Kino Québec

Kino-Québec Scientific Committee Position Statement

KNOWING AND ACTING



# INCREASING PHYSICAL ACTIVITY AMONG QUEBECERS

## *Recommendations*

Votre gouvernement

Québec

# INCREASING PHYSICAL ACTIVITY AMONG QUEBECERS

*Recommendations*

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# HIGHLIGHTS

**To ensure that all Quebecers derive the greatest possible benefits from physical activity,[a] the Kino-Québec Scientific Committee makes two general recommendations:**

1. **That Quebecers increase their physical activity;**
2. **That Quebecers vary their physical activities.**

a See the definition in the glossary at the end of this document.

1. Physical activity guidelines have evolved over the years and through research. However, most of them have shortcomings and are often misinterpreted.

2. Most physical activity guidelines focus on improving and maintaining physical health, especially cardiovascular and metabolic health, and promote weight control. However, there are many other individual and collective benefits associated with physical activity.

3. The scientific evidence is clear: physical activity, if it is adapted, is beneficial for everyone, regardless of fitness level.

4. Each dose-response relationship between the various physical activity parameters and the associated benefits is unique. In general, however, it can be argued that beneficial effects increase with physical activity.

5. It is better to do a little than none at all, and doing more is even better.

6. Each type of physical activity provides specific health benefits, but none combines all the benefits of all physical activities, hence the importance of engaging in a variety of activities.

7. Different opportunities for physical activity allow everyone to find the formula that suits them best while respecting their tastes and interests.

8. It is preferable to encourage the regular practice of varied physical activities of all types and at different intensities, either structured or unstructured, indoors or outdoors and in different contexts and environments.

9. While it is essential to increase and vary the physical activities, we must not overlook the importance of reducing sedentary behaviour.

10. It is important that organizations in Québec's various living environments reduce barriers and make it easy for people to partake in physical activity every day, regardless of age, gender, income, ability, culture or living environment.

# INTRODUCTION

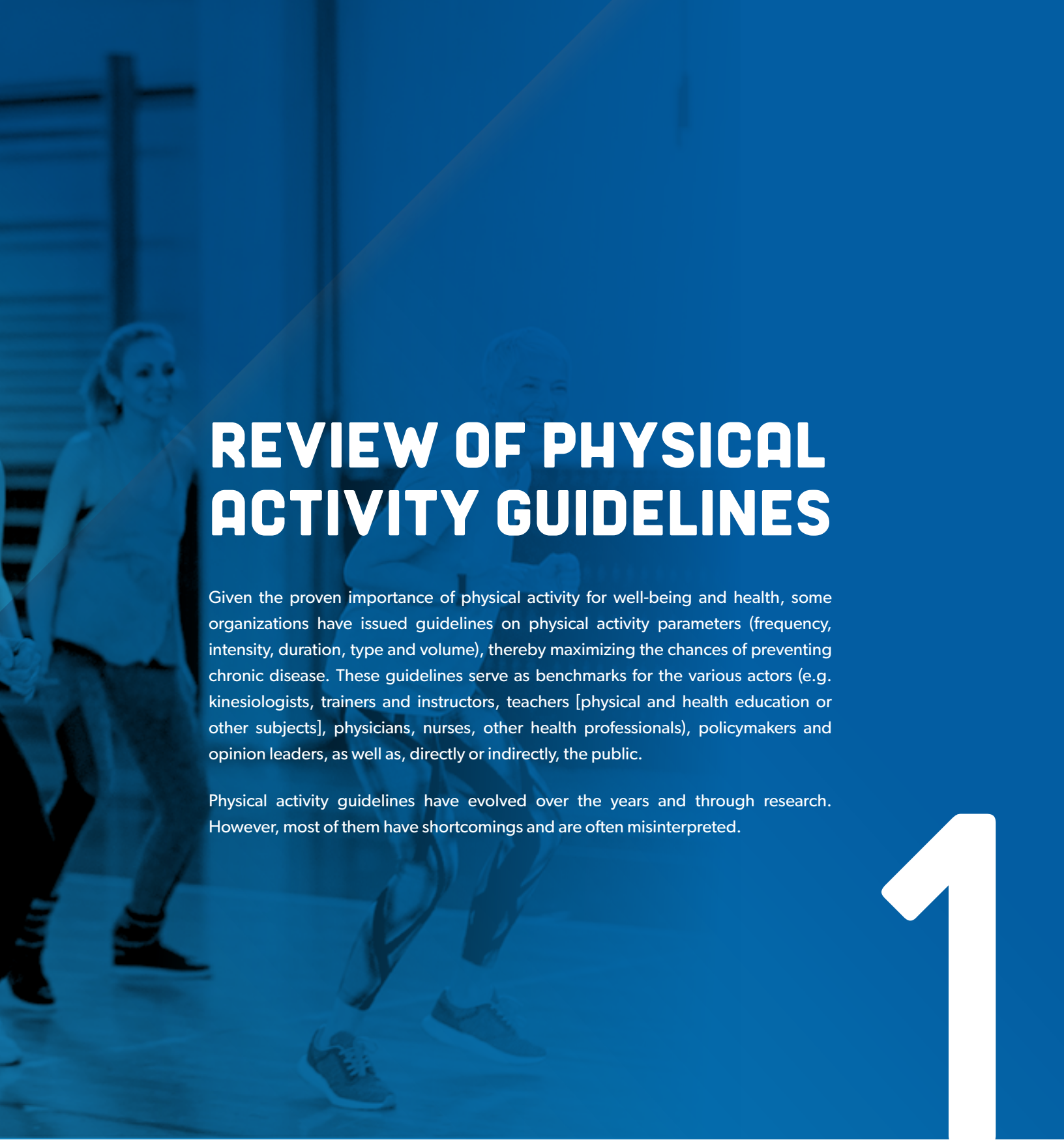
Physical activity generates many individual and collective benefits, as attested by many studies conducted in the last few decades by scientists around the world. These studies have also led to the development of guidelines by influential organizations in the health and fitness fields.

Following the *Policy on Physical Activity, Sport and Recreation: Quebecers on the move!* launched in 2017, Kino-Québec's Scientific Committee deemed it appropriate to take stock of the current state of knowledge on the subject. The report *Increasing Physical Activity Among Quebecers: Recommendations / Knowing and Acting* is the result of the work of this committee made up of Québec experts from the physical activity scientific, medical and professional communities who, by bridging the gap between research and action, ensured the quality of its content.

This position statement presents evidence-based information from a broad literature review, as well as arguments for the value of regular and varied physical activity. It is intended for all individuals and organizations from different backgrounds that can contribute, directly or indirectly, to increasing physical activity among all Quebecers, regardless of age, gender, income, ability, culture or living environment.[b] Divided into three chapters, this position statement:

- discusses the limitations of the current guidelines;
- presents the dose-response relationship between the various physical activity parameters and their benefits;
- presents physical activity recommendations for the entire Québec population and invites the various stakeholders to take them into account in their discourse and actions.

b In this regard, the position statement takes up the concept of Universal Design advocated by the United Nations General Assembly. "Universal Design" is the design of products, equipment, programs and services to be usable to the greatest extent possible, by everyone, without the need for adaptation or specialized design.



# REVIEW OF PHYSICAL ACTIVITY GUIDELINES

Given the proven importance of physical activity for well-being and health, some organizations have issued guidelines on physical activity parameters (frequency, intensity, duration, type and volume), thereby maximizing the chances of preventing chronic disease. These guidelines serve as benchmarks for the various actors (e.g. kinesiologists, trainers and instructors, teachers [physical and health education or other subjects], physicians, nurses, other health professionals), policymakers and opinion leaders, as well as, directly or indirectly, the public.

Physical activity guidelines have evolved over the years and through research. However, most of them have shortcomings and are often misinterpreted.

1

# 1.1 The history of guidelines around the world

Guidelines in this area are not new. In Québec, in the 1920s, Dr. Jean-Gaudiose Paradis had already issued some in the *Manuel pratique d'hygiène, anatomie et physiologie*, intended for use by teachers and written in accordance with the regulations of the Catholic Committee of the Conseil de l'instruction publique.[244] He then stressed that [translation] "exercise, play and sports are not only for pleasure and entertainment; they are also important for health."[244] This section discusses some of the most influential guidelines in the United States, Canada and the world.

**In the United States**, the American College of Sports Medicine (ACSM) was the first organization to issue, in 1975, evidence-based physical activity guidelines for the population. The ACSM addressed the level of physical activity required to improve aerobic fitness, while intimating that there were no health benefits if the prescribed minimum threshold was not met: 20 to 30 minutes of exercise at 60% to 90% of maximum oxygen uptake, 3 times per week. The belief at the time was that only vigorous exercise could improve cardiovascular health. Several studies subsequently revealed that moderate-intensity physical activity could also improve aerobic fitness[c] while providing a variety of other benefits.

While the gains associated with vigorous exercise improve fitness more, moderate physical activity also provides health benefits. Since then, recommendations no longer focused solely on fitness development[d] but also included primary prevention.[e]

In 1996, some scientific and government authorities, in particular the U.S. Surgeon General, revised the minimum recommended intensity downwards, which affected several recommendations in different countries.[46] The new message to the public was that high intensity was not necessary. In 2007, the ACSM recommended 30 minutes of moderate-intensity physical activity 5 days a week or 20 minutes of vigorous-intensity physical activity 3 days a week, adding that more benefits can be obtained by doing more.

In the early 2000s, the harmful effects of sedentary behaviour[f] on cardiovascular health, regardless of physical activity level, were clarified[257] with the result that the recommendations no longer focused solely on the level of physical activity but also on sedentary behaviour such as prolonged sitting.

In November 2018, the U.S. Department of Health and Human Services revised its recommendations for physical activity, stating that adults should engage in at least 150 to 300 minutes a week of moderate or 75 to 150 minutes of vigorous physical activity,[250] and stressing how everyone would benefit health-wise by moving more and sitting less.

**In Canada**, the first guidelines were developed by the Canadian Society for Exercise Physiology (CSEP) in 1998 and updated in 2011.[315] According to these guidelines, adults should engage in at least 150 minutes a week of moderate to vigorous physical activity.

c Aerobic fitness refers to the ability of the cardiorespiratory system—heart, lungs, circulatory system, muscle cells, etc.—to transport and use oxygen to do muscle work.

d Physical fitness is based on physiological qualities such as aerobic fitness, muscular fitness, flexibility and body composition, all of which make it easier to engage in physical activity.

e According to the World Health Organization, primary prevention refers to actions that seek to reduce the incidence of a health problem or disease, in other words, to reduce the occurrence of new cases in a healthy population by reducing its causes and risk factors.

f Sedentary behaviour is any waking behaviour characterized by very low energy expenditure (≤ 1.5 METs) while in a sitting, lying or reclining position.[342]

In 2016, the CSEP broke new ground by releasing the first 24-hour movement guidelines (physical activity at different intensities) and non-movement (sedentary behaviour and sleep) for 5- to 17-year-olds: no more than 2 hours of recreational screen time per day, limit sedentary (motorized) travel and reduce time spent sitting.[316] However, such guidelines for sedentary behaviour have not yet been developed for adults of all ages. For those aged 18 to 64, U.K. and Australian guidelines generally suggest reducing the time allotted to sedentary activities and interrupting long periods of immobility with frequent active breaks.

**Elsewhere in the world**, the best known physical activity guidelines were issued in 2010 by the World Health Organization with the aim of providing policymakers with guidance on the physical activity parameters needed to prevent chronic disease.[237] The following are the key points.

***In order to improve cardiorespiratory endurance, muscular fitness and bone health, and reduce the risk of non-communicable diseases and depression, the following are recommended:***

1) ***Adults aged 18-64 years should do at least 150 minutes of moderate[g] endurance activity throughout the week or do at least 75 minutes of vigorous endurance activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity.***

2) ***Aerobic activity should be performed in bouts of at least 10 minutes duration.***

3) ***For additional health benefits, adults should increase their moderate-intensity aerobic physical activity to 300 minutes per week, or engage in 150 minutes of vigorous-intensity aerobic physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity.***

4) ***Strength training exercises using the major muscle groups should be done two or more days a week.[237]***

g In other words, aerobic activities.

## Other relevant publications

In 2017, **the Gouvernement du Québec** launched the *Policy on Physical Activity, Sport and Recreation*: *Quebecers on the move!* The goal: To increase the proportion of the population that does the minimum recommended amount of physical activity in their free time by at least 10%.[214]

In 2018, the World Health Organization launched the *Global Action Plan on Physical Activity 2018-2030: More Active People for a Healthier World*.[382] The goal: Through measures achievable through 20 actions, to create more active societies by improving environments and providing more opportunities to be physically active.

In 2018, the **Public Health Agency of Canada** released *A Common Vision for Increasing Physical Activity and Reducing Sedentary Living in Canada: Let's Get Moving*.[3]

The goal: To support coordination and collaboration across sectors and orders of government to increase physical activity and reduce sedentary living among Canadians.

# 1.2 Current guidelines: an imperfect framework

Most of the current guidelines recommending at least 150 minutes of moderate or vigorous physical activity per week are useful and fairly simple, and provide a general framework for physical activity for the entire population. These guidelines and their general interpretation do, however, have a number of shortcomings, namely they:

1. **focus predominantly on aerobic activities;**[321]

   **It** is also important to encourage people to engage in a variety of physical activities aimed at improving muscle fitness, flexibility and motor skills.

2. **focus on general health improvement and disease prevention;**

   (e.g. heart disease, metabolic disorders —type 2 diabetes, insulin resistance, hyperinsulinemia and dyslipidemia—and certain cancers);

   **Being** physically active provides other benefits: better mood, psychological health, stress management, cognitive functions, social skills, and more.

3. **call for a minimum level of physical activity, suggesting that there are no benefits if it is not attained;**

   **All** physical activity is beneficial for well-being and health. In fact, the benefits are greatest when people go from no physical activity to some activity.

4. **do not take into consideration people's level of physical activity, their motivation, their fitness level and their state of health;**

   **Getting** 150 minutes of physical activity per week may be too difficult a goal for people who are inactive or minimally active or have health problems and not ambitious enough for those who are already active.

5. **suggest that all of the benefits associated with vigorous physical activity can be achieved through moderate physical activity, provided people do enough of it;**

   **Vigorous** physical activity has more benefits, particularly in improving and maintaining aerobic fitness.

6. **suggest that just doing the minimum amount of physical activity will have the same effect on all the components of well-being, health and quality of life;**[h]

   **The** same amount of physical activity has a different effect depending on the health indicator measured.

h Many factors determine quality of life, including physical health, psychological state, personal beliefs, social relationships and their relationship to living environments.[377]

**7** **imply that all activities have the same value, regardless of the desired benefit;**

**While** all physical activities can be beneficial, none provide the benefits of all physical activities.

**8** **do not sufficiently stress the importance of finding the experience enjoyable and rewarding;**

**The** pleasure and satisfaction of being active are motivating factors in continuing to do so.

**9** **do not take into account the historical, cultural and geographical characteristics of populations;**

**In light of** Québec's northern character, its many bodies of water and the importance of certain sports in its history and culture, winter, aquatic and nautical activities should be especially taken into account.

