D5.2c Interactions between physical activity, stress, sleep and nutrition

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Summary

A healthy lifestyle comprises many different behaviors, including being physically active, eating a balanced and nutritious diet, sleeping well, and reducing stress. Many people engage in one or more unhealthy behaviors, which negatively affect their health in the long run. Not only do these unhealthy lifestyle behaviors influence each other, creating negative feedback loops, they may also increase each other's effect on the person's health. To improve one's health it is important to break these negative feedback loops and turn them into **positive feedback loops** composed of healthy behaviors. As a first step towards a full understanding of the mechanisms involved, this document provides a literature overview of scientifically reported interactions between stress, sleep, nutrition and physical activity. We show that there are many interactions between stress, sleep, nutrition and physical activity. Especially stress and sleep strongly affect each other and, in turn, they both strongly affect nutrition and physical activity.

The results of this document can be used to guide the development of **holistic lifestyle interventions** that target multiple behaviors (and their interactions) simultaneously. The positive feedback loops created in such holistic interventions can leverage behavior change, making these interventions more effective than interventions that address single behaviors separately.

Contents

1 Introduction

SWELL aims at developing solutions to support knowledge workers to reach or keep a healthy work-life balance. This includes stimulating physical activity and increasing mental fitness, providing insights into the barriers that hinder mental and physical fitness, and reducing stress. Many people engage in a lifestyle that is characterized by multiple unhealthy behaviors; an unhealthy diet, insufficient physical exercise, insufficient sleep and having too much stress. These unhealthy lifestyle behaviors do not only have a negative impact on health, they also negatively affect each other, creating **negative feedback loops** that are difficult to break. For example, when a person experiences stress, this will negatively affect their sleep. Conversely, a not being able to sleep well (for any reason) may result in higher stress levels and an impaired ability to cope with stressors during the day.

When developing lifestyle intervention programs, it is important to take the interactions between the unhealthy behaviors into account, for the following reasons:

- Insight into the interactions between different behaviors allows for optimizing the intervention to specific combinations of behaviors. For example, a sleep program should be different for users who experience a combination of sleeping problems and stress than for users who only experience sleeping problems.

- Many people are unaware of the interactions between different behaviors. Providing them with more insight could support them in finding the barriers that hinder them in performing healthy behavior. For example, Figure 1 shows a screenshot of the Jawbone app explaining about the relationship between eating and sleeping.

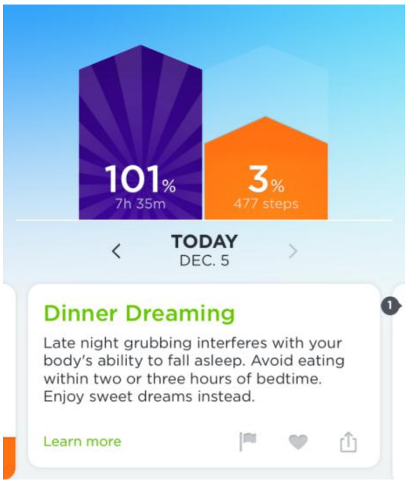

Figure 1. *Jawbone app showing message about the interaction between late night eating and sleep.*

This document describes the results of an extensive literature study providing an overview of the most important and scientifically proven interactions between lifestyle behaviors and on behavior change. The studies can be roughly divided into two categories: epidemiological studies that aim to find co-relations between different lifestyle behaviors, and experimental studies that try to explain the interactions physiologically and often describe causal relationships.

2 Interactions between Sleep and Stress

Sleep plays an important role in physical and mental health (Walker, 2009). It has been repeatedly shown that sleep loss causes disruption of a number of bodily functions and is often followed by increased stress levels and impaired cognitive function (Van Dongen, Maislin, Mullington, & Dinges, 2003). Conversely, it has also been repeatedly shown that stress, or more specifically, increased arousal, hamper sleep onset and sleep maintenance (Bonnet & Arand, 2010; Perlis, Giles, Mendelson, Bootzin, & Wyatt, 1997; Tang & Harvey, 2004).

2.1 Sleep deprivation is associated with decreased levels of the neurotropic factor BDNF, which in turn is related to stress.

