Swiss Re Institute

Life & Health Trend Spotlight

Is sleep the new blood pressure?

Understanding how sleep affects health and mortality for new underwriting methods

Sleep is as universal as eating and breathing. We do it every day and it affects how long we live. Too little – or even too much – also affects our mental health, heart health and more. And our sleep is woven into a complicated web of lifestyle factors that play off one another – for better or for worse. In addition, sleep interacts with traditional clinical risk factors like blood pressure and weight – which in turn drive health and mortality.

The more we understand the underlying dynamics of these interactions, the better insurers can leverage sleep data. It's a complex knot, but through our "Big Six" lifestyle research, we aim to unwind it enough to develop reliable criteria that can inform credible risk assessment and drive better health outcomes. As insurers work to streamline risk assessment, knowing how to factor these new data points into underwriting decisions will be essential. This research is just the beginning.

Could sleep data help us understand cardiovascular risk?

Could other lifestyle factors such as physical activity be a proxy for the quality of someone's sleep?

The BIG 6 Lifestyle Factors

- mental wellbeing
- physical activity
- environment
- **sleep**
- nutrition
- substance use

The two sides of sleep

Today our wearables and phones can tell us how long, and often how "well" we sleep. Sleep duration and lack of disturbance both impact sleep quality, which is largely driven by the time we spend in different sleep cycles, some which provide more restorative and physiological benefits than others.

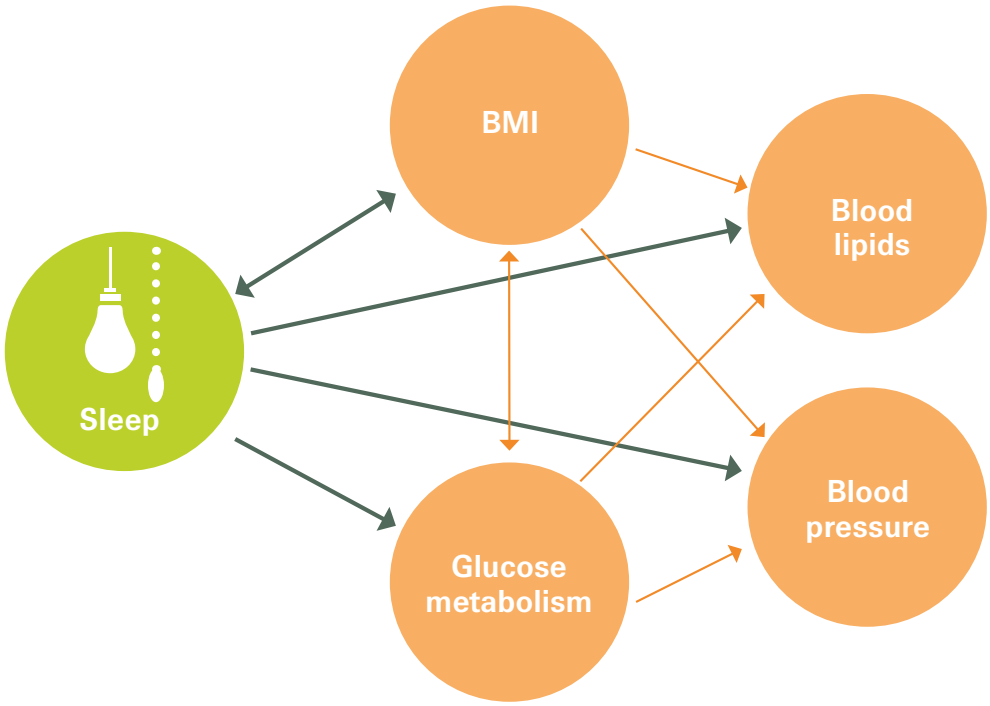
Shorter sleep and fragmented sleep interrupt key biological pathways and mechanisms such as our endocrine functioning and over-activation of our autonomic nervous system. These negatively impact our immune function, blood pressure, inflammatory markers, and insulin resistance. Just as poor sleep negatively impacts our health in many ways, a good sleep routine can improve health and longevity. Adequate sleep helps to strengthen our immune systems, lower blood pressure, decrease inflammation and even improve insulin sensitivity. The potential for improved sleep to ultimately improve health outcomes is encouraging for insurers and customers alike.