**10** **do not always mention the environmental determinants of physical activity.**

**The** physical, socio-cultural, political and economic environments play a role in the decision whether or not to engage in physical activity.

The current guidelines, which recommend at least 150 minutes of moderate to vigorous physical activity per week, are therefore far from perfect.

Establishing the dose-response relationship, presented in the next chapter, between the various physical activity parameters and their benefits is certainly not straightforward. Nevertheless, physical activity guidelines have more impact and credibility when they are based on validated, properly interpreted data.

# DOSE-RESPONSE RELATIONSHIP

This chapter focuses on the dose-response relationship between the various physical activity parameters and their benefits. The dose-response relationship describes the magnitude of the physiological response to a stimulus after a certain duration of exposure. In the context of physical activity, this relationship therefore describes the responses observed following a change in one or more physical activity parameters (frequency, intensity, duration, type and volume). Physiological responses (or adaptations when the stimulus is applied repeatedly over a period of time) are generally associated with a multitude of health benefits, which will be discussed in this section. Research is currently underway and more research is needed to better understand the varied responses to a combination of stimuli applied in different contexts. In the meantime, we present a review of current knowledge on the subject.

Most physical activity guidelines focus on improving and maintaining physical health, especially cardiovascular and metabolic health, and on weight control. However, as mentioned earlier, there are many other individual and collective benefits associated with being active, such as the effects of adaptations associated with physical activity on:

- **lifespan** (healthy or without disabilities);
- the **components of physical fitness** (aerobic fitness, muscular fitness, flexibility and body composition);
- **primary prevention** (cardiovascular and metabolic health, cancer, cognitive health, mental health, bone health, respiratory health and immune function);
- **healthy lifestyle choices** (reduction of sedentary behaviour, balanced diet, moderate alcohol consumption, quality sleep and smoking cessation).

Added to these individual benefits are collective benefits, including **financial** (e.g. costs associated with health care, absenteeism and reduced productivity).

# 2.1 Life expectancy

In Québec, life expectancy at birth, that is, the average age at death,[150] has increased and is among the highest in the world.[12] In 2017, despite a slight increase in the mortality rate, it was 80.6 years for men and 84.5 years for women.[12] According to some researchers, it will continue to increase in 35 industrialized countries, including Canada.[175]

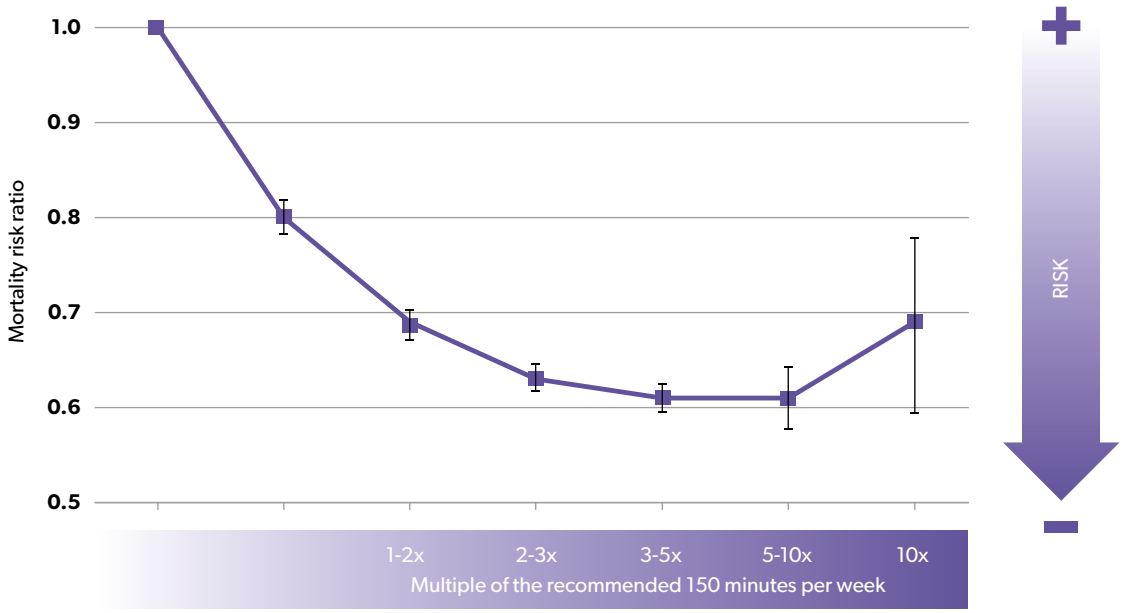
But what about the quality of the "extra" years gained? What are the effects of physical activity on healthy life expectancy or disability-free life expectancy?

"Healthy life expectancy" means the number of years a person can expect to live in good health, that is, without disabilities or limitations in daily activities.[151] For example, if a person's life expectancy at birth is 82 years and his or her healthy life expectancy is 71 years, that person will live about 11 years with some form of disability or limitation. Healthy life expectancy thus combines mortality and morbidity.[i]

i While mortality refers to death, morbidity refers to disease and can refer to the state of illness or the number of people affected by illness in a given population and over a given period of time.

***According to many studies, for an inactive person, any increase in the amount of physical activity will result in a significant reduction in MORTALITY risk. Compared to people who are not physically active, those who do just under the recommended minimum of 150 minutes per week can already reduce their mortality risk by approximately 20% (Figure 1).[8] Even at more than 10 times the recommended amount of physical activity (Figure 1), the mortality risk is not significantly higher. One thing is clear, this risk is still lower than for inactive people.***

**FIGURE 1** › *Dose-response relationship between volume of physical activity and mortality risk*




Adapted from: Arem et al.[8]

**Although there does not appear to be a minimum amount of physical activity that will increase life expectancy, the most pronounced reduction in mortality risk is found at 7.5 hours of moderate exercise (e.g. brisk walking) per week or 3.75 hours of vigorous exercise (e.g. running), which is already 3 times more than the generally recommended minimum amount. Fewer hours of physical activity compensated for by higher intensity can reduce the risk of mortality just as much.**[287, 372]

**In addition, it should be noted that the difference is not significant when comparing 10 times the minimum recommended amount and 5 to 10 times this amount, given the very small sample size. Very few people reach this level of physical activity.**

It is estimated that if all Canadians engaged in at least 150 minutes of physical activity each week, the number of deaths due to the following diseases would be lower:[161]

- coronary artery disease (↓ 19%);
- stroke (↓ 24%);
- osteoporosis (↓ 24%);
- colon cancer (↓ 18%);
- breast cancer (↓ 14%).

There is also a growing body of research that shows an association between long periods of sitting and an increased risk of mortality, which, regardless of physical activity level, can be as high as 50% for those who spend most of their time sitting.[23, 54, 86, 159, 178, 353] A meta-analysis suggests that a high level of moderate-intensity physical activity (e.g. 60-75 minutes per day) appears to eliminate the risk.[91] While physical activity may offer some protection against the detrimental effects of sedentary behaviour, researchers still stress the importance of limiting the amount of prolonged uninterrupted sedentary time accumulated on a daily basis.

Among the ways to reduce MORBIDITY, physical activity is particularly important,[100, 148, 194, 363, 369] as evidenced by two of the many examples of association rather than cause and effect from studies on the subject:

- People in their seventies with a healthy lifestyle (including physical activity) and few risk factors for cardiovascular disease lived five years longer than other subjects[369] and suffered half as many disabilities in the last two years of life.
- Runners (with an initial average age of 58 years) were at risk of not being able to carry out daily activities (such as walking) 8.6 years later than the control group.[50]

## 2.2 Physical fitness

The main benefit of exercise is an improved ability to make physical effort, in other words, better physical fitness. For many, this is one of the main goals other than the pleasure and satisfaction derived from exercise.[67, 217]

### 2.2.1 Aerobic fitness

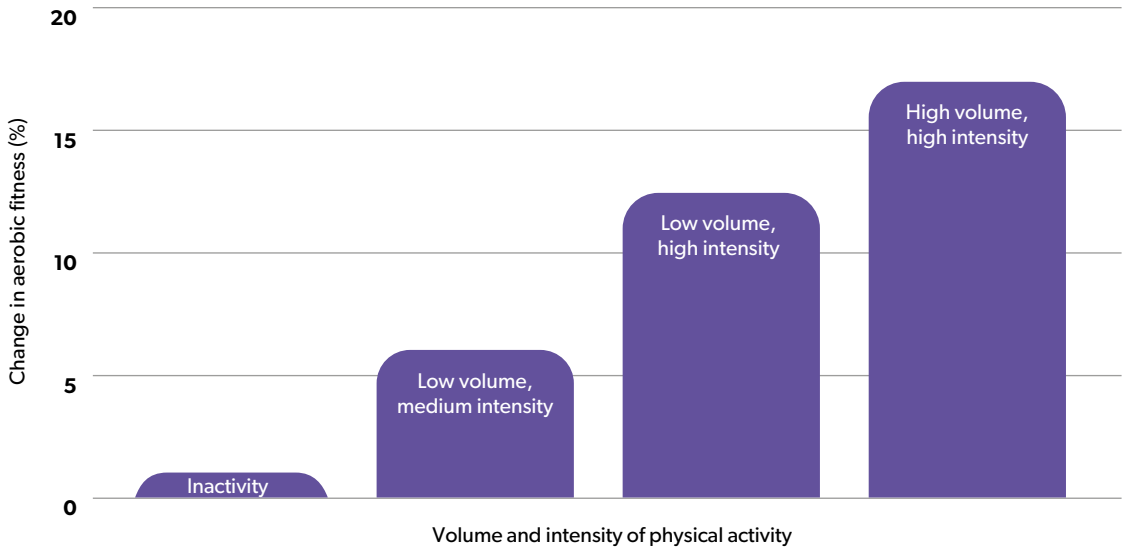
Aerobic fitness refers to the ability of the cardiopulmonary and muscular systems—the heart, lungs, circulatory system and muscles—to carry and use oxygen to do muscle work.

Low maximum oxygen uptake ($VO_2$ max)[j] is currently the best predictor of mortality and morbidity, far exceeding the traditional risk factors for cardiovascular disease.[76, 273] It is even suggested that this variable be considered a vital sign in the control of risk factors for coronary heart disease.[76, 273.] Several studies have been conducted on the subject, including an epidemiological study that followed 25,341 men and 7,080 women and that found that a low $VO_2$ max is associated with a greater risk of all-cause mortality than high blood pressure, high cholesterol, obesity and smoking alone.[24]

***As shown in Figure 2, any increase in the amount of physical activity is accompanied by an improvement in aerobic fitness.[87, 186] For the same volume, vigorous physical activity has significantly more benefits, particularly for the development and maintenance of aerobic fitness.[7, 87, 326, 328, 374]***

j $VO_2$ max is the most common indicator of aerobic fitness, in other words, the maximum amount of oxygen per unit of time that the body can use to produce energy.

**FIGURE 2** › *Improvement in aerobic fitness by amount and intensity of activities after seven to nine months of training*




Source: Duscha et al.[87]

### *Interval or continuous training*

Interval training (IT) involves periods of very high-intensity aerobic activity interspersed with periods of rest (stopping the activity) or recovery (continuing the activity at a sufficiently low intensity so that the person is able to complete the next period of effort). In a continuous workout, the intensity of the exercise does not vary (or only slightly) between warm-up and cool-down. IT involves a longer period of high-intensity exercise. It also offers infinite possibilities since each component is modular:

- the number of sets;
- the number of repetitions per set;
- the intensity and duration of effort intervals and recovery periods between repetitions and sets;
- the overall degree of difficulty, etc.

★ **IMPROVING AEROBIC FITNESS**

**Improve aerobic fitness through physical activity:**

- continuous: e.g. swimming, jogging, pedalling at a stable or almost stable intensity;
- intermittent (in intervals): e.g. team sports, tennis, bout of interval training on a stationary bicycle or while running.

IT improves aerobic fitness faster and more dramatically than continuous training, even when the energy expenditure is the same.[71] A wealth of recent research clearly shows that high-intensity interval training (HIIT) has more benefits than continuous exercise not only on aerobic fitness but also on cardiovascular health (including blood pressure), insulin sensitivity, lipid profile and body composition.[29, 165]

This benefit, which appears both following strength training sessions[243] and intermittent aerobic activity, has been observed in both asymptomatic subjects and those at risk for cardiovascular disease[123, 375] (including hypertension[30]) and metabolic disorders[41] or who suffer from these health problems.

## 2.2.2 Muscular fitness

Muscular fitness includes strength, power and endurance. Muscle strength is the ability of a muscle or group of muscles to exert force against resistance. Muscle power is the ability to move a load quickly (product of applied force and speed of movement). Finally, muscle endurance is the ability to sustain a contraction or repeated contractions with a given load and over a long period of time (with many repetitions, for example).

In general, muscle strength increases from early childhood to early adulthood and then decreases. Since skeletal muscle is one of the most adaptable tissues in the human body, muscle strength can be maximized or its decline slowed through sufficient physical activity.

Muscle building exercises increase or maintain muscle mass and strength, even in people with a health problem or disease such as stroke, multiple sclerosis, cerebral palsy, spinal cord injury or cognitive impairment.[350.]

In older people, a marked deterioration in muscle capacity, particularly due to lack of strength-building activities, is especially problematic as it accelerates the normal decline in muscle mass and strength.[28] The loss of muscle strength (dynapenia) is faster than the loss of muscle mass (sarcopenia).

Physical activities, particularly those involving strength building, can, however, help prevent and combat age-related sarcopenia and dynapenia since they positively impact both the nervous and muscular systems. Still, a few strength-building exercises are not enough to increase the muscle mass and strength older adults need to maintain their independence and functional abilities. It takes at least two or three intensive weekly sessions.[198] Aerobic exercise can also help slow the loss of muscle mass due to aging[350] but never as much as strength-building exercises.

Between 2000 and 2013, 12,003 seniors died in Québec as a result of a fall, an average of 857 per year.[109] Fear of falling also has unfortunate consequences because limiting daily activities, independence and social interactions reduces quality of life. Strength building and balance exercises are the most effective ways to reduce the risk of falling.

**★ PRESERVING AUTONOMY AND FUNCTIONAL ABILITIES**

Muscle-building activities are necessary to increase strength and endurance[381] and thus preserve autonomy and functional abilities over the years.

### 2.2.3 Flexibility

Flexibility is the ability to move a joint through its full range of motion. Although it decreases with age, immobility and inactivity, flexibility is necessary to maintain mobility and motor skills. In addition to reducing the risk of fractures, it can preserve autonomy.[163] However, to improve flexibility, stretching must be done regularly and diligently. Ideally, for optimal effectiveness, stretching exercises should be done in dedicated sessions or following a training session.