The interaction between sleep and stress has been investigated on different levels ranging from neurochemistry to behavioral function. Giese and colleagues (2013) showed that sleep loss results in higher stress vulnerability and that brain-derived neurotropic factor (BDNF) could be the central player in this relationship (Giese et al., 2013). BDNF is a protein playing an important role in the survival of neurons, the development of new synapses and involved in memory formation. Results showed that individuals having sleep complaints exhibited lower BDNF levels. In addition, increased perceived stress was similarly associated with a decrease in the concentration of BDNF. However, this was only found in subjects experiencing stress without having sleep complaints. This result made the authors to conclude that stress affects sleep and BDNF levels and that sleep vice versa has an impact on the link between stress and BDNF.

2.2 Evening-types are more vulnerable to stress than morning-types.

Inter-individual differences in the sleep-wake rhythm may also play a role in how an individual responses to stress. It is shown that *eveningness*, i.e. the preference to be most active towards the evening and not in the morning, is associated with a higher susceptibility to stress (Roeser et al., 2012). When participants performed a mental arithmetic task while heart rate and blood pressure were recorded, it appeared that evening-types had significantly higher heart rates and systolic blood pressure than morning-types.

2.3 Sleep loss increases cardiovascular risk during acute psychological stress.

The combined effects of psychological stress and sleep disturbances on cardiovascular reactivity has recently been investigated by Franzen and associates (Franzen et al., 2011). A total of 20 healthy young adults were exposed to acute stress following a night of normal sleep or following a night of total sleep deprivation. Blood pressure was recorded every 2.5 minutes and mean blood pressure responses were taken as an index for cardiovascular reactivity. Results showed that systolic blood pressure was significantly higher in the sleep deprivation condition as compared to the normal sleep condition when subject were presented with psychological stress. It was concluded that sleep loss may increase cardiovascular risk by dysregulating stress physiology.

2.4 Stress is strongly associated with sleep problems.

The interaction of sleep and stress on a higher behavioral level were investigated by Kristiansen et al. (2010). A public health survey among 12093 respondents revealed that work stress (job strain and job demands), pain, and worries such as worrying about losing the job, experiencing bullying at work, having troubles paying the bills, and having a sick, disabled, or old relative to take care of were independently associated with general sleep problems.

3 Interactions between Sleep and Nutrition

Modern society is resulting in a majority of people being chronically sleep restricted (Banks & Dinges, 2007). Simultaneously, the proportion of humans suffering from obesity has been increasing as well (Leng et al., 2014). Although the exact relationship is still under investigation, there is growing evidence that sleep difficulties are associated with weight problems.

3.1 Poor sleep is associated with increased food intake and poor diet quality

Short sleep duration, poor sleep quality, and later bedtimes are all associated with increased food intake, poor diet quality, and excess body weight (Chaput, 2013). It is hypothesized that shortened sleep may increase caloric intake by six mechanisms: (1) obviously, less sleep means more wake time and as such there is more time and there are more opportunities for eating, (2) psychological distress causes people to look for food to upgrade energy levels and to alleviate mood, (3) there is a greater sensitivity to food reward, (4) people are less able to inhibit their eating behavior, there is less self-control, (5) there is more energy needed to sustain extended wakefulness, and (6) there are changes in appetite hormones.

3.2 Sleep restriction increases neuronal response to unhealthy food.

On the neuronal level St-Onge and colleagues recently found remarkable results for the interaction between sleep and nutrition (M-P St-Onge, Wolfe, Sy, Shechter, & Hirsch, 2013). A total of 25 normal-weight individuals, who normally slept 7-9 hours per night were presented with healthy and unhealthy food stimuli while lying in a MRI scanner. Functional MRI was conducted after either having slept 4 or 9 hours. The results showed that after the sleep restricted period there was greater neuronal activation in various brain reward and food-sensitive areas when unhealthy food stimuli were presented when compared to healthy food stimuli. The same stimuli presented after a period of habitual sleep produced not significant differences.

3.3 Short sleep duration is associated with appetite related hormones.

Leptin and ghrelin have been extensively studied in relation to sleep (Marie-Pierre St-Onge, 2013). In general, it has been shown that shortened sleep is associated with decreased levels of the appetite-inhibiting hormone leptin and increased levels of the opposite-stimulating hormone ghrelin. Leptin signals the brain that the body has had enough to eat, producing a feeling of satiety. Ghrelin has an opposite effects, in that it stimulates hunger or appetite. It is hypothesized now that genetic variation may play a role in the responses of leptin and ghrelin on shortened sleep duration. A specific gene has been identified and, interestingly, is also associated with evening-types.