Is sleep at the heart of cardiovascular disease?

Cardiovascular disease (CVD) is a primary driver of mortality. We also know that quality and amount of sleep are strongly correlated to CVD and vary based on gender and age. How can we account for these interactions when evaluating risk?
To understand the full picture, we need to breakdown each relationship. There are four key clinical CVD risk factors – increased body mass index (BMI), hypertension (high blood pressure), dyslipidemia (poor cholesterol), and impaired glucose metabolism (insulin resistance). The likelihood of having high blood pressure, suffering from poor cholesterol, being overweight or having diabetes is significantly associated with sleep duration. Sleeping less or experiencing disturbed sleep puts you at a greater risk for developing these health conditions.

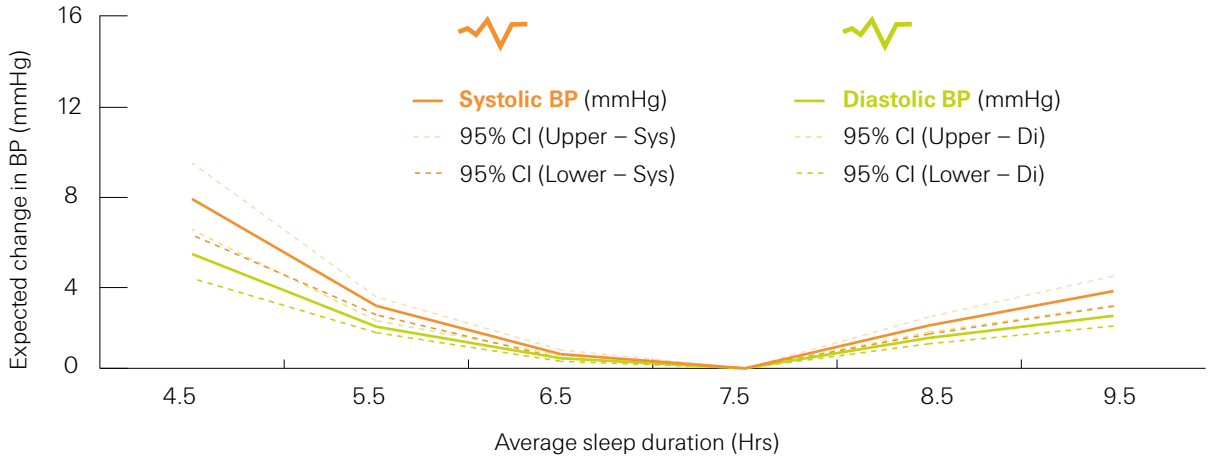
Furthermore, these conditions are not mutually exclusive and their effects on each other can exacerbate complications. For example, while poor quality sleep can increase your chance of a cardiovascular-related condition, a high BMI can negatively affect your sleep quality. People with high BMI are also more likely to have high blood pressure or poor cholesterol. This is why determining the combined effects of these risk factors for underwriting purposes is especially complex. We begin with how sleep interacts with other CVD risk factors.

Figure 1
Interactions between sleep and traditional clinical risk factors



The association between sleep and blood pressure is U-shaped. Those who sleep on average less or more than seven hours each night are more likely to have high blood pressure. Studies show the impact is more severe when someone gets less sleep (4–5 hours),

Figure 2
Expected change in blood pressure as a result of how much sleep you get



Inadequate sleep is strongly associated with impaired glucose metabolism which leads to insulin resistance and increased risk of developing conditions like diabetes. For example, a 2018 study found that the risk of developing pre-diabetes was significantly higher for individuals who slept less than 6 hours per night compared to individuals who received 6–8 hours per night[1]. Across the world, the number of people living with diabetes has been steadily rising for the last 50 years. A large meta-analysis found the risk of developing diabetes when sleeping less than 5 hours and more than 9 hours per night was 1.48 and 1.36 times higher respectively.