There are a number of ways to increase flexibility, including:

- static (with constant resistance) or dynamic (with movement) stretching exercises;
- proprioceptive neuromuscular facilitation ("stretch-contract-release-stretch" technique), which appears to be the most effective method;[281, 334]
- physical activities with a wide variety of extended range of motion moves, including yoga[147] and tai chi.[126]

### *Static and dynamic stretching*

**Static stretching** does very little, if anything at all, to increase flexibility in the long run and can briefly reduce muscle strength and power significantly.[241, 247] On the other hand, it can restore the flexibility lost after a long period of physical inactivity or after an intensive or long bout of physical activity.[208]

**Dynamic stretching** significantly increases strength, power, speed and agility when done before an activity.[241, 247] It is more appropriate for warming up before an activity that requires:

- strength and power (e.g. jumps, strength training, golf);
- speed and agility (e.g. soccer, hockey).[19, 241, 247]

Since dynamic stretching has not been well studied, its effects on activities that require endurance (e.g. running, cycling, triathlon) are not well known.[247]

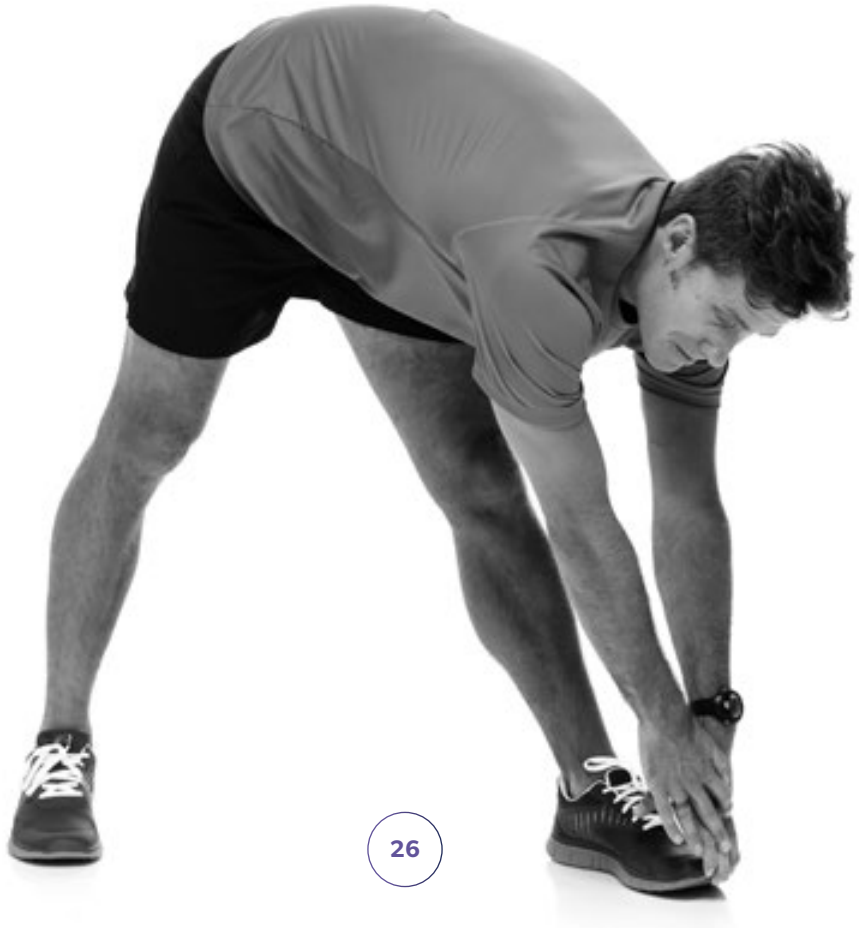
Since the effects of stretching can vary from one person to another,[66, 69, 219] flexibility programs should be personalized,[241] especially in the case of dynamic stretching, which can cause a person to tire faster.[247]

Finally, several studies have shown that stretching exercises, performed during a warm-up or cool-down, do not reduce post-workout aches and pains or the risk of injury.[136, 137, 241, 303, 304, 334]

If the goal is to reduce the risk of injury, it would be more appropriate to do stretching exercises that target the muscles and joints at risk in the activity performed.[196]

## Physical activities and stretching go hand-in-hand

People who walk regularly tend to have more flexibility in their hips and spine.[32] However, limited motion of a specific joint can lead to a loss in flexibility. [32] For example, people who spend several hours per day sitting may find that their shoulders round forward as a result of decreased range of motion at their shoulder joint.[32] Physical activities therefore complement simple stretching to improve flexibility.



## 2.2.4 Body composition

Body composition can be defined, in simple terms, as the relative proportion of fat and lean body mass in the human body.[327] Excess weight and obesity, particularly a significant accumulation of abdominal fat, are linked to very high risks of chronic diseases such as type 2 diabetes, hypertension, dyslipidemia and cardiovascular disease.[77, 314, 327]

It is now known that physical activity, even without calorie restriction, can lead to weight loss, and a decrease in visceral adipose tissue,[k] subcutaneous fat tissue[l] and total body fat.[275, 276] However, this requires a tremendous amount of exercise that is not easily attainable.

Expending more energy through physical activity is also beneficial in that it:

- improves physical fitness, which could eventually allow people to increase the duration and intensity of the activities;
- reduces the muscle and bone mass loss that often follows weight loss;[275, 276;]
- diminishes the decrease in resting metabolic rate following weight loss.[275, 276]

Several studies have also shown the effectiveness of physical activity in weight management programs. There is a registry in the United States of more than 10,000 people who, after losing at least 30 lb (~13.6 kg), have managed to maintain their weight for at least one year. Most of them had, among other things, engaged in moderate to vigorous exercise for approximately one hour a day.[42, 44]

**★ A WINNING COMBINATION**

Physical activity can lead to greater weight loss if combined with a dietary change involving a reduction in caloric intake.[298] In addition, combining aerobic activities AND muscle strengthening activities promotes fat loss while limiting the decrease in lean body mass.[1]

***For more than a decade, numerous studies have converged towards the same conclusion: physical activity reduces the risk factors for cardiovascular disease, including reducing abdominal obesity, whether or not accompanied by weight loss,*** [75, 118, 153, 162, 228, 274, 298, 311, 362] ***thereby taking advantage of the positive impact of physical activity regardless of body composition. This message needs to be "hammered home" to promote physical activity for its benefits, which go far beyond weight loss.***

k Accumulation of adipose tissue around the intra-abdominal organs (visceral fat).

l Accumulation of fatty tissue under the skin.

# 2.3 Primary prevention

Numerous studies show the effectiveness of physical activity in primary prevention[m] of cardiovascular disease, metabolic disorders, certain cancers, cognitive, mental, bone and respiratory problems, and immune disorders. Kino-Québec's Scientific Committee chose to focus on the primary prevention of certain diseases and is aware that not all diseases are covered in this narrative review.

## 2.3.1 Cardiovascular and metabolic health

A growing number of researchers are suggesting that low-intensity physical activity can have benefits for heart and metabolic health[n] and reduce the overall mortality risk.[108] However, moderate or vigorous intensity provides more cardiovascular and metabolic benefits because it:

- promotes the mobilization of visceral adipose tissue or ectopic fat deposits, even without weight loss;[29, 165]
- helps reduce the risk of coronary heart disease;[189, 331]
- helps improve insulin sensitivity,[155] glycemic control[2, 197] and lipid profile.[345]

However, regardless of intensity, many of the observed positive effects are most pronounced in the hours following a bout of exercise. This is the case for insulin sensitivity, which improves for 48 to 72 hours,[22] and for systolic and diastolic blood pressure, which decrease for a few hours after a bout of exercise.[55, 112, 127]

> ***These immediate effects suggest that partaking in physical activity every day or two helps maintain cardiovascular and metabolic benefits. In addition, getting at least 150 minutes of physical activity per week in short bursts can reduce certain risk factors associated with cardiovascular disease as much as longer bouts.[115]***

One study showed that improving aerobic fitness by one MET[o] is associated with a 13% decrease in all-cause mortality risk and a 15% decrease in cardiovascular disease mortality risk.[186] Strength-building exercise also has positive effects, including improved lipid profile, glycemic control and insulin sensitivity, and a reduction in systolic and diastolic blood pressure.[45, 64, 95, 176, 330] Adding them to an aerobic-type activity can therefore further reduce these risks.[167, 279, 321, 322, 379]

m There are, of course, many studies showing the benefits of physical activity in secondary and tertiary prevention. There are also positive impacts for people with a known health problem. However, these relationships are complex and are not addressed in this position statement.

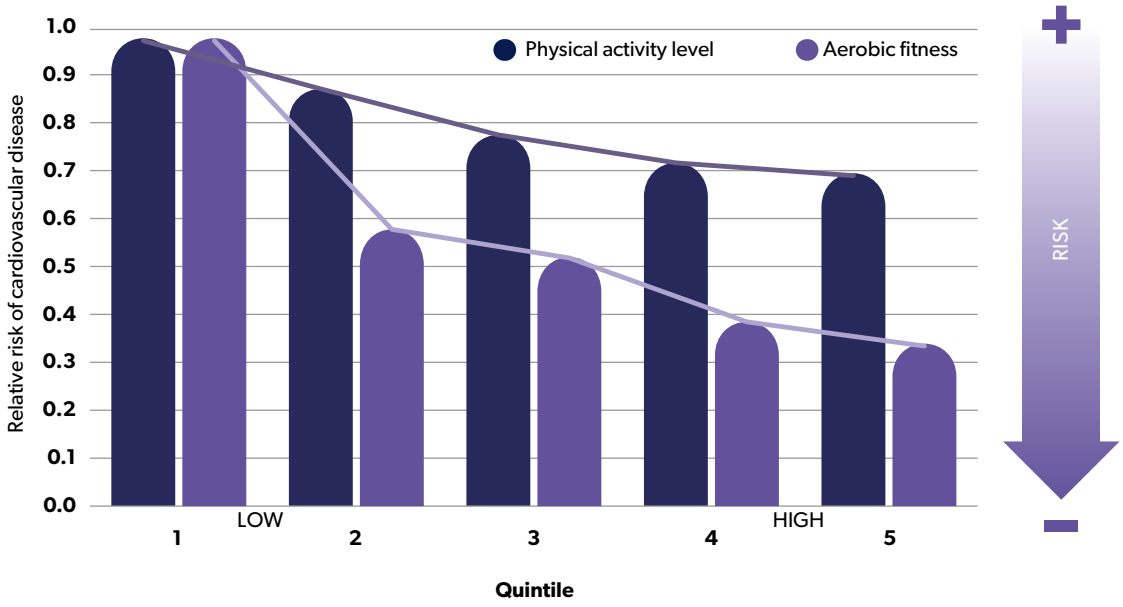
n Cardiometabolic risk factors include glucose metabolism, low blood levels of HDL cholesterol, high blood pressure and excess weight.

o One MET, or metabolic equivalent, is a ratio of energy used in exercise and the resting energy expenditure.

In 2001, a group of researchers examined the links between aerobic fitness, physical activity level and cardiovascular disease risk. While the risk was 64% lower in those with high aerobic fitness than in those with low aerobic fitness, there was only a 30% difference between those with the highest and lowest levels of physical activity (Figure 3).[380]

Beyond the physical activities, people with excellent aerobic fitness are therefore twice as protected from cardiovascular disease. It should be noted that the only way to improve aerobic fitness is to engage in moderate or vigorous aerobic exercise, but for equivalent total energy expenditure, vigorous-intensity activities are more effective.[326, 329.] Aerobic fitness is not only genetic; it can be improved and thus impact mortality.[26, 174, 183, 202, 297]

**FIGURE 3** › *Cardiovascular disease risk by aerobic fitness and physical activity levels*




Source: Swain[326] and Williams[380]

**Aerobic fitness is associated more with cardiovascular and metabolic health than activity level.**[25, 172, 358, 380]

N.B. The measurement of physical activity level, expressed here in quintiles, is often subjective (self-reported) and subject, among other things, to overestimation, whereas the measurement of aerobic fitness is objective.[284]

Also, good aerobic fitness is not enough; its level must be maintained and benefits increase as it improves.[26, 94, 183]

### Sudden cardiac death

The incidence of sudden cardiac death[p] in apparently healthy people ranges from 1 in 3,000 to 1 in 1 million people, depending on ethnicity, gender and the sport involved.[131, 253] Vigorous physical exertion slightly increases the risk of sudden death during and within an hour of exertion, but the risk is extremely low.[10, 173] Because the population's lack of physical activity is such a serious problem, the prevalence of sudden cardiac death is negligible in comparison.

## 2.3.2 Cancer

Physical inactivity is increasingly recognized as a major risk factor for cancer.[98] Approximately 25% of cancer cases are thought to be due to excess weight and lack of physical activity.[207]

Cancer mortality is inversely associated with the level of physical activity at work and leisure time.[240, 333] A 2016 study of 1.44 million people confirmed the inverse association between physical activity level and the risk of colon, breast, lung and endometrial cancer.[220] According to the data from this study, high levels of physical activity are associated with lower risks for 13 types of cancer: esophageal adenocarcinoma; liver, lung, kidney, stomach or endometrial cancer; myeloid leukemia; myeloma; colon, head and neck, rectal, bladder and breast cancer.[220] The risk reduction ranges from 10% for breast cancer to 42% for esophageal cancer.

The **intensity of** physical activity appears to play a role in reducing cancer risk. While moderate-intensity activities reduce this risk, vigorous-intensity activities are associated with greater reductions for breast cancer,[107] colorectal cancer and prostate cancer.[28, 180] High-intensity interval training improves insulin sensitivity and makes weight management easier.[165] Excess weight is one of the main risk factors for several types of cancer.

The minimum weekly **duration** required to prevent cancer varies depending on the type of cancer. For example, one study found that just under 2 hours of physical activity per week reduces the risk of colon cancer by 28%, by 32% with 3 or 4 hours, 41% with 4 to 6 hours and 17% with 7 hours or more.[52] For breast cancer, some studies suggest that 30 to 60 minutes of physical activity every day are needed to reduce its incidence.[187]

Although **frequency** does not appear to be the most important determinant, it is important to be active as often as possible, since each bout can influence several mechanisms related to certain cancers.

p Sudden death is defined as a natural (non-traumatic) unexpected fatal event occurring within one hour after the onset of symptoms (chest pain, shortness of breath) in an apparently healthy subject.[256] Sudden cardiac death is a sudden unexpected fatal event from a cardiac cause that was either known or established by an autopsy, or from an unknown cause.[10]

### 2.3.3 Cognitive health

It's not just intellectual stimulation, such as doing crosswords, memory games or mathematics, that improves cognition.[q] A growing body of research shows that physical activity plays a direct role in brain structure and cognitive activity.[320, 365, 370]

Through its positive effects on cardiovascular health, neurotrophic factors, insulin sensitivity, oxidative stress and inflammation, physical activity is believed to influence cognitive health at different stages of life[164, 201, 260] and to provide some protection against neurodegenerative disorders, including Alzheimer's (dementia) and Parkinson's disease.[201]

While it has been proven that physical activity is good for the brain, further studies are needed to determine which physical activity parameters have the most important effects on cognition.

#### *Anatomical structure*

**In young people**

From birth to adulthood, the brain undergoes many developmental changes.[166, 191] During childhood, physical activity, especially aerobic, can preserve grey matter[r] and white matter,[s] which could have a positive effect on cognitive development.[37, 141, 142]

Several studies of children aged 8 to 11 years have found that high aerobic fitness is associated with:

- a greater volume of the brain structures that participate in regulating attention, memory and learning;
- preservation of white matter and better myelin formation, resulting in more efficient nerve signal transmission between neurons.[201, 291, 293]

In addition, high aerobic fitness is also a predictor of better learning, better memory, and increased volume of the hippocampus,[48, 49, 139] an important site for memory performance.[302] However, studies on the subject suggest that aerobic activities contribute more to encoding new memories than to improving memory itself.

q Mental processes involved in gaining knowledge and involving memory, language, reasoning, learning, intelligence, problem solving, decision-making, perception and attention.

r The grey matter is where mental operations are processed and information is stored. This is the outer layer of the brain, the cerebral cortex, which consists of many neuron cell bodies that store information.

s A white substance that lies beneath the grey matter composed of millions of communication "cables," each containing a single long fibre (axon), covered by myelin, a white, fatty substance.