3.4 Insufficient sleep results in excess of food intake and weight gain.

On a behavioral level insufficient sleep has been shown to produce excessive food intake and to indirectly result in weight gain (Markwald et al., 2013). Sixteen adults participated in a 14-day inpatient study in which insufficient sleep was realized for 5 consecutive days, simulating a workweek. Although a decrease of 5% in total daily energy expenditure was detected, an excess of energy intake was shown as well. This led to an average of 0.82 kg weight gain in five days. Additionally, the study showed that recovery to normal sleep resulted in an average weight loss of -0.03 kg.

3.5 A large proportion of severely obese adults report has poor sleep quality.

Another study identifying associations between sleep and nutrition found strong correlations between scores on the most frequently used sleep quality questionnaire, the Pittsburgh Sleep Quality Index, and mean body mass index (BMI) (Cleator, Abbott, Judd, Wilding, & Sutton, 2013). The study was conducted in a total of 144 participants with a mean BMI of 46.9 kg/m^2. The majority reported having poor sleep quality (73%), but only 2.8% reported reverting to night-eating behavior.

3.6 Short sleep is associated with elevated food consumption in individuals who are prone to eat in response to aroused emotional states.

Dweck and colleagues (Dweck, Jenkins, & Nolan, 2014) investigated the role of emotional eating and stress in the influence of short sleep. In the first part of the study the authors found that emotional eating (eating in response to aroused emotional states) and external eating (eating in response to the presentation of food regardless of hunger) was significantly more frequent in women who reported poor sleep quality. Thereafter, they showed that in 64 women who were provided with snacks under stressed and control conditions, elevated food consumption was observed in those who scored high on emotional eating and who reported short sleep. Remarkably, in this study no strong associations were found between BMI and sleep quality. It was concluded that the relationship between short sleep and elevated food consumption exists in those who are prone to emotional eating.

3.7 Specific sleep symptoms are associated with intake of specific dietary nutrients.

Grandner and colleagues (Grandner, Jackson, Gerstner, & Knutson, 2014) have conducted a very detailed study associating specific dietary nutrients with sleep symptoms. In a total of 4552 individuals subjective sleep was assessed and diet and nutrition data were collected. Nutrients that were independently and strongly associated with difficulty falling asleep included alpha-carotene, selenium, dodecanoic acid, calcium, and hexadecanoic acid. Nutrients strongly associated with sleep maintenance difficulties were salt, butanoic acid, carbohydrate, dodecanoic acid, vitamin D, lycopene, hexanoic acid, and moisture. Nutrients associated with non-restorative sleep were butanoic acid, calcium, vitamin C, water, moisture, and cholesterol. Nutrients associated with sleepiness were moisture, theobromine, potassium, and water.

The potential link between sleep quality and dietary nutrients has important implications for health. If increased consumption or deficiency of certain nutrients can impair sleep, this would increase the risk of sleep disorders and consequently the risk of cardiometabolic health problems.

4 Interactions between Sleep and Physical Activity

Although sleep and exercise seem to be two completely separate and distinct behaviors, there is growing evidence for important relationships between them (Atkinson & Davenne, 2007).

4.1 Physical activity improves sleep through thermoregulation in people with normal sleep schedules and in shift-workers.

To date, the effects of temperature on sleep have extensively been investigated (Raymann, 2005). It has become clear that thermoregulatory changes regulate sleep and direct neural pathways have been identified. In addition, when rightly timed, i.e. not too close to bedtime, exercise-mediated hyperthermia has been shown to improve slow wave sleep (Atkinson & Davenne, 2007). The aforementioned findings appear to be the underlying mechanism for improved tolerance to shift-work. Shift-work is associated with greater health problems, but when engaging in physical activity at least twice a week health improves (Atkinson & Davenne, 2007).

4.2 Engaging in physical activity has beneficial effects on sleep quality.

Similar findings were reported by Sherrill and associates (Sherrill, Kotchou, & Quan, 1998). The authors investigated the influence of moderate exercise or physical activity on self-reported sleep disorders among a total of 722 adults. Results showed that regular activity at least once a week, participating regularly in an exercise program, and walking at normal pace for more than 6 blocks (approximately 1.2 km) per day was associated with reduced risk of sleep maintenance disorders. It was therefore concluded that programs of regular exercise may be useful therapeutic modalities in the treatment of patients with sleep disorders.

4.3 Low physical activity and short sleep duration is associated with increased risk of developing insulin resistance.

Insulin resistance is closely linked to the development of type 2 diabetes (Zuo et al., 2012). In addition, it has been shown that physical activity can reduce insulin resistance. Zuo and associates (Zuo et al., 2012) investigated whether besides physical activity also sleep would play a role in the development of insulin resistance. They conducted a study with 1124 young non-diabetic adults and assessed physical activity and sleep. Results showed that low physical activity and short sleep duration were associated with an increased risk of developing insulin resistance, as compared to those with high physical activity and adequate sleep duration.