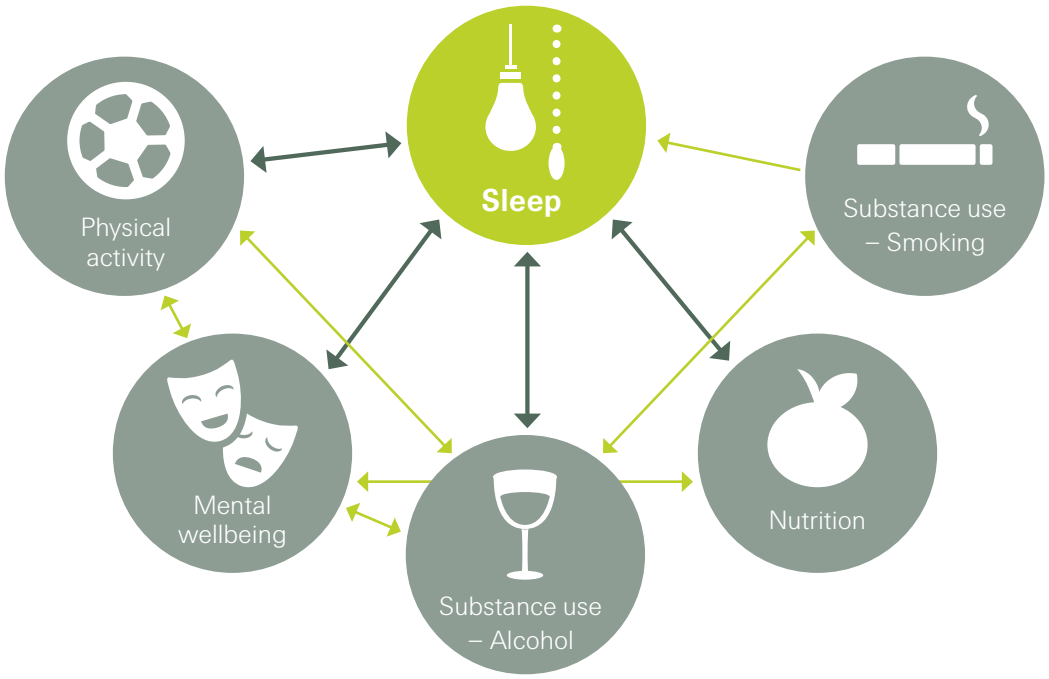
It's not only the hours of sleep that count. Poor sleep quality, obstructive sleep apnea (OSA) and nightshift work all can disrupt homeostasis and increase the risk of developing diabetes by 40%, 102% and 40% respectively[2].

Sleep, lifestyle and their combined effects

Beyond its connection with clinical factors, sleep also strongly affects other lifestyle factors, which, in turn, impact mortality.

Our sleep affects physical activity, nutrition, mental wellbeing and substance use – and each of these, in turn, influence the amount and quality of our sleep. These factors also independently influence one another creating an intricate web that supports – or harms overall health.

Figure 3
Interactions between sleep and lifestyle risk factors



According to an analysis from the Centers for Disease Control and Prevention, adults who sleep less than 7 hours per night are more likely to smoke cigarettes and report being obese and physically inactive than their sound sleeper counterparts who got sufficient shut eye (7 hours or more per night). Of the short sleepers, 27.2% reported no physical activity within the last 30 days. For those who got sufficient sleep, only 20.9% reported the same.

Poor sleep also increases the risk of alcohol abuse. Insomniacs are believed to be 2.4 times more likely to develop alcohol abuse disorders than adequate sleepers [3,4]. Likewise, sleep has an intimate connection with mental health. Those who get too little or too much sleep are 31% and 42% more likely to develop depression than someone who gets optimal sleep[5].

Alcohol use and smoking are typically the only lifestyle risks used by insurers to assess risk. An insurer might consider an applicant's mental wellbeing through self-disclosed questions or medical records that focus on clinically diagnosed mental conditions, but it's often partial view at best. Nutrition and exercise are seldom even considered in underwriting.