**In adults**

According to a literature review published in 2017, at least 82% of grey matter volume is modifiable by physical activity.[17] A Finnish study of self-reported physical activity by 1,449 subjects aged 45-57 years found a positive relationship between physical activity level and total brain volume, which is mostly attributable to a higher volume of grey matter.[277]

These results suggest that physical activity has a positive effect on the anatomical structures of the adult brain.

**In older people**

From the age of 60 onwards, grey matter decreases by 0.5 to 1.0% per year,[103] which causes, to a substantial degree, an accelerated decline in cognitive function.[103, 285] Aerobic physical activity can slow this decrease and even help increase grey matter in the frontal, parietal and temporal regions.[59]

A 2018 meta-analysis suggests that physical activity slows age-related hippocampal volume loss.[102] In a randomized controlled study of an exercise program, researchers observed an increase in hippocampal volume and spatial memory.[93]

Other studies also show a relationship between improved aerobic fitness and a decrease in the severity and volume of age-related lesions in white matter.[235, 296, 347]

***Since there is a correlation between aerobic fitness and cortical network connectivity,[367] older people should engage in a variety of physical activities to improve it.[201]***

### *Cognitive activities*

**In young people**

Several scientists have found a relationship between physical activities and cognition, particularly executive functions[t] and memory. However, it is increasingly clear that executive functions are especially sensitive to physical activities.[57, 92, 361] The positive cognitive effects could be due to an increase in cerebral blood flow and therefore oxygenation in the frontal region of the brain.[361] This would manifest, for example, by a significant improvement in planning ability and by a positive linear relationship between the amount of exercise and degree of improvement.[72]

Regarding memory, researchers have found that to achieve similar performance, the hippocampus of adolescents with poor aerobic fitness must work harder than that of young people with high aerobic fitness.[140]

Is there a relationship between academic performance and physical activity? According to the majority of studies on the subject, the relationship is positive and statistically significant, although weak.[96, 190, 254] In the case of mathematics, 86% of the studies found a positive effect.[309] In any case, increased physical activity, even when accompanied by a reduction in classroom learning time, is not associated with lower academic performance. In fact, in just over half of the studies, it was linked to improvement in school performance in addition to improved fitness.[47, 346]

In terms of improving attention in the classroom, two strategies have proven successful:

- Encourage students to be active and play during recess;[205, 263]
- Introduce active breaks during school hours.[263] This is especially beneficial for students with Attention Deficit Hyperactivity Disorder (ADHD).[318]

In a 2015 study, a five-minute period of high-intensity active play restored the attention span of children aged 10 to 16 diagnosed with ADHD. Their scores on an attention test were 30% higher than those of the group that had not participated in the activity and the same as those of students without ADHD.[305]

**In adults**

Cognitive performance—memory, reasoning and processing speed—begins to decline as early as age 20.[286] Although the very definite relationship between physical activity and cognitive health has been less studied in adults than in children and older people, a number of research studies show that physical activity can:

- improve cognitive function, especially attention, information processing, executive functions and memory;[65, 308, 312]
- preserve and even improve future cognitive health.[105, 201]

In addition, aerobic activities, because they lead to the formation of new neuronal cells (neurogenesis) in the brain, improve performance in cognitive tasks.[89, 99, 354]

t Executive functions help in goal-oriented actions. It is defined as a set of functions that is often compared to a conductor whose goal is to coordinate other cognitive functions.[9]

**In older people**

An increase in aerobic activity and strength training has a positive impact on cognitive function.[51, 58] The authors of a study of women aged 70 to 80 years observed an improvement in spatial working memory in both the aerobic and strength-building groups,[220] suggesting that these activities positively impact memory in older adults.[225]

A literature review published in 2018 goes further: aerobic and strength-building activities should be combined with body and mind exercises (yoga, tai chi, mahjong or a combination of these).[119]

### *Long-term cognitive health*

**In young people**

A growing body of research indicates that the positive effects of physical activity on cognitive health continue into old age.

For example, physical activity between the ages of 15 and 25 is associated with better processing speed in men aged 62-85 but not in women (which may be due, in part, to lower-intensity physical activity).[79] In contrast, a study of 9,000 women found a lower prevalence of cognitive impairment at age 71 among those who had been physically active in adolescence, at age 30, at age 50 and later in life than among women who reported never having engaged in physical activity or sports.[211] But—and this is very important—the greatest protective factor was physical activity during adolescence.[211]

***In light of the proven and recognized benefits of physical activity in childhood and adolescence for healthy cognitive and brain development and the fact that it can contribute to improved cognitive performance decades later, physical activity should be encouraged from early childhood onwards.***[201]

**In adults**

A growing number of studies show a link between physical inactivity in adulthood and an increased risk of later cognitive impairment, particularly Alzheimer's disease.[16, 231]

It is estimated that 30% of dementia cases worldwide are attributable to seven interrelated modifiable risk factors:[231] inactivity, hypertension and obesity in adulthood, diabetes, depression, smoking and low educational attainment. Physical activity in adulthood may slow or prevent cognitive decline and dementia by reducing the prevalence of obesity, diabetes, hypertension and depression.[201]

Many researchers consider that physical activity in the 25 or so years before the age of 50 is a guarantee of good cognitive function.[143] However, low levels of physical activity and television viewing for more than three hours a day contribute to slowing down executive functions and processing speed around the age of 50.

***In short, the results of meta-analyses and retrospective and longitudinal studies all point in the same direction: physical activity in adulthood is one of the most important factors in maintaining or even improving cognitive function and preventing dementia.***[201]

## Preventing dementia

If 25% of the world's population were more physically active, more than 1 million cases of dementia would be prevented.[16]

**In older people**

Three lifestyle factors are believed to slow cognitive decline and prevent dementia:

- An integrated social network
- Cognitive leisure activities
- Exercise[102]

Physical activity, including aerobic exercise targeting modifiable risk factors and neuroprotective mechanisms, reduces age-related cognitive decline and neurodegenerative diseases such as Alzheimer's and other types of dementia.[169] People aged 70 to 80 who have engaged in moderate or vigorous physical activity for more than 150 minutes per week for the past 5 years or more have a 40% lower risk of developing Alzheimer's disease than those who partake in little or no physical activity.[288]

Researchers also found that cognitive function improved in women and men with dementia who performed at least 15 minutes of stationary bike exercise a day for 15 months, while that of the control group declined. The more severe the cognitive impairment at baseline, the greater the improvement.[34] However, a large randomized controlled trial indicated a lack of clinical improvement despite an improvement in physical fitness.[181]

Even in centenarians, there is a positive correlation between cognitive health and performance in the three-metre walk test and between cognitive health and handgrip strength.[359]

In summary, low physical activity is a modifiable risk factor for cognitive decline and dementia.

***While increasing the amount of physical activity provides some protection against dementia, varying the type and intensity increases the protection.***[236, 252]

### 2.3.4 Mental health

A growing body of research shows the positive effect of physical activity on mental health.[u] An international consensus statement published in 2018 recommended that physical activity be integrated into the treatment of mental illness[v] to reduce its impact on comorbidities and life expectancy.[271] However, physical activity seems to be a recommendation that is still too often overlooked in mental health care.[383]

This is unfortunate since most people with mental health problems have a higher risk of chronic diseases (diabetes, hyperlipidemia and cardiovascular disease) associated with sedentary behaviour and the many side effects of medication.[268] The mortality rate associated with these chronic diseases is also higher.[40, 313, 325]

However, physical activity can:

- improve mood;[106]
- increase self-confidence;[68, 106]
- increase the sense of social inclusion[290] and psychological well-being;[83, 110, 130, 245, 255]
- ease schizophrenia symptoms,[101, 145, 355] anxiety,[184] post-traumatic stress,[272, 357] and depression;[20, 83, 184, 294, 355]
- help weight loss and alleviate drug-induced metabolic syndrome.[356]

Many of these positive effects are due to the production of endorphins, because these so-called pleasure hormones do more than just boost the immune system: they protect against stress, improve mood and induce a sense of euphoria.[78]

#### Depression causes illness and disability

The World Health Organization reckons that in 2020, depression will be the second leading cause of disease and disability after cardiovascular disease.

People with anxiety disorder who engage in at least 150 minutes per week of moderate to vigorous physical activity maximize the benefits of that activity, while those who do more derive little or no additional benefit.[110, 130] These are therefore short-term effects, as they are the same after a single bout or several weeks.

***In terms of mental health prevention and promotion, it is important to encourage people to engage in physical activity regularly and diligently but not excessively.[w] That said, further studies are needed to clarify the dose-response.***

### 2.3.5 Bone health

People who do regular weight-bearing activities have higher bone mineral density than those who do little or none. However, the effect of physical activity on bone mass is limited to the structures loaded during exercise. For example, during walking, the mineral content and structural architecture of the lower limb bones, which are heavily and frequently used, are enhanced, unlike those of the upper limbs, which are not directly used.[61]

u Mental health is [translation] "a state of well-being in which a person can achieve self-fulfilment, cope with the normal stresses of life, perform productive and rewarding work, and contribute to community life."[238]

v Mental illness is characterized by changes in a person's thinking, mood or behaviour that cause distress or suffering.[216]

w Excessive physical activity can cause extreme fatigue and generate psychological symptoms that mimic depression.[242]

Bone mineral density varies depending on the activity and:

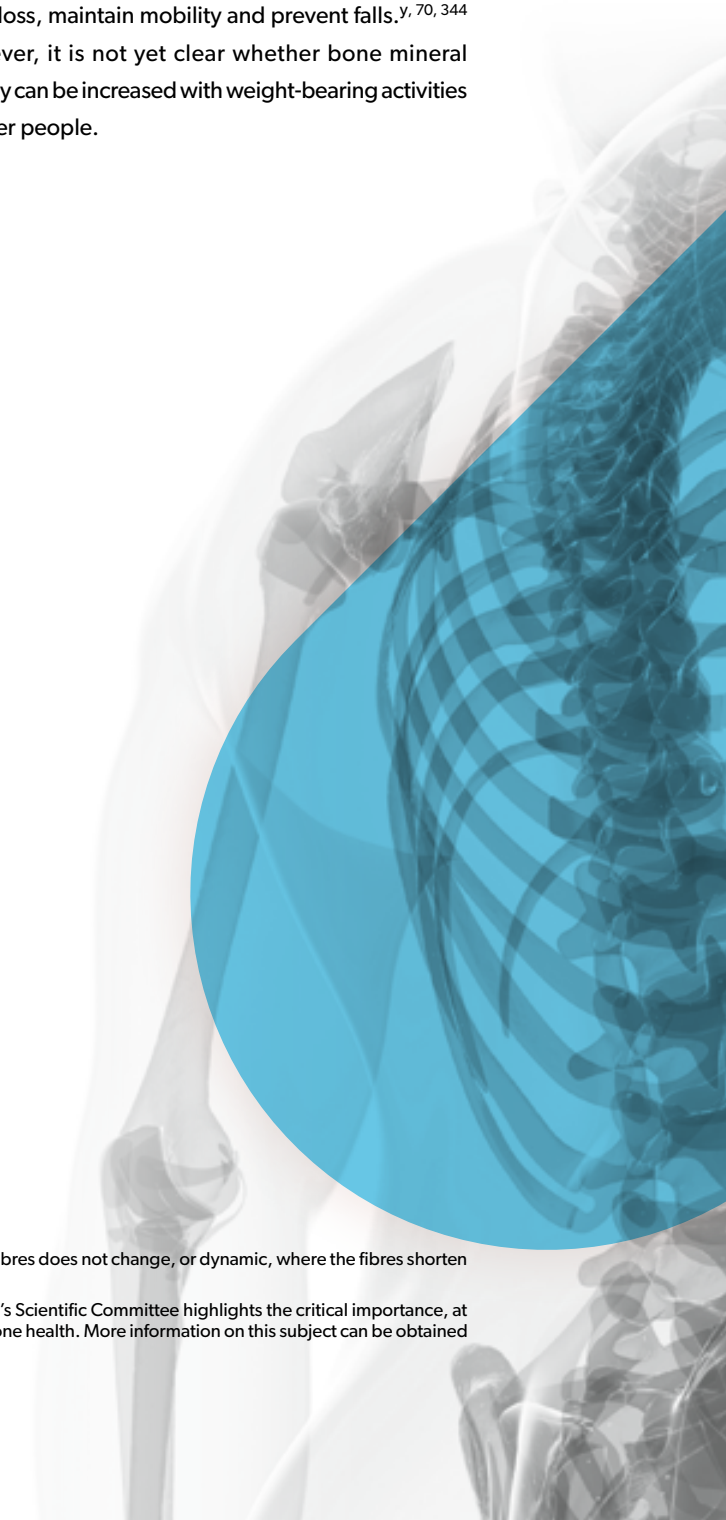
- is no higher in swimmers, kayakers and cyclists who partake only in these low-impact, weight-bearing activities than in those who engage in little or no activity;
- is higher in runners than in people who do little or no physical activity because the impact force is three to five times the body weight but much lower than in people who do gymnastics, an intermittent activity where the impact forces are multidirectional and ten to twelve times the body weight;
- is very high in people who play squash, soccer and volleyball, which are intermittent sports with large, multi-directional impact forces.[13]

Physical activities that place significant, but not excessive, mechanical stress on bones are those that induce the best bone adaptation. The adaptation is greater if the mechanical stress is applied rapidly, in short repeated periods, and is multidirectional.[13] Frequent stimuli optimize gains, provided there is an average of eight hours of recovery time [61, 269] to restore 100% skeletal sensitivity to the mechanical stimuli.

Strength-building exercises also improve bone mass.[221] However, high loads are necessary even if the number of repetitions is lower and are preferable for improving bone mass to a strength training program focused on endurance. Explosive exercises or exercises involving eccentric muscle contractions[x] increase bone mineral density more than concentric muscle contractions.[122, 366]

A higher volume of physical activity leads to a smaller decrease in total bone mineral density, which will persist even after training is stopped.[120]

In addition, bone adaptation is much more pronounced during periods of growth, especially before and at the onset of puberty.[158] Thus, intermittent physical activities, where the progressively increased, multidirectional impact force stresses the lower and upper limbs, can significantly increase the bone mass of young people. For those over age 35, exercise can reduce bone loss and, in some cases, lead to a modest increase. And for those over 50 who have not been diagnosed with osteoporosis, it can slow age-related bone loss, maintain mobility and prevent falls.[y, 70, 344] However, it is not yet clear whether bone mineral density can be increased with weight-bearing activities in older people.



x A muscle contraction can be static or isometric, that is, the length of the muscle fibres does not change, or dynamic, where the fibres shorten (concentric) or lengthen (eccentric).

y In its position statement *Activité physique et santé osseuse* (2008), Kino-Québec's Scientific Committee highlights the critical importance, at every stage of life, of regularly engaging in certain types of physical activity for bone health. More information on this subject can be obtained by consulting that document.