5 Interactions between Nutrition and Stress

The relationship between stress and eating behavior is complex and involves physiological, hormonal and psychological processes. As will be explained in the following sections, while acute stress suppresses appetite and reduces eating, chronic stress can lead to increased food intake. Furthermore, the relationship between stress and eating behavior is moderated by individual differences in personality (e.g., emotional eating) and responsivity to stress (e.g., cortisol reactivity). In order to model the effect of stress on eating behavior, it is important to take the following findings into account.

5.1 Acute stress suppresses appetite and reduces food intake

A comprehensive overview of the relation between stress and eating is provided by Adam and Epel (2007). They explain the effect of acute stress on appetite and food intake in the following way: “The stress response is comprised of a cascade of adaptive responses originating in the central nervous system as well as in the periphery. It leads to dramatic but time-limited physiological, psychological and behavioral changes that affect appetite, metabolism and feeding behavior. The acute stress response includes behavioral, autonomic and endocrinological changes promoting heightened vigilance, increased heart rate and blood pressure, and a redirection of blood flow to fuel the muscles, heart and the brain. Stressors evolutionarily required an immediate fight or flight response, so energy is diverted to the brain and muscle tissue to save life. Under such circumstances energy spent on housekeeping activities–such as food intake, digestion and reproduction–would be potentially life threatening. Thus, part of the acute stress response includes suppression of appetite and food intake.” (Adam & Epel, 2007, p. 450).

5.2 Cortisol stimulates food consumption

The hypothalamic-pituitary-adrenal (HPA) axis is a principal mediator of physiological stress responses and may play a role in the link between stress and food intake. In response to perceived threat or challenge, corticotrophin releasing hormone (CRH) is released from the hypothalamus, triggering release of adrenocorticotropic hormone (ACTH) from the pituitary, followed by glucocorticoid (GC) release from the adrenal cortex. In a study by George and colleagues (2010), healthy, non-obese adults were injected with CRH at a dose that is subjectively undetectable (eliciting no stress or anxiety). Subsequently, cortisol level and subsequent food intake was measured. Participants ate more after a CRH injection than after a placebo injection.

5.3 People with high cortisol reactivity eat more in response to stress

People differ in their reactivity to stress. It is hypothesized that cortisol reactivity influences stress-related eating. In a study by Epel and colleagues (2001) women were exposed to a stress session and a control session on different days. High cortisol reactors consumed more calories on the stress day compared to low reactors, but ate similar amounts on the control day. This finding was confirmed in another study (Newman, O’Connor, & Conner, 2007), demonstrating that high cortisol reactivity predicts a greater intake of snack food in a naturalistic setting. Thus, People who have high cortisol levels in response to a stressor are likely to eat more, particularly calorically dense food

5.4 Emotional eaters and restrained eaters eat unhealthier foods during stress.

Several studies have shown that people, in particular emotional and restrained eaters, eat unhealthier food when they are stressed (Zellner et al., 2006). Restrained eaters are defined as “chronic dieters who are concerned with their weight and chronically try to restrict the amount they eat” (Papies, Stroebe, & Aarts, 2009, p. 279). In a lab study (G Oliver, Wardle, & Gibson, 2000), participants who performed a stressful task and were classified as emotional eaters (van Strien, Frijters, Bergers, & Defares, 1986) ate more sweet high-fat foods and a more energy-dense meal than unstressed and non-emotional eaters. This finding was confirmed by Habhab et al. (2009). A self-report study by Oliver and Wardle (1999) also showed corroborating evidence. Participants indicated that they snacked more when stressed, and ate less ‘meal-type’ food fruit and vegetables, meat and fish).

5.5 Restrained eaters tend to eat more under stress.

A study by Wardle and colleagues (2000) investigated the effect of work stress on food intake. Restrained eaters had higher energy intake and fat and saturated fat intake when work stress was high, but non-restrained eaters did not. In addition, restrained eaters ate relatively more saturated food during times of high work stress, but this was not the case for non-restrained eaters. Restrained eaters may rely strongly on effortful, deliberate processes to restrain their eating. However, this strategy fails when their mental capacity is low, as is the case when they are under stress.