More sleep isn't always better

Seven hours per night is the magic number and considered to be the "sweet spot" for adults. Sleeping a lot more – or a lot less – often has a two-way link to other risk factors. Longer sleep may be a consequence of an underlying health condition that reduces sleep quality. Typical conditions include sleep disorders, OSA, chronic pain, depression and anxiety. In these cases, duration does not equal quality. Instead, sleeping longer is compensation for the underlying condition which disturbs sleep and creates more fatigue. In many cases, these underlying conditions are closely linked to cardiovascular diseases and therefore come with increased mortality risk.

According to our analysis, sleeping more than 9 hours a night increases mortality risk by an average of 37%, Too little sleep also affects mortality to a lesser degree (increased mortality risk of 11% for those sleeping less than 5 hours). Mortality among groups that slept longer is likely confounded by an underlying disease which leads to longer sleep duration (See Fig. 4).

Figure 4

Relative risk of all-cause mortality per sleep duration

Hours	< 5	5–6	6–7	7–8	8–9	> 9
Relative Risk (all-cause mortality)	**1.11**	**1.05**	**1.03**	**1.00**	**1.12**	**1.37**
	95% CI	**95% CI**	**95% CI**	(Ref)	**95% CI**	**95% CI**
	1.06–1.29	1.03–1.09	1.00–1.10		1.08–1.20	1.18–1.62

Weighted averages of 5 large meta-analyses (n > 6 million) for different sleep duration subgroups. [6,7,8,9,10]

What does this mean for insurers?

It may be too soon to understand if sleep is the new blood pressure, but we know one thing is certain – to get a complete picture of health, you need to account for a person's sleep habits. As insurers look to streamline the underwriting journey and use new forms of data, more and more reach for sleep numbers because they are measurable and relatively easy to track and report.

Here are some practical considerations for incorporating sleep data into your underwriting process:

- **Duration is currently the best measure of sleep.** Eventually sleep disruption may be a more valuable data point but validating its accuracy and the validation of consumer devices compared to gold standard measures like polysomnography (PSG) will take time.
- **Sleep data from devices are likely more accurate than self-reported data.** However not all devices are created equal and accuracy depends on the device type and generation.
- **Don't assume more sleep is better.** Longer sleep risk is often confounded by underlying health conditions which cause fragmented sleep. Some conditions like OSA are strongly linked to cardiovascular disease.
- **Allow for complex synergies.** Sleep's interaction with clinical and other lifestyle factors is complex. In some cases, the interplay are additive, but in many cases, relationships across risk factors are synergistic or overlapping.
- **Include as many lifestyle factors as is practical.** Having a full picture of all the lifestyle behaviours of an individual will allow for a more accurate picture of their risk.
- **Time matters more with lifestyle factors.** Underwriting at point of sale gives you a static picture of someone's health. While expected changes in clinical measures like BMI or blood pressure are priced for, lifestyle factors like sleep are probably not. Here's what you might consider:
    - Request longer term evidence. Experts quote one month of sleep data to be an indication of longer-term behaviour.
    - Adjust the weighting you give sleep in your risk assessment. A reduced weighting can help you test and learn while incorporating and gathering new data.
    - Consider the average applicant's sleep duration and the expected distribution of sleep durations. This will help you determine appropriate debits and credits and whether a base rate adjustment is needed.
    - Contemplate incorporating dynamic underwriting into your process to allow for regular reassessment and adjust for changing lifestyle risks like sleep.

As devices and technologies continue to evolve for better tracking of sleep duration and disturbance, we can find new correlations that will help us assess risk in novel ways. Already we can begin to understand what sleep means for your heart or how it affects what you eat, for example. And sleep is just one of the "Big Six" lifestyle factors insurers can use more effectively. Incorporating multiple lifestyle factors opens the door to better, more holistic risk assessment and to longer-term support for policyholders throughout their journey to improve their health and wellbeing.

Our research is helping us understand from a scientific and medical perspective how lifestyle factors like sleep and activity levels and second-hand smoke interact with each other and with ultimate health outcomes. We are working to embed this knowledge into Life Guide, our flagship underwriting guide and philosophy.

Are you considering how sleep or other lifestyle data could support or change the way you underwrite? Looking to create a new product that offers dynamic underwriting over time or incorporates wellness programs? Want to understand more of the science behind sleep? Contact your Swiss Re Underwriting Propositions Lead to learn more.

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