### 2.3.6 Respiratory health

Physical activity improves respiratory health by increasing the amount of oxygen extracted by tissue and improving blood distribution to active muscles.[381]

The respiratory system rarely restricts physical activity in healthy individuals since its capacity generally exceeds the demands of maximum effort.[278, 381] In addition, the body's adaptations to physical activity are seen mainly in muscle cells and not in the lungs.[381]

## Beware of harmful environments

Scientists believe that the presence of harmful elements in certain physical activity environments, such as chlorine in swimming pools and cold dry air in gyms, is responsible for some lung diseases.[97] People repeatedly exposed to such elements for long periods of time are therefore more likely to suffer from asthma, for instance, than the general population.[349]

Athletes with a genetic predisposition to developing common allergies are 25 times more likely to develop asthma if they engage in speed and power activities and 75 times more likely to develop asthma if they partake in endurance activities.[295]

### 2.3.7 Immune function

By improving immune function, physical activity allows the body to better defend itself against infections. However, prolonged (> 1.5 hours) bouts of moderate- to vigorous-intensity exercise over long periods without adequate recovery has a detrimental effect on immune function[116, 117] that can last upwards of 24 hours, resulting in greater risk of infection.[116, 117] For example, marathon runners or athletes with a high training load may be more prone to upper respiratory tract infections (e.g. cold, cough, flu, sinusitis, tonsillitis and other throat or middle ear infections).[117]

The decline in immune function after prolonged physical activity is thought to be due to:[117, 246]

- an increase in the concentration of stress hormones circulating in the body (e.g. adrenaline and cortisol);
- a change in the balance of pro-inflammatory or anti-inflammatory immune system hormones that slow or stop immune activation.

Further research on the subject will provide a better understanding of the effect of physical activity parameters on immune function markers and the mechanisms associated with improving the immune system by type of physical activity and population.

Aerobic-type activities appear to have the greatest positive impact on immune function.[299] Researchers have found a significant decrease in the incidence and severity of colds in people who partake in aerobic activities five or more days a week compared to those who do so less than once a week.

They also found a significant decrease in the incidence of upper respiratory tract infections:[229]

- in people who engage in physical activity more than once a week, compared to those who engage on average in less than one bout per week;
- among people who report being in good physical shape, compared to those who describe it as poor.

Although no clear relationship has been demonstrated between strength-building activities and immune function,[104, 230, 261] positive effects have been observed in a number of studies, particularly in people who are new to strength training.[212] In addition, there is some evidence to suggest that relaxation and flexibility activities such as yoga improve immune function after just a single bout.[258]

#### Intestinal immune function

Physical activity influences the regulation of intestinal immune function[63, 144, 319] and the intestinal microbiota[z] (intestinal flora), including its diversity, quantity and quality.[21, 63, 218]

***In short, engaging in moderate or vigorous physical activity several times a week, particularly aerobic exercise, is associated with improved immune function. However, extreme, long-lasting or vigorous physical activities without sufficient rest reduce the effectiveness of the immune system.***

z The microbiome is the combined genetic material of the microorganisms that live on and inside the human body.[74] However, the term is sometimes used more broadly to refer to the microbial ecosystem as a whole: bacteria and their genes as well as the environment in which they live.[74] Although there are different human microbiota (e.g. on the skin, in the mouth, vagina, lungs, nose, digestive tract and even the eye), the most studied is gut microbiata.[74]

# 2.4 Healthy lifestyle habits

Physical activity goes hand in hand with adopting and maintaining healthy lifestyle habits: a reduction in sedentary behaviour, a balanced diet, moderate alcohol consumption, quality sleep and smoking cessation.

## 2.4.1 A reduction in sedentary behaviour

Sedentary behaviour is generally defined as a state of wakefulness characterized by very low energy expenditure (≤ 1.5 METs) in a sitting, lying or reclining position.[342] In these positions requiring little or no muscle contraction,[84] muscles take up less glucose and lipids, leading to higher blood levels of triglycerides, cholesterol and glucose, and therefore an increased risk of type 2 diabetes, atherosclerosis, cardiovascular disease and metabolic disorders.[343]

**★ SEDENTARY BEHAVIOUR**

Standing upright and immobile (about 2 METs) is not considered sedentary behaviour. It's therefore already better than sitting or lying. In addition, simply fidgeting may reduce the mortality risk for people who spend too much time sitting.[124]

In many developed countries, including Canada, technological advances and modernization have been driving the increase in sedentary behaviour for decades. This is of concern since Canadian adults are reported to spend almost half (46%) of their waking hours in sedentary activities.[262] According to a U.S. study, they spend more time sitting (8.2 hours) each day than on low-intensity (5.7 hours) or moderate- or vigorous-intensity (0.4 hours) physical activity.[239]

The all-cause mortality risk is significantly higher for people who spend more time sitting, regardless of their activity level.[159]

> ***According to a 2018 study, the mortality risk increases significantly after seven to nine hours of daily sedentary activities.[178] This increase is approximately 5% for each additional hour.[50]***

However, the mechanisms underlying the relationship between sedentary behaviour and mortality risk are not yet well understood and further studies are needed in this regard.

The type of sedentary behaviour and the manner in which sedentary time is accumulated may also be important risk factors.[14, 36] Sedentary behaviour can be broken down into two types:[133]

- Continuous sedentary, where sedentary time accumulates in a prolonged period without interruption;
- Intermittent sedentary, in which sedentary time accumulates in short periods interspersed with frequent interruptions.

Regardless of total sedentary time, frequent interruptions are associated with improvements in some cardiometabolic indicators.[135] Other studies also suggest that replacing sedentary behaviour with low-intensity physical activity (e.g. standing or walking) is associated with a number of health benefits independent of total sedentary time.[35, 133, 135, 195, 200]

***Decreasing sedentary behaviour and interrupting prolonged sedentary periods with frequent active breaks:***

- ***reduce:***
  - ***cardiovascular and metabolic disease risks;***[14, 39, 85, 133, 134]
  - ***the incidence of certain cancers;***[199]
  - ***obesity;***[133]
- ***increase bone mineral density;***[53]
- ***improve mental health.***[84]

### 2.4.2 A balanced diet

Physical activity can influence food choices.[138, 203, 206] Although no direct cause-and-effect relationship has been established, more active people generally have a better diet.[113] For example, physically active children and adolescents appear to be more likely to eat fruits, vegetables and whole grain products and to eat breakfast.[222]

In addition, a bout of exercise temporarily reduces hunger.[168] However, for the same caloric expenditure, vigorous aerobic effort reduces post-exercise compensation of caloric intake.[149] Indeed, people who exercise vigorously seem to be less prone to being overweight.[340] However, a high-fat diet induces overeating, which can negate the effect of vigorous exercise.[341] In fact, in this context, a positive energy balance can be observed despite considerable physical effort.

Although people who start exercising tend to eat more,[209] they exhibit healthy appetite regulation.[4, 206, 306] According to the scientific literature, active people adjust their caloric intake better than those who do not engage in much physical activity.[203] For example, after eating more than usual, they would eat less at the next meal.

Further research is needed to fully understand the effect of regular exercise on appetite regulation. In any case, we must always remember that some people, perhaps for genetic reasons, will have different physiological responses to the same level of physical activity.

### 2.4.3 Moderate alcohol consumption

People who partake in sports (not high performance) consume more alcohol and are more likely than to drink excessively than less active people.[62, 249.] However, physical activity levels are generally lower among heavy drinkers and those who drink excessively than those with a moderate alcohol intake.[249, 310]

In addition, team sports may lead young adults to consume more alcohol.[360, 378]

Many researchers have measured the combined effect of alcohol intake and lifestyle habits, including physical activity, on various indicators of cardiovascular disease.[156, 224, 317] For example, a study of 36,370 British people (2016) found that at least 150 minutes of moderate to vigorous physical activity per week reduces the cancer, cardiovascular disease and all-cause mortality risk associated with alcohol consumption.[248]

Also, a British researcher observed that at least 150 minutes of physical activity per week appears to eliminate the risk of increased mortality for both those who followed the weekly drinking guidelines (fewer than 12 drinks for men and less than 8 for women) and heavy drinkers (12-20 drinks for men and 8-12 drinks for women).[317] Only heavy drinkers (more than 20 drinks for men and more than 12 for women) seem to be at risk.[317] Thus, while physical activity reduces some of the risks associated with excessive alcohol consumption, it does not eliminate them completely.[185]

### 2.4.4 Quality sleep

Exercise helps improve sleep quality and duration,[82, 170, 182] especially deep sleep, which is the most restorative.[56] Lack of sleep can reduce the amount of time spent on physical activities,[292] and poor sleep habits (e.g. irregular sleep routine, exposure to artificial lighting before bedtime) can reduce the positive effects of physical activity.

#### Obstructive sleep apnea

Obstructive sleep apnea (OSA) is a condition in which breathing is blocked during sleep, resulting in a decrease in blood oxygen and in brief awakenings. In addition to altering sleep quality, this syndrome could affect adaptation to physical activities.[27, 265, 266, 376] Inactivity and weight gain increase the risk of OSA.[6, 81, 171]

For a long time it was thought that exercising shortly before bedtime was harmful. Now, it is suggested that people exercise whenever is most convenient for them.[227] It is important, however, that the exercise not diminish the quality and length of sleep.

*In short, it is essential that exercise be combined with a sufficient number of hours of quality sleep.*[226]

### 2.4.5 Smoking cessation

Exercise may play a role in smoking cessation and prevention. It is also associated with a decrease of almost 30% in mortality risk among smokers and ex-smokers.[233]

In terms of **prevention**, teenagers are the first to be targeted since most people start smoking in adolescence.[307] Studies have shown that:

- being a smoker appears to be inversely associated with the practice of leisure-time physical activities among Québec high school students;[152]
- the proportion of physically active students is significantly higher among non-smokers than smokers;[152]
- regular participation in physical activity during adolescence reduces the odds of progressing to smoking or a higher level of smoking by 50%;[11]
- participating in a team sport also has "protective" effects[270] in this regard;
- teens who are not physically active are more likely to become regular smokers than those who are;[179]
- Adolescents who participate in sports and who are smokers are more likely to give up their sport than non-smokers.[146]

Initiation to smoking and the cessation of sports activities therefore seem to be linked. By helping to improve self-esteem, exercise can help adolescents resist peer pressure to smoke and keep from smoking for fear that it will affect their athletic performance.[152]

*It is therefore important to do everything possible to ensure that young people can take part in a variety of physical and sporting activities that will help them to resist the temptation to give up sport and start smoking.*

Physical activity alone is not enough to get people to **stop smoking**, but it: [254, 332, 338, 352]

- plays a role in controlling the craving to smoke;
- alleviates the physical and psychological symptoms of withdrawal;
- helps with weight control after quitting smoking;
- increases the likelihood that a smoking cessation program will succeed.

★ AN EFFECTIVE COMPLEMENT

**Physical activity is an effective complement to smoking cessation programs.**

- **Before**: Engaging in physical activities is recommended in the weeks before quitting smoking.[338]
- **During**: 5 to 10 minutes of physical activity (e.g. brisk walking, isometric exercises that can be done while sitting) can help control cravings.[352]
- **A few days after quitting**: Gradually increase the duration of physical activities.[97]

# 2.5 Financial impact of physical inactivity

At a time when already very high healthcare costs continue to rise, several studies all draw the same conclusion:[154, 160, 177, 289] physical inactivity and sedentary behaviour can have major financial repercussions on the health system, employers and the economy.[336]

In Canada, from 2009 to 2012, the direct, indirect (e.g. absenteeism, benefits) and total costs of physical inactivity increased, respectively, from $2.4 billion, $4.3 billion and $6.8 billion to $3.3 billion, $7.5 billion and $10.8 billion.[154, 177] In 2012, the total annual costs in Canada were $21.3 billion for smokers, $19.0 billion for overweight people and $10.0 billion for those who engaged in little or no physical activity.[177]

A few years earlier, another study found that people who did little or no physical activity compared to those who did at least 150 minutes weekly:[289]

- had 5% more medical visits;
- used 13% more specialist services;
- spent 30% more days in hospital.

This significant difference in demand for medical interventions can be explained by the many adverse health effects of physical inactivity.[160, 289, 373]

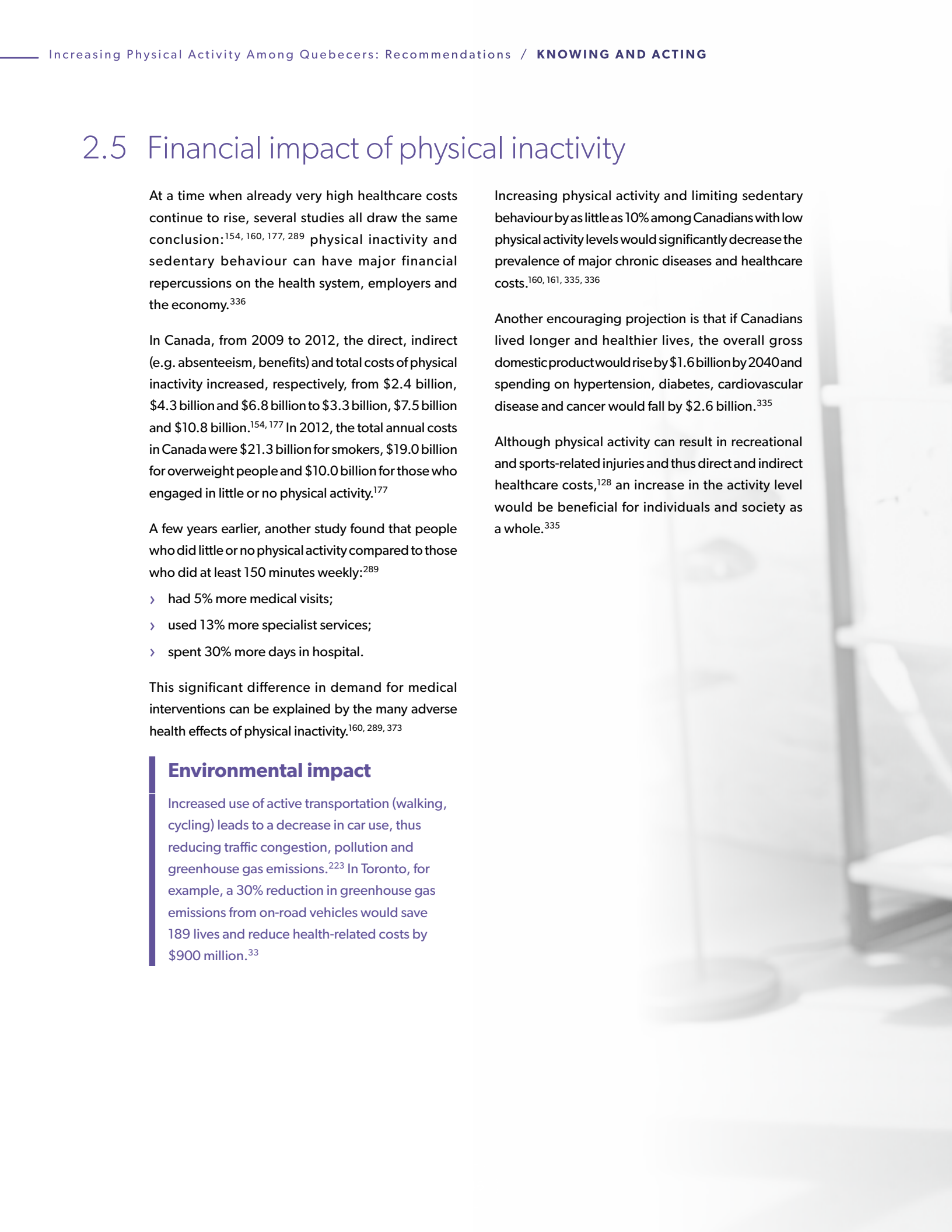
### Environmental impact

Increased use of active transportation (walking, cycling) leads to a decrease in car use, thus reducing traffic congestion, pollution and greenhouse gas emissions.[223] In Toronto, for example, a 30% reduction in greenhouse gas emissions from on-road vehicles would save 189 lives and reduce health-related costs by $900 million.[33]

