff, Charles Nelson, Lisbeth Nielsen, Jason Ong, Dean Ornish, Bernard and Barbro Osher, Alexsis de Raadt St. James, Judith Rodin, Brenda Penninx, Ruben Perczek, Kate Pickett, Stephen Porges, Aric Prather, Eli Puterman, Cliff Saron, Robert Sapolsky, Zindel Segal, Dan Siegel, Felipe Sierra, Daichi Shimbo, the late Richard Suzman, Michael Scheier, Shannon Squires, Matthew State, Janet Tomiyama, Bert Uchino, Pathik Wadhwa, Christian Werner, Darrah Westrup, Mary Whooley, Jay Williams, Redford Williams, Janet Wojcicki, Owen Wolkowitz, Phil Zimbardo, and Ami Zota. A big thanks to Aging, Metabolism, and Emotions (AME) lab members, and especially to Alison Hartman, Amanda Gilbert, and Michael Coccia, for support on various aspects of the book. We thank Coleen Patterson of Coleen Patterson Design for her inspired illustrations, and amazing transference of images from our heads to this book.

We also thank the dedicated readers of our book focus group who gave us their Sunday afternoons and invaluable input: Michael Acree, Diane Ashcroft, Elizabeth Brancato, Miles Braun, Amanda Burrowes, Cheryl Church, Larry Cowan, Joanne Delmonico, Tru Dunham, Ndifreke Ekaette, Emele Faifua, Jeff Fellows, Ann Harvie, Kim Jackson, Carole Katz, Jacob Kuyser, Visa Lakshi, Larissa Lodzinski, Alisa Mallari, Chloe Martin, Heather McCausland, Marla Morgan, Debbie Mueller, Michelle Nanton, Erica “Blissa” Nizzoli, Sharon

Acknowledgments

Nolan, Lance Odland, Beth Peterson, Pamela Porter, Fernanda Raiti, Karin Sharma, Cori Smithen, Sister Rosemarie Stevens, Jennifer Taggart, Roslyn Thomas, Julie Uhernik, and Michael Worden. Thanks to Andrew Mumm of Idea Architects for his wizardry and patience connecting us across geographic and technical challenges.

We'd also like to thank the people who generously talked with us about their personal experiences, some anonymously, some named below. We weren't able to incorporate every single one of the wonderful stories we heard, but throughout the writing process the spirit of all those stories has informed and profoundly moved us. We are indebted to Cory Brundage, Robin Huiras, Sean Johnston, Lisa Louis, Siobhan Mark, Leigh Anne Naas, Chris Nagel, Siobhan O'Brien, Tim Parrish, Abby McQueeney Penamonte, Rene Hicks Schleicher, Maria Lang Slocum, Thulani Smith, and Rod E. Smith.

We extend *tremendous* thanks to Leigh Ann Hirschman, of Hirschman Literary Services, our collaborative writer. Her writing and depth of editorial experience helped make this book as readable as it is. She was a pleasure to work with: joining our immersion in the world of telomere science, ever patient with our bringing in the constant flow of new studies that entered the scientific literature as we wrote, and a balanced and guiding voice when at times we thought we would never emerge from the thickets of research.

We are also very grateful to our editor, Karen Murgolo of Grand Central Publishing, for her faith in this book and her expertise, time, and care in every decision needed throughout this process. We felt so fortunate to have benefitted from her wisdom and patience.

We have deep gratitude to Doug Abrams of Idea Architects. It was Doug who first saw the need for a book that we could not yet see. We thank him for his dedication and for his wonderful and wise curation as a developmental editor. And for making what could have been taxing to our telomeric base pairs both a delightful process and the grounding of enduring friendship.

Acknowledgments

Lastly, we are so grateful to our families (nuclear and extended) for their loving support and enthusiasm during the many seasons of the writing process, and the many more seasons that laid the scientific foundation for it.

We are also grateful for the opportunity to share this work with you, the readers, and sincerely hope that this work promotes your wellbeing and healthspan.

Information about Commercial Telomere Tests

If you'd like to estimate your telomere health, you can take the self-test on page 161. You can also take a commercial company test to determine telomere length. But should you? You don't need to have your own lungs biopsied in order to make the wise decision to stop smoking! Many of you would probably perform the same restorative activities in life whether you have a telomere test or not.

We wondered how people would react to learning the results of telomere tests. If a person learns she has short telomeres, for example, would that knowledge be depressing? So we tested volunteers and told them their results. Then we followed up to ask about their reactions. Most were neutral to positive, and none was very negative. But those who were short did experience some distressing thoughts about that in the ensuing months. Telomere testing is a personal decision. Only you can decide if knowing your length will benefit you. Imagine if you learn your telomeres are short—is that more motivating to you than upsetting? Learning that your telomeres are short is like seeing the “check engine” light on a dashboard; it's usually just a sign that you need to take a closer look at your health and your habits and step up your efforts.

We're often asked if we've had our own telomeres measured:

I (Liz) have, out of curiosity. My results were reassuringly good,

Information about Commercial Telomere Tests

but I always keep in mind that telomere length is a statistical indication of health, not an absolute predictor of the future.

I (Elissa) haven't had my telomeres measured yet. I would rather not know definitively if my telomeres are short. I try to engage in the life practices good for telomeres on an AMAP (as much as possible) basis, given this busy life. Telomere length trajectories over time will be more valuable than single checks. They tell us something unique about a cell's potential to replicate that no one indicator can. However, they are just one marker. It is likely that algorithms including many biomarkers and health status variables will be more useful for personal use once they are better developed. When the measures have more predictive value for individuals and are easier to get repeatedly, I will be more interested in getting testing done.

As of this writing, only a few commercial companies offer telomere testing.

We do not have any knowledge about—or control over—the accuracy and reliability of telomere length measurements performed by these commercial entities. Because these companies change rapidly, we list the details on our book website. At this writing, testing costs anywhere from around \$250 to \$500.

A few caveats: Telomere testing is an unregulated business, so there is no government agency checking whether for-profit companies are using methods and values that are accurate, or whether what they tell you about your risks is accurate. It can be interesting to learn the results of a telomere test, but we caution everyone that telomeres do not necessarily predict the future. Again, it's like smoking. Smoking does not guarantee that you'll get a lung disease, and not smoking does not guarantee that you will stay free of disease. But the statistics on smoking are in, and the message is clear: The more you smoke, the greater your chances of getting emphysema, cancer, and other serious health problems. There are plenty of good reasons to quit—or better still, not to smoke at all. In the

Information about Commercial Telomere Tests

same way, the countless studies on the relationship between telomere length and human health and disease have given us the data we need to create guidelines for keeping your telomeres (and therefore you) healthier. You may enjoy knowing your telomere length, but you don't need that information to prevent premature cellular aging.

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Chapter Eleven: The Places and Faces That Support Our Telomeres

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