5.6 Women with higher dietary restraint have higher levels of cortisol, a biological marker of stress.

Several studies (Anderson, Shapiro, Lundgren, Spataro, & Frye, 2002; McLean, Barr, & Prior, 2001; Rideout, Linden, & Barr, 2006) compared the cortisol levels (a biological marker of stress) in women with high and low dietary restraint. **Dietary restraint** or **Cognitive Eating Restraint** is defined as the intent to limit food intake to prevent weight gain or to promote weight loss. Women with high dietary restraint scores had higher cortisol concentrations than did women with low restraint scores. The authors speculate that women with high dietary restraint experience more stress in relation to their daily food-related experiences. Stress activates the hypothalamic-pituitary-adrenal axis, resulting in a release of cortisol into the bloodstream and leading to increased urinary excretion.

6 Interactions between Physical Activity and Stress

There is ample evidence that physical activity and physical fitness is beneficial for mental wellbeing. Physical activity is found to have an immediate effect: engaging in physical activity before or after the occurrence of a stressor alleviates the physiological and psychological response to the stressor. It also has a long-term effect: people who are regularly active and/or physically fit tend to respond better to stressors. The effect of stress on physical activity is studied less extensively. However, there is evidence that stress lowers the level of physical activity. This effect, however, depends on the type of stressor and on people's physical activity habits. The relationships are described in the sections below.

6.1 Cardiovascular fitness reduces the cardiovascular response to psychological stressors

Multiple studies have shown that cardiovascular fitness influences the cardiovascular response following a stressor. Jackson and Dishman (2006) performed a meta-regression analysis of 73 studies that examined whether cardiorespiratory fitness mitigates cardiovascular responses during and after acute laboratory stress in humans. The results indicate that fitness is related to slightly greater reactivity, but better recovery.

6.2 Physical activity is associated with lower levels of perceived stress

People who are regularly active report lower subjective stress levels. Furthermore, physical activity interventions have been shown to result in less perceived stress in real-world settings. Randomized clinical trials have determined that exercise is an effective method for improving perceived stress, stress symptoms, and quality of life (Stults-Kolehmainen & Sinha, 2014, p. 83). Exercise could also lead to reduced stress indirectly, by increasing one's level of self-efficacy and self-confidence. Experiencing improvement and success in the sports domain (e.g., noticing that you can run longer or faster that you would have thought a few weeks ago) may cross over to other domains and help you to better cope with stressors.

6.3 Physical activity immediately before or after a stressful event attenuates the stress response

In addition to the beneficial effects of regular physical activity, studies have shown that even a single bout of aerobic activity may lower the cardiovascular response to a stressor. A meta-review by Hamer and colleagues (2006) showed that performing exercise immediately before a stressful event reduces the blood pressure response.

While most studies investigate the effect of exercising *before* a stressor, one study (Chafin, Christenfeld, & Gerin, 2008) showed that exercising *after* a stressor reduces the duration of the cardiovascular response.

6.4 When stressed, people are less active, especially when they do not have strong physical activity habits

During stressful periods, people are less likely to engage in physical activity (Stults-Kolehmainen & Sinha, 2014). For many people, structured exercise is highly inconvenient (''one more thing to do''), and may be perceived as a burden or minor stressor. Langlie et al (1977) found that during times of stress, individuals feel a lack of control and perceive maintaining health behaviors as costly. Thus, it is likely that those who view exercise as a disruption, an inconvenience or another demand on their time will exercise less during periods of stress. However, research also shows that not all stressors lead to less activity. Some major life events that may be perceived as stressful are associated with an increase in activity (e.g., beginning a new close personal relationship, retirement, changing work conditions, and death of a spouse/partner, divorce and income reduction). This suggests that the negative effect of stress on physical activity may partially be explained by time constraints.

Furthermore, habitual exercisers are found to increase their level of activity when facing stress (Lutz, Stults-Kolehmainen, & Bartholomew, 2010). One explanation may be that habitual exercisers use exercise as a way of coping with stress.

7 Interactions between Nutrition and Physical Activity

Nutrition is related to **energy intake (EI)**, whereas physical activity is related to **energy expenditure (EE),** together resulting in **energy balance**. In order to keep the balance, it is important to match energy intake and energy expenditure. There are several mechanisms that perturb this balance, as explained below.

7.1 People may compensate for exercise by eating more, but there is large variability among individuals

When energy expenditure increases as a result of exercising, the energy balance is perturbed. To restore the balance, several compensatory mechanisms may occur. There are metabolic mechanisms (e.g., decreasing the resting metabolic rate) as well as behavioral mechanisms (e.g., increasing food intake).