Increasing physical activity and limiting sedentary behaviour by as little as 10% among Canadians with low physical activity levels would significantly decrease the prevalence of major chronic diseases and healthcare costs.[160, 161, 335, 336]

Another encouraging projection is that if Canadians lived longer and healthier lives, the overall gross domestic product would rise by $1.6 billion by 2040 and spending on hypertension, diabetes, cardiovascular disease and cancer would fall by $2.6 billion.[335]

Although physical activity can result in recreational and sports-related injuries and thus direct and indirect healthcare costs,[128] an increase in the activity level would be beneficial for individuals and society as a whole.[335]



# RECOMMENDATIONS

3

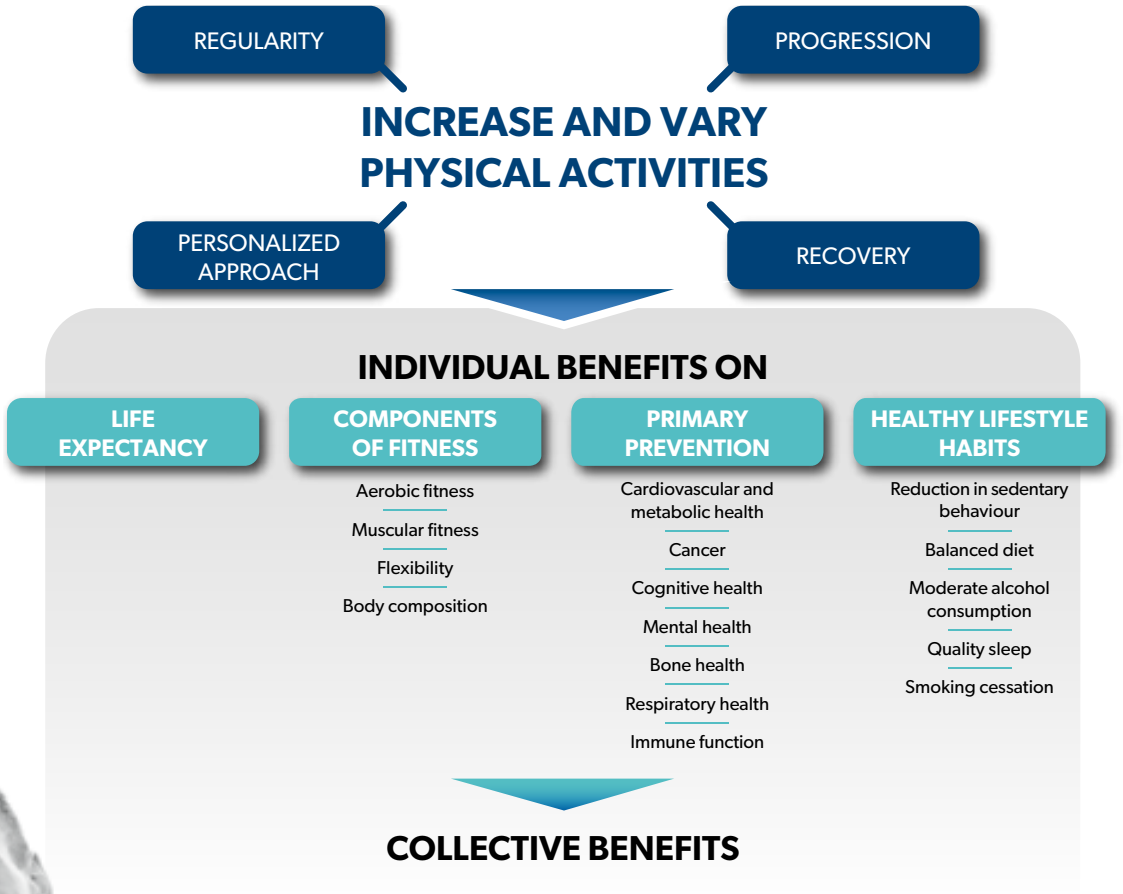
The science is clear: physical activity is good for everyone. But what can we recommend to Quebecers to ensure that they get the most out of staying active? This requires knowledge of the dose-response relationships between the various physical activity parameters and the associated benefits. However, the fact is that these relationships are complex and are not always well documented.

Nevertheless, based on the available evidence, Kino-Québec's Scientific Committee considers that the general population[aa] can derive the most benefits by:

- increasing their level of physical activity
- varying their physical activities

aa Although they can be applied to everyone, the recommendations of Kino-Québec's Scientific Committee are mainly for people with no contraindications to physical activity.

**FIGURE 4** › *Kino-Québec Scientific Committee recommendation summary*




## Remember

While it is essential to increase and vary physical activity, it is also essential to reduce sedentary behaviour (see section 2.4.1).

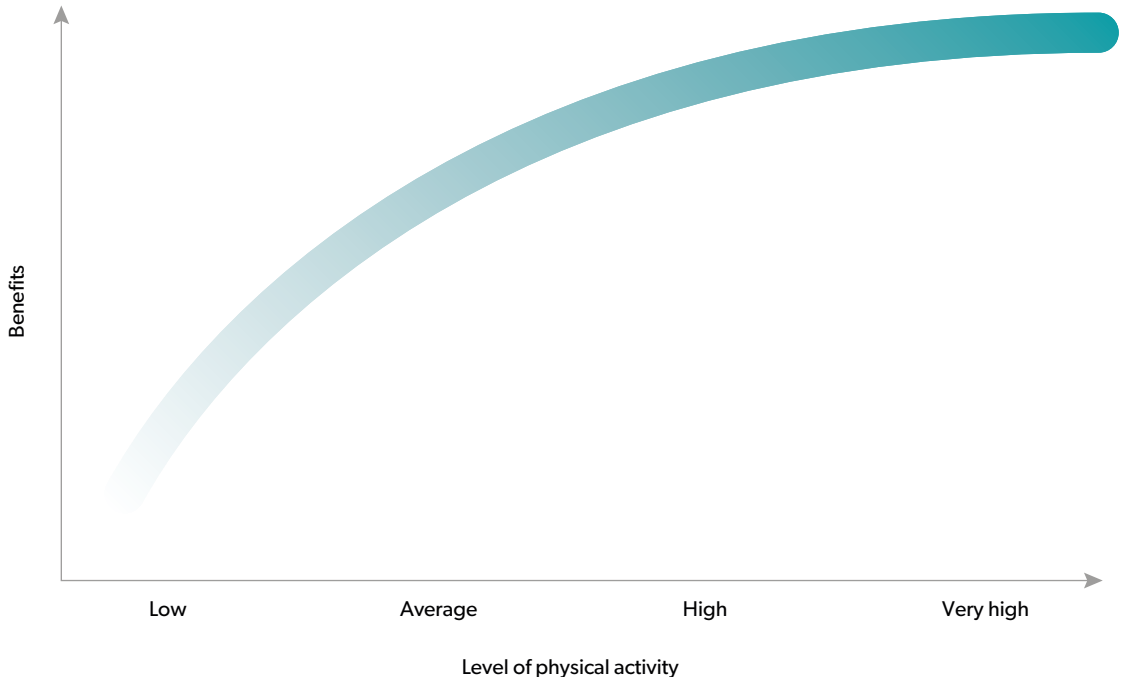
# 3.1 Increase the level of physical activity

A little physical activity is certainly better than none and doing more is even better.[264, 371]

- Even a small increase in physical activity among people who are sedentary or minimally active has a significant impact on well-being and health.[192, 282]
- In absolute terms, an increase in physical activity level has a greater impact on a person who does little or none than it does on a more active person.
- There does not appear to be an established threshold below which physical activity does not positively impact well-being and health. **No threshold was observed in the dose-response relationships studied, and no studies show that a specific threshold exists. Ultimately, the best thing is to move more, a recommendation that applies to everyone except the tiny percentage who exercise too much.**
- Even people who exercise moderately or vigorously can improve their well-being and health by doing more and varying their activities.

We saw in Chapter 2 that each dose-response relationship is unique and that not all positive effects on well-being or health change in the same way with increases in physical activity parameters. Despite this uniqueness, it can generally be argued that positive effects increase with higher levels of physical activity (Figure 5).

**FIGURE 5** › *Positive effects associated with physical activity levels*




Adapted from: Kino-Québec's Scientific Committee[60] and Eijsvogels et al.[90]

### 3.1.1 Regularity, progression, recovery

**Regular** physical activity means the repetition of a stimulus that allows the body to adapt if given a sufficient, but not too long, recovery period. Since the determinants of fitness decline rapidly when exercise is interrupted, it is vital to do it on a regular basis.

Some people only engage in or can only engage in physical activities on weekends. Although little is known about the effects of this frequency on health and well-being,[188, 234] they are being active, and even this frequency is associated with a decrease in mortality risk.[301] However, it would be preferable, where possible, to be physically active throughout the week.

The more regularly people engage in physical activity, i.e. at a consistent and continuous frequency, the greater the benefits. It is therefore preferable to be active almost every day because:

- each bout temporarily improves blood pressure, blood triglyceride levels and blood glucose levels after physical exertion;[1]
- people who increase the frequency of their physical activities improve their health profile;[129]
- physical activity stimulates different brain mechanisms that very often provide a soothing effect and a feeling euphoria after a bout of aerobic activity[267] or strength training.[204, 232, 324]

Regardless of activity level, **progression** is also important. This usually takes the form of adjustments to any one of the physical activity parameters[132] (Table 1). The rate of progression naturally varies, depending on each person's health, fitness level, response to the activity and goal.[111]

**TABLE 1** › *Aerobic and strength-building activities: examples of adjustments that can encourage progression*

| AEROBIC ACTIVITIES | MUSCLE STRENGTHENING ACTIVITIES |
|---|---|
| Type of activity (e.g. running, cycling, cross-country skiing) | Type of activity |
| Continuous or interval | Number of repetitions |
| Bout duration | Number of sets |
| Duration of recovery between bouts | Load |
| Duration of effort and rest period | Type of resistance (e.g. body weight, dumbbells, equipment) |
| Number of repetitions | Order of exercises |
| Number of repetitions per set | Duration of recovery between sets |
| Number of sets | Types of contractions (concentric, eccentric or isometric) |
| Intensity and duration of recovery between sets | Duration of recovery between bouts |
| Others | Others |

Whatever the activity or its parameters, **recovery** is closely tied to progression. The benefits of physical activity come from the body's adaptation to physiological stress. This adaptation occurs only after the physical effort has stopped, when the body recovers. Inadequate recovery, in other words, not allowing all systems to recover, makes the person more vulnerable to excessive fatigue and accidental or overuse injuries.[132]

### 3.1.2 Personalized approach

Everyone can benefit from physical activity. However, a personalized approach makes it possible to better identify the parameters most likely to provide the desired benefits.

Since the dose-response relationship is based on the frequency, intensity, duration, type and volume of physical activity, it is useful to quantify these parameters. Because most people tend to overestimate their physical activity, the use of monitors (e.g. activity bracelets, smart watches, training watches) can help to assess the level. With the data thus collected, the activity can be adapted or a personalized approach developed since the response or adaptability potential differs from one person to another.

With this approach, where the level of difficulty is tailored to each person,[31] the odds that people will regularly and diligently engage in physical activity increase considerably. If the challenges are personalized, in other words, if they allow people to apply their skills and feel a sense of accomplishment, they will derive pleasure and satisfaction from the activity. If the task is too difficult for their skill level, the activity will make them anxious and unlikely to want to repeat the experience. Another scenario is where the level of difficulty is too low for a person's skill level, which can cause them to lose interest and give up the activity. Individual abilities should therefore be considered and re-evaluated based on the progression observed.

Physical activity and health experts are able to develop a program based on personal characteristics such as fitness, abilities, goals, preferences, and family, social and work environment.

# 3.2 Engage in a variety of physical activities

Physical activities can be classified into four main areas: domestic, work-related, leisure-time[ab] and transportation.[80] Leisure-time activities can take the form of a sport,[ac] an outdoor activity,[ad] fitness training, indoor training, dance and others.[323]

Each type of physical activity provides specific health benefits, but none combines all the benefits of all physical activities. For example, cycling and swimming are excellent for aerobic fitness but do not really contribute to bone health. This is because the body weight is being supported and therefore the load applied to the skeleton is insufficient to positively influence bone mineral density or the internal architecture of the bones.[300]

Since the body adapts to the demands placed on it,[327] engaging in a variety of physical activities:

- allows people to develop more components of physical fitness;
- helps prevent injuries;[1]
- allows people to stay active if there is a change in their fitness level or health or if they suffer an injury, for example, by trading running for soccer, downhill skiing for swimming and cycling for kayaking;
- provides more opportunities to acquire knowledge and skills, to feel a greater sense of accomplishment, to have fun, and by extension increase motivation to continue regularly and diligently engaging in physical activity.[114, 157, 210]

### Motivation

There are two types of motivation:

- Intrinsic, which allows a person to adopt a behaviour for the pleasure and satisfaction it brings without expecting external rewards, is the most important motivation for maintaining a behaviour.[28, 120.]
- Extrinsic (e.g. financial support for cycling to work), which can be an opportunity to discover the pleasure and satisfaction associated with a sport or physical activity, can be the first step towards regular, diligent participation.[32, 193, 333]

Whether it's running long distances, lifting weights, practising yoga or doing agility exercises, the body adapts, but differently in each case.

ab Leisure-time activities are either structured or unstructured, and people do them in their free time, either for entertainment or relaxation.[214]

ac Sport is a physical activity involving rules, equipment and specific facilities that makes use of physical, technical, motor or perceptual skills, and is practised individually or in teams in various contexts of action. [214] The Ministère de l'Éducation et de l'Enseignement supérieur defines five contexts for sport participation: discovery, introduction, recreation, competition and high performance.

ad An outdoor activity is a non-motorized activity in which participants interact with nature outside the context of competitive sport.[214]

### *Diversifying opportunities*

The activities one practises in their free time is of course a personal choice. Being in control of one's choices and actions responds to the innate need for autonomy.[73, 280, 364] Still, there are ways to get more people to make exercise a priority and to regularly and diligently partake in a variety of enjoyable and beneficial physical activities.

**Organized** physical activity is a particularly interesting way to break social isolation[15] or to fill the need for social belonging. It can give people of all ages with similar tastes and interests the opportunity to develop a sense of belonging to a team, club, group or community.[88, 368] This is particularly true for social integration, especially of people with disabilities.

**Free practice** allows people to choose the type, pace, context and timing of the activity. It may therefore be more appealing to some because it is less restrictive, for example, in terms of time management.

Organizations would benefit from varying the opportunities or services they offer so that each person can find the formula that best suits their tastes and interests.

## Trendy workouts

People seek out new experiences either out of curiosity or out of a desire to change things up. This is also true for physical activity, where certain trends are emerging. For those interested in what's new in the world of fitness, the American College of Sports Medicine publishes an annual survey on fitness trends.[339]

What matters is that everyone have a choice and find what suits them. With its four seasons and vast natural spaces, Québec is full of possibilities for engaging in aquatic, nautical, land-based, skiing and other activities. We should take advantage of the appeal of the outdoors,[207] among other things, to partake in more winter activities since physical activity tends to decrease when the weather turns cold.[38, 251, 348]

***It would be good for Quebecers to have a wide choice of physical activities and to be informed of what's available to them so that they can experiment, through a quality experience, and find what they like best, thereby opening the door to a wide range of benefits.***

# 3.3 Put knowledge into action

***Kino-Québec's Scientific Committee would like to see attention focused on all the benefits of regularly engaging in a variety of physical activities. We therefore recommend that Quebecers be encouraged to increase their activity level by facilitating access to a range of activities so that they can derive as many benefits as possible from them.***

To that end, the discourse and actions of hundreds of people and organizations from different backgrounds—early childhood education and care services, educational institutions, municipalities, community organizations, workplaces, the healthcare system, private organizations—must reflect these recommendations. By working to reduce barriers and make it easier for all citizens, regardless of age, gender, income, ability or culture, to engage in varied physical activity every day, each living environment will help Quebecers move more.

## The importance of an inclusive perspective

When services are offered or facilities are made available, it is important to ensure from the outset that they are accessible to everyone.[ae]

While the initial interest in physical activity is personal, much depends on the physical, socio-cultural, political and economic environments, which can make it easier or harder to step into action.[18, 46, 125, 213, 215, 259] It is therefore not enough to rely on people's willingness by launching campaigns to get people to move more. Their environments must also be conducive to physical activity.

## The power to act on environments

The physical, socio-cultural, political and economic environments affect people, but people also have the power to affect their environments[283] because they are stakeholders in the efforts and measures put in place to improve their living environments. Therefore, the relationship between individual and collective factors must be considered in order to act effectively.

Physical activity is everyone's business. A multitude of organizations—sports and outdoor sports federations, regional and national recreation organizations, community recreation and outdoor organizations, municipalities, daycare services, schools, groups, associations, leagues, teams, clubs, practice centres, day camps and summer camps, private businesses, and others—play a role in helping Quebecers become more active.

The stakeholders (e.g. kinesiologists, members of training and program staff, teachers [physical and health education or other subjects], physicians, nurses, other health professionals), policymakers and opinion leaders also have a key role to play. Both in their discourse and by providing services and support to the public at the local, regional and national levels, these individuals and their organizations are helping to implement the recommendations made in this position statement. Their collaboration is indispensable for they share with the government the responsibility for getting Quebecers to adopt a more physically active lifestyle.

ae "An inclusive perspective seeks to improve the conditions offered to all users rather than the implementation of measures specific to certain groups of the population, with the result that places and facilities are developed and designed to accommodate everyone."[121]

This context, where it is difficult to isolate the contribution of an environment or a living environment, is conducive to the sharing of knowledge, mutual influences and the coherence and complementarity of actions. While everyone has a responsibility to improve their own discourse and environment, they also have a responsibility to work with others to implement actions that encourage people to regularly engage in varied physical activities.

To achieve the desired collective benefits, these individuals and organizations must define their respective roles and contributions in terms of not only their responsibilities but also their degree of influence or power to make things happen. Even if their roles differ and they do not have the same tools to drive change, it is in their interest to get involved and work together. Success lies in the sum of the efforts and actions, big and small, of each and every one of them.

**FIGURE 6** › *Stakeholders*

# Conclusion

While the physical activity guidelines proposed to date provide a general framework for getting people to move more, it is important to recognize the complexity of the relationship between the various physical activity parameters and the many benefits associated with them. It is therefore necessary to know the dose-response relationships based on recent scientific knowledge about the benefits associated with specific activities and parameters. Such an approach will improve the current guidelines and make it possible to tailor the recommendations and discourse based on the target populations and desired benefits.

Kino-Québec's Scientific Committee hopes to harness the knowledge and experience accumulated over many decades to carry out its mission to encourage Quebecers to regularly engage in a variety of physical activities.

***The Committee therefore invites organizations from the sectors concerned to reflect on how to create, maintain and make environments conducive to physical activity accessible to all Quebecers. The Committee also encourages them to adjust their discourse and to mobilize to effect change, in particular through the implementation of planned interventions through partnerships and intersector coordination based on shared values, namely:***

1. ***promoting the importance of partaking in more physical activity as often as possible;***
2. ***raising awareness of the importance of engaging in a variety of physical activities.***

When everyone has the opportunity and desire to partake in more varied physical activities that meet their needs and abilities, the people of Québec will be the winners. An ambitious goal, but not impossible.

# Glossary

**Physical Activity**
Physical activity is any form of bodily movement that utilizes the body's physical resources to perform movements leading to energy expenditure.[193]

**Sedentary Behaviour**
Sedentary behaviour is a waking behaviour characterized by very low energy expenditure (≤ 1.5 METs) while in a sitting, lying or reclining position.[342] Standing upright and immobile (about 2 METs) is not considered sedentary behaviour.

**Physical Inactivity**
Physical inactivity refers to low or very low levels of physical activity. (The terms "physical inactivity" and "sedentariness" are often confused. Sedentariness is considered as an overall high or very high level of sedentary behaviour.)

**Physical Activity Level**
In this position statement, refers to the product of the volume (frequency X duration) and intensity of physical activity performed over a given period of time.

**Physical Activity Parameters**
Physical activity parameters influence the resulting physiological and psychological adaptations.[111]

- Frequency refers to the number of bouts of a given type of physical activity over a period of time, usually per week or per day.
- Intensity is the level of effort, which may be expressed in absolute or relative terms using different indices and units. There are various relationships between them.[5]
- Duration is the time spent on each bout of activity.
- The type of physical activity generally refers to the physiological component most affected,[5] for example, cardiovascular (aerobic activities), muscular, flexibility or motor (testing balance, agility and coordination) activities.
- The total volume (amount) of physical activity is the product of the bout frequency and duration in a given period.

**Dose-Response Relationship**
Refers to the way a given effect (e.g. an aspect of physical fitness, an aspect of physical or mental health, or the risk of premature death) fluctuates with changes in a physical activity parameter (e.g. frequency, intensity, duration, type and volume).

# References


1. 2018 Physical Activity Guidelines Advisory Committee. *2018 Physical Activity Guidelines Advisory Committee Scientific Report*. U.S. Department of Health and Human Services, 2018.

2. Adams, O.P. "The Impact of Brief High-Intensity Exercise on Blood Glucose Levels." *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, vol. 6, 2013, pp. 113-122.

3. Public Health Agency of Canada. *A Shared Vision for Increasing Physical Activity and Reducing Physical Inactivity in Canada: Getting Active*. Federal, Provincial and Territorial Governments, 2018.

4. Albert, M.-H., et al. "Timing of Moderate-to-Vigorous Exercise and its Impact on Subsequent Energy Intake in Young Males." *Physiology & Behavior*, vol. 151, 2015, pp. 557-562.

5. American College of Sports Medicine. *ACSM Guidelines for Exercise Testing and Prescription*. 10th ed., Wolters Kluwer, 2015.

6. Andrade F.M., and R.P. Pedrosa. "The Role of Physical Exercise in Obstructive Sleep Apnea." *Jornal Brasileiro de Pneumologia*, vol. 42, no. 6, 2016, pp. 457-464.

7. Anton S.D., et al. "How Much Walking is Needed to Improve Cardiorespiratory Fitness? An Examination of the 2008 Physical Activity Guidelines for Americans." *Research Quarterly for Exercise and Sport*, vol. 82, no. 2, 2011, pp. 365-370.

8. Arem H., et al. "Leisure Time Physical Activity and Mortality: A Detailed Pooled Analysis of the Dose-Response Relationship." *JAMA Internal Medicine*, vol. 175, no. 6, 2015, pp. 959-967.

9. "La neuropsychologie : les fonctions cognitives." *Association Québécoise des neuropsychologues*, https://aqnp.ca/la-neuropsychologie/les-fonctions-cognitives. Accessed 12 June 2018.

10. Auby P., et al. "Mort subite cardiaque et anomalies de connexion des artères coronaires : connaissances et questions." *Annales de cardiologie et d'angéiologie*, vol. 66, no. 5, 2015, pp. 309-318.

11. Audrain-McGovern, J., et al. "Smoking Progression and Physical Activity." *Cancer Epidemiology and Prevention Biomarkers*, vol. 12, no. 11, 2003, pp. 1121-1129.

12. Azeredo, A.C. *La mortalité et l'espérance de vie au Québec en 2017*. Institut de la statistique du Québec, Coup d'œil sociodémographique, 2018.

13. Bailey, C., and K. Brooke-Wavell. "Exercise for Optimising Peak Bone Mass in Women: Postgraduate Symposium." *Proceedings of the Nutrition Society*, vol. 67, no. 1, 2008, pp. 9-18.

14. Bankoski, A., et al. "Sedentary Activity Associated with Metabolic Syndrome Independent of Physical Activity." *Diabetes Care*, vol. 34, no. 2, 2011, pp. 497-503.

15. Barber, B.L. et al. "Whatever Happened to the Jock, the Brain, and the Princess? Young Adult Pathways Linked to Adolescent Activity Involvement and Social Identity." *Journal of Adolescent Research*, vol. 16, no. 5, pp. 429-455.

16. Barnes, D.E., and K. Yaffe. "The Projected Effect of Risk Factor Reduction on Alzheimer's Disease Prevalence." *The Lancet Neurology*, vol. 10, no. 9, 2011, pp. 819-828.

17. Batouli, S.A., and V. Saba. "At Least Eighty Percent of Brain Grey Matter is Modifiable by Physical Activity: A Review Study." *Behavioural Brain Research*, vol. 332, 2017, pp. 204-217.

18. Bauman, A.E., et al. "Correlates of Physical Activity: Why Are Some People Physically Active and Others Not?" *The Lancet*, vol. 380, no. 9838, 2012, pp. 258-271.

19. Behm, D.G., and A. Kibele. "Effects of Differing Intensities of Static Stretching on Jump Performance." *European Journal of Applied Physiology*, vol. 101, no. 5, 2007, pp. 587-594.

20. Bennie, J.A., et al. "Associations Between Aerobic and Muscle-Strengthening Exercise with Depressive Symptom Severity among 17,839 U.S. Adults." *Preventive Medicine*, vol. 121, 2019, pp. 121-127.

21. Bermon, S., et al. "The Microbiota: An Exercise Immunology Perspective." *Exercise Immunology Review*, vol. 21, 2015, pp. 70-79.

22. Bird, S.R., and J.A. Hawley. "Update on the Effects of Physical Activity on Insulin Sensitivity in Humans." *BMJ Open Sport & Exercise Medicine*, vol. 2, no. 1, 2017, p. e000143.

23. Biswas, A., et al. "Sedentary Time and its Association with Risk for Disease Incidence, Mortality, and Hospitalization in Adults: A Systematic Review and Meta-Analysis." *Annals of Internal Medicine*. vol. 162, no. 2, 2015, pp. 123-132.

24. Blair, S.N., et al. "Influences of Cardiorespiratory Fitness and Other Precursors on Cardiovascular Disease and All-Cause Mortality in Men and Women." *JAMA*, vol. 276, no. 3, 1996, pp. 205-210.

25. Blair, S.N., et al. "Is Physical Activity or Physical Fitness More Important in Defining Health Benefits?" *Medicine and Science in Sports and Exercise*, vol. 33, no. 6, 2001, pp. S379-S399.

26. Blair, S.N., et al. "Changes in Physical Fitness and All-Cause Mortality. A Prospective Study of Healthy and Unhealthy Men." *JAMA*, vol. 273, no. 14, 1995, pp. 1093-1098.

27. Bollens, B., and G. Reychler. "Efficacy of Exercise as a Treatment for Obstructive Sleep Apnea Syndrome: A Systematic Review." *Complementary Therapies in Medicine*, vol. 41, 2018, pp. 208-214.

28. Bouchard, C., et al. *Physical Activity and Health*. 2nd ed., Human Kinetics, 2012.

29. Boutcher, S.H. "High-Intensity Intermittent Exercise and Fat Loss." *Journal of Obesity*, vol. 2011, 2010, p. 868305.

30. Boutcher, Y.N., and S.H. Boutcher. "Exercise Intensity and Hypertension: What's New?" *Journal of Human Hypertension*, vol. 31, no. 3, 2017, pp. 157-164.

31. Brunelle, J., and M. Tousignant. "Supervision of Interaction in Physical Activity," in: Brunelle, J., editor. *La supervision de l'intervention en activité physique*. Gaëtan Morin, 1988, pp. 109-124.

32. Bushman, B. and American College of Sports Medicine. *ACSM's Complete Guide to Fitness & Health*. 2nd ed., Human Kinetics, 2017.

33. Campbell, M., et al. *Air Pollution Burden of Illness from Traffic in Toronto – Problems and Solutions*. Toronto Public Health, 2007.

34. Cancela, J.M., et al. "Effects of a Long-Term Aerobic Exercise Intervention on Institutionalized Patients with Dementia." *Journal of Science and Medicine in Sport*, vol. 19, no. 4, 2016, pp. 293-298.

35. Carr, L.J., et al. "Total Worker Health Intervention Increases Activity of Sedentary Workers." *American Journal of Preventive Medicine*, vol. 50, no. 1, 2016, pp. 9-17.

36. Carson V., et al. "Systematic Review of Sedentary Behaviour and Health Indicators in School-Aged Children and Youth: An Update." *Applied Physiology, Nutrition and Metabolism*, vol. 41, no. 6, 2016, pp. S240-S265.

37. Carson, V. et al. "Systematic Review of Physical Activity and Cognitive Development in Early Childhood." *Journal of Science and Medicine in Sport*, vol. 19, no. 7, 2016, pp. 573-578.

38. Carson V., and J.C. Spence. "Seasonal Variation in Physical Activity among Children and Adolescents: A Review." *Pediatric Exercise Science*, vol. 22, no. 1, 2010, pp. 81-92.

39. Carson, V., et al. "Patterns of Sedentary Time and Cardiometabolic Risk among Canadian Adults." *Preventive Medicine*, vol. 65, 2014, pp. 23-27.

40. Casey, D.E. and T.E. Hansen. "Excessive Morbidity and Mortality in Schizophrenia," in: Meyer, J.M. and H.A. Nasrallah, editors. *Medical Illness and Schizophrenia*, 2nd ed., American Psychiatric Pub, 2009, pp. 17-36.

41. CASSIDY, S., et al. "High-Intensity Interval Training: A Review of its Impact on Glucose Control and Cardiometabolic Health." *Diabetologia*, vol. 60, no. 1, 2017, pp. 7-23.