A review study by King and colleagues (2007) concluded that people do not fully compensate for exercise-induced energy expenditure by increasing their energy intake. However, there is large inter-individual variability in the amount of energy compensated after exercise. King and colleagues (2007) showed that individuals who participated in a 12-week exercise intervention and experienced a lower than predicted weight loss were actually compensating for the increase in EE by eating more. The authors distinguished 'compensators' and 'non-compensators' and proposed that this distinction may explain why some people experience disappointing weight loss results.

(Church et al., 2009) showed that compensation may be dependent on exercise dose. These findings were part of the results of the Dose-Response to Exercise in postmenopausal Women (DREW) study. This study was designed to examine the health benefits of 50%, 100%, and 150% of the recommended amount of physical activity. Participants (postmenopausal, sedentary and overweight women) were randomized to a non-exercise control or 1 of 3 exercise groups; exercise energy expenditure of 4, 8, or 12 kcal/kg/week (KKW). In the 4 and 8 KKW groups the actual weight loss closely matched the predicted weight loss of −1.0 and −2.0 kg. However, in the 12 KKW group the actual weight loss was less than the predicted weight loss (−2.7 kg) resulting in 1.2 (0.5, 1.9) kg of compensation. Although the cause of this compensation is unclear, the study shows that higher doses of physical activity may not always result in more weight loss.

7.2 People tend to overestimate energy expenditure during exercise and underestimate energy intake by eating.

A study by Willibond and colleagues (2010) shows that people overestimated the amount of energy spent during exercise by 3-4 folds. When they were asked to precisely compensate for the energy expended by eating, the resulting energy intake was 2 to 3 folds greater than the measured energy expenditure of exercise.

8 Summary and conclusions

As has become clear, there are many interactions between various health related behaviors. All of these interactions are negative, in the sense that an impair in one domain is associated with negative results in another domain. Since most interactions are bidirectional, they could result in **negative feedback loops** (e.g., work stress leading to sleep problems, which in turn can lead to impaired coping with stressors). In order to turn these negative feedback loops into **positive feedback loops**, it is important to offer holistic health coaching, addressing multiple problem areas simultaneously. The positive feedback loops created in such holistic interventions can leverage behavior change, making these interventions more effective than interventions that address single behaviors separately.

The table below provides an overview of the interactions described in the previous sections.

Relation	Details
Sleep -> Stress	2.1 Sleep deprivation is associated with decreased levels of the neurotropic factor BDNF, which in turn is related to stress. 2.2 Evening-types are more vulnerable to stress than morning-types. 2.3 Sleep loss increases cardiovascular risk during acute psychological stress.
Stress -> Sleep	2.4 Stress is strongly associated with sleep problems.
Sleep -> Nutrition	3.1 Poor sleep is associated with increased food intake and poor diet quality 3.2 Sleep restriction increases neuronal response to unhealthy food. 3.3 Short sleep duration is associated with appetite related hormones. 3.4 Insufficient sleep results in excess of food intake and weight gain. 3.5 A large proportion of severely obese adults report has poor sleep quality. 3.6 Short sleep is associated with elevated food consumption in individuals who are prone to eat in response to aroused emotional states.
Nutrition -> Sleep	3.7 Specific sleep symptoms are associated with intake of specific dietary nutrients.
Activity-> Sleep	4.1 Physical activity improves sleep through thermoregulation in people with normal sleep schedules and in shift-workers. 4.2 Engaging in physical activity has beneficial effects on sleep quality.
Sleep -> Activity	Poor sleep quality is associated with poorer physical performance (Goldman et al., 2007) . Better sleep quality promotes more day-time physical activity (N. K. Y. Tang & Sanborn, 2014).
Stress -> Nutrition	5.1 Acute stress suppresses appetite and reduces food intake 5.2 Cortisol stimulates food consumption 5.3 People with high cortisol reactivity eat more in response to stress 5.4 Emotional eaters and restrained eaters eat unhealthier foods during stress. 5.5 Restrained eaters tend to eat more under stress.
Activity->Stress	6.1 Cardiovascular fitness reduces the cardiovascular response to psychological stressors

	6.2 Physical activity is associated with lower levels of perceived stress 6.3 Physical activity immediately before or after a stressful event attenuates the stress response
Stress->Activity	6.4 When stressed, people are less active, especially when they do not have strong physical activity habits
Activity -> Nutrition	7.1 People may compensate for exercise by eating more, but there is large variability among individuals 7.2 People tend to overestimate energy expenditure during exercise and underestimate energy intake by eating.

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