42. Catenacci, V.A., et al. "Physical Activity Patterns Using Accelerometry in the National Weight Control Registry." *Obesity*, vol. 19, no. 6, 2011, pp. 1163-1170.

43. Catenacci, V.A., et al. "Physical Activity Patterns in the National Weight Control Registry." *Obesity*, vol. 16, no. 1, 2008, pp. 153-161.

44. Catennaci, V.A., et al. "Dietary Habits and Weight Maintenance Success in High Versus Low Exercisers in the National Weight Control Registry." *Journal of Physical Activity and Health*, vol. 11, no. 8, 2008, pp. 1540-1548.

45. Cauza, E., et al. "Strength and Endurance Training Lead to Different Post Exercise Glucose Profiles in Diabetic Participants Using a Continuous Subcutaneous Glucose Monitoring System." *European Journal of Clinical Investigation*, vol. 35, no. 12, 2005, pp. 745-751.

46. Centers for Disease Control and Prevention. "Surgeon General's Report on Physical Activity and Health." *JAMA*, vol. 276, no. 7, 1996, p. 522.

47. Centers for Disease Control and Prevention. *The Association Between School Based Physical Activity, Including Physical Education, and Academic Performance*. U.S. Department of Health and Human Services, 2010.

48. Chaddock, L., et al. "A Neuroimaging Investigation of the Association Between Aerobic Fitness, Hippocampal Volume, and Memory Performance in Preadolescent Children." *Brain Research*, vol. 1358, 2010, pp. 172-183.

49. Chaddock, L., et al. "Basal Ganglia Volume is Associated with Aerobic Fitness in Preadolescent Children." *Developmental Neuroscience*, vol. 32, no. 3, 2010, pp. 249-256.

50. Chakravarty, E.F., et al. "Reduced Disability and Mortality among Aging Runners: A 21-Year Longitudinal Study. *Archives of Internal Medicine*. vol. 168, no. 15, 2008, pp. 1638-1646.

51. Chang, Y.-K., et al. "Effect of Resistance-Exercise Training on Cognitive Function in Healthy Older Adults: A Review." *Journal of Aging and Physical Activity*. vol. 20, no. 4, 2012, pp. 497-517.

52. Chao, A., et al. "Amount, Type, and Timing of Recreational Physical Activity in Relation to Colon and Rectal Cancer in Older Adults: The Cancer Prevention Study II Nutrition Cohort." *Cancer Epidemiology and Prevention Biomarkers*, vol. 13, no. 12, 2004, pp. 2187-2195.

53. Chastin, S.F., et al. "The Frequency of Osteogenic Activities and the Pattern of Intermittence Between Periods of Physical Activity and Sedentary Behaviour Affects Bone Mineral Content: The Cross-Sectional NHANES Study." *BMC Public Health*, vol. 14, no. 1, 2014, p. 4.

54. Chau, J.Y., et al. "Daily Sitting Time and All-Cause Mortality: A Meta-Analysis." *PLOS ONE*, vol. 8, no. 11, 2013, p. e80000.

55. Chen, C.Y., and A. C. Bonham. "Postexercise Hypotension: Central Mechanisms." *Exercise and Sport Sciences Reviews*, vol. 38, no. 3, 2010, pp. 122-127.

56. Chennaoui, M., et al. "Sleep and Exercise: A Reciprocal Issue?" *Sleep Medicine Reviews*, vol. 20, 2015, pp. 59-72.

57. Chevalier, N. "Les fonctions exécutives chez l'enfant : concepts et développement." *Psychologie canadienne*, vol. 51, no. 3, 2010, pp. 149-163.

58. Colcombe, S., and A.F. Kramer. "Fitness Effects on the Cognitive Function of Older Adults: A Meta-Analytic Study." *Psychological Science*, vol. 14, no. 2, 2003, pp. 125-130.

59. Colcombe, S.J., et al. "Aerobic Exercise Training Increases Brain Volume in Aging Humans." *The Journals of Gerontology: Series A*, vol. 61, no. 11, 2006, pp. 1166-1170.

60. Comité scientifique de Kino-Québec. *Quantité d'activité physique requise pour en retirer des bénéfices pour la santé*, position statement of the Kino-Québec, Direction du sport et de l'activité physique, Ministère de l'Éducation, Gouvernement du Québec, 1999.

61. Comité scientifique de Kino-Québec. *Activité physique et santé osseuse*. Ministère de l'Éducation, du Loisir et du Sport, position statement written by Claudine Blanchet, Ph.D., and Guy Thibault, Ph.D., under the direction of Dr. François Croteau and Pierre Gauthier, Ph.D., and Gaston Godin, Ph.D., Gouvernement du Québec, 2008.

62. Conroy, D.E., et al. "Daily Physical Activity and Alcohol Use across the Adult Lifespan." *Health Psychology*, vol. 34, no. 6, 2015, pp. 653-660.

63. Cook, M.D., et al. "Exercise and Gut Immune Function: Evidence of Alterations in Colon Immune Cell Homeostasis and Microbiome Characteristics with Exercise Training." *Immunology & Cell Biology*, vol. 94, no. 2, 2016, pp. 158-163.

64. Cornelissen, V.A., et al. "Endurance Exercise Beneficially Affects Ambulatory Blood Pressure: A Systematic Review and Meta-Analysis." *Journal of Hypertension*, vol. 31, no. 4, 2013, pp. 639-648.

65. Cox, E.P., et al. "Relationship Between Physical Activity and Cognitive Function in Apparently Healthy Young to Middle-Aged Adults: A Systematic Review." *Journal of Science and Medicine in Sport*, vol. 19, no. 8, 2016, pp. 616-628.

66. Curry, B.S., et al. "Acute Effects of Dynamic Stretching, Static Stretching, and Light Aerobic Activity on Muscular Performance in Women." *The Journal of Strength & Conditioning Research*, vol. 23, no. 6, 2009, pp. 1811-1819.

67. Dacey, M., et al. "Older Adults' Intrinsic and Extrinsic Motivation Toward Physical Activity." *American Journal of Health Behavior*, vol. 32, no. 6, 2008, pp. 570-582.

68. Daley, A.J., et al. "Exercise Therapy as a Treatment for Psychopathologic Conditions in Obese and Morbidly Obese Adolescents: A Randomized, Controlled Trial." *Pediatrics*, vol. 118, no. 5, 2006, pp. 2126-2134.

69. Dalrymple, K.J., et al. "Effect of Static and Dynamic Stretching on Vertical Jump Performance in Collegiate Women Volleyball Players." *The Journal of Strength & Conditioning Research*, vol. 24 no. 1, 2010, pp. 149-155.

70. Daly, R.M. "Exercise and Nutritional Approaches to Prevent Frail Bones, Falls and Fractures: An Update." *Climacteric*, vol. 20, no. 2, 2017, pp. 119-124.

71. Daussin, F.N., et al. "Effect of Interval Versus Continuous Training on Cardiorespiratory and Mitochondrial Functions: Relationship to Aerobic Performance Improvements in Sedentary Subjects." *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, vol. 295, no. 1, 2017, pp. R264-R272.

72. Davis, C.L., et al. "Exercise Improves Executive Function and Achievement and Alters Brain Activation in Overweight Children: A Randomized, Controlled Trial." *Health Psychology*, vol. 30, no. 1, 2011, pp. 91-98.

73. Deci, E., and R.M. Ryan. *Intrinsic Motivation and Self-Determination in Human Behavior*, Plenum Press, 1985.

74. Desautels-Marissal, M. *Mille milliards d'amies : comprendre et nourrir son microbiome*, Les éditions Cardinal, 2016.

75. Després, J.-P. "Obesity and Cardiovascular Disease: Weight Loss is Not the Only Target." *Canadian Journal of Cardiology*, vol. 31, no. 2, 2015, pp. 216-222.

76. Després, J.-P. "Physical Activity, Sedentary Behaviours, and Cardiovascular Health: When Will Cardiorespiratory Fitness Become a Vital Sign?" *Canadian Journal of Cardiology*, vol. 32, no. 4, 2016, pp. 505-513.

77. Després, J.-P., et al. "Abdominal Obesity and the Metabolic Syndrome: Contribution to Global Cardiometabolic Risk." *Arteriosclerosis, Thrombosis, and Vascular Biology*, vol. 28, no. 6, 2008, pp. 1039-1049.

78. Dietrick, A., and W.F. McDaniel. "Endocannabinoids and Exercise." *British Journal of Sports Medicine*, vol. 38, no. 5, 2004, pp. 536-541.

79. Dik, M.G., et al. "Early Life Physical Activity and Cognition at Old Age." *Journal of Clinical and Experimental Neuropsychology*, vol. 25, no. 5, 2003, pp. 643-653.

80. Dishman, R.K., et al. *Physical Activity Epidemiology*, 2nd ed., Human Kinetics, 2012.

81. Dobrosielski, D.A., et al. "Diet and Exercise in the Management of Obstructive Sleep Apnoea and Cardiovascular Disease Risk." *European Respiratory Review*, vol. 26, no. 144, 2017, p. 160110.

82. Dolezal, B.A., et al. "Interrelationship Between Sleep and Exercise: A Systematic Review." *Advances in Preventive Medicine*, vol. 2017, 2017, pp. 1-14.

83. Dunn, A.L., et al. "Exercise Treatment for Depression: Efficacy and Dose Response." *American Journal of Preventive Medicine*. vol. 28, no. 1, 2005, pp. 1-8.

84. Dunstan, D.W., et al. "Chapter 3: Physiological Effects of Reducing and Breaking Up Sitting Time," in: Zhu, W., and N. Owen, editors. *Sedentary Behavior and Health: Concepts, Assessments, and Interventions*, Human Kinetics, 2017, pp. 31-44.

85. Dunstan, D.W., et al. "Breaking Up Prolonged Sitting Reduces Postprandial Glucose and Insulin Responses." *Diabetes Care*, vol. 35 no. 5, 2012, pp. 976-983.

86. Dunstan, D.W., et al. "Prolonged Sitting: Is It a Distinct Coronary Heart Disease Risk Factor?" *Current Opinion in Cardiology*, vol. 26, no. 5, 2011, pp. 412-419.

87. Duscha, B.D., et al. "Effects of Exercise Training Amount and Intensity on Peak Oxygen Consumption in Middle-Age Men and Women at Risk for Cardiovascular Disease." *Chest*, vol. 128, no. 4, 2005, pp. 2788-2793.

88. Eccles, J.S. et al. "Extracurricular Activities and Adolescent Development," *Journal of Social Issues*, vol. 59, no. 4, 2003, pp. 865-889.

89. Ehninger, D., and G. Kempermann. "Neurogenesis in the Adult Hippocampus." *Cell and Tissue Research*, vol. 331, no. 1, 2008, pp. 243-250.

90. Eijsvogels, T.M.H., et al. "The Extreme Exercise Hypothesis: Recent Findings and Cardiovascular Health Implications." *Current Treatment Options in Cardiovascular Medicine*. vol. 20, no. 10, p. 84.

91. Ekelund, U., et al. "Does Physical Activity Attenuate, or even Eliminate, the Detrimental Association of Sitting Time with Mortality? A Harmonised Meta-Analysis of Data from More Than 1 Million Men and Women." *The Lancet*, vol. 388, no. 10051, pp. 1302-1310.

92. Ellember, D. and M. St-Louise-Deschênes (2010). "The Effect of Acute Physical Exercise on Cognitive Function During Development." *Psychology of Sport and Exercise*, vol. 11, no. 2, 2010, pp. 122-126.

93. Erickson, K.I., et al. "Exercise Training Increases Size of Hippocampus and Improves Memory." *Proceedings of the National Academy of Sciences*, vol. 108, no. 7, 2011, pp. 3017-3022.

94. Erikssen, G., et al. "Changes in Physical Fitness and Changes in Mortality," *The Lancet*, vol. 352, no. 9130, pp. 759-762.

95. Erikssen, J.S, et al. "Exercise and the Metabolic Syndrome, *Diabetologia*, vol. 40, no. 2, pp. 125-135.

96. Esteban-Corgnejo, I., et al. "Physical Activity and Cognition in Adolescents: A Systematic Review. *Journal of Science and Medicine in Sport*, vol. 18, no. 5, 2015, pp. 534-539.

97. European Lung Foundation. *L'exercice physique et vos poumons*, n.d.

98. Eyre, H., et al. "Preventing Cancer, Cardiovascular Disease, and Diabetes: A Common Agenda for the American Cancer Society, the American Diabetes Association, and the American Heart Association." *Circulation*, vol. 109, no. 25, 2004, pp. 3244-3255.

99. Fabel, K., et al. "VEGF is Necessary for Exercise-Induced Adult Hippocampal Neurogenesis." *European Journal of Neuroscience*, vol. 18, no. 10, 2003, pp. 2803-2812.

100. Ferrucci, L., et al. "Smoking, Physical Activity, and Active Life Expectancy." *American Journal of Epidemiology*, vol. 149, no. 7, 1999, pp. 645-653.

101. Firth, J., et al. "A Systematic Review and Meta-Analysis of Exercise Interventions in Schizophrenia Patients." *Psychological Medicine*, vol. 45, no. 7, 2015, pp. 1343-1361.

102. Firth, J., et al. "Effect of Aerobic Exercise on Hippocampal Volume in Humans: A Systematic Review and Meta-Analysis." *NeuroImage*, vol. 166, 2018, pp. 230-238.

103. Fjell, A.M., and K.B. Walhovd. "Structural Brain Changes in Aging: Courses, Causes and Cognitive Consequences." *Reviews in the Neurosciences*, vol. 21, no. 3, 2010, pp. 187-222.

104. Flynn, M., et al. "Effects of Resistance Training on Selected Indexes of Immune Function in Elderly Women." *Journal of Applied Physiology*, vol. 86, no. 6, 1999, pp. 1905-1913.

105. Fondell, E., et al. "Physical Activity across Adulthood and Subjective Cognitive Function in Older Men." *European Journal of Epidemiology*, vol. 33, no. 1, 2017, pp. 79-87.

106. Fox, K.R., et al. "The Case for Exercise in the Promotion of Mental Health and Psychological Well-Being," in: Biddle, S.J.H., et al., editors, *Physical Activity and Psychological Well-Being, Routledge*, 2003, pp. 13-15.

107. Friedenreich, C.M., and A.E. Cust. "Physical Activity and Breast Cancer Risk: Impact of Timing, Type and Dose of Activity and Population Subgroup Effects." *British Journal of Sports Medicine*, vol. 42, no. 8, 2008, pp. 636-647.

108. Füzéki, E., et al. "Health Benefits of Light-Intensity Physical Activity: A Systematic Review of Accelerometer Data of the National Health and Nutrition Examination Survey (NHANES)." *Sports Medicine*, vol. 47, no. 9, 2017, pp. 1769-1793.

109. Gagné, M. *Décès attribuables à une chute*, Fichier des décès du registre des évènements démographiques (2000-2013), Bureau d'information et d'études en santé des populations, Institut national de santé publique du Québec, special request. 2017.

110. Galper, D.I., et al. "Inverse Association Between Physical Inactivity and Mental Health in Men and Women." *Medicine and Science in Sports and Exercise*, vol. 38, no. 1, 2006, pp. 173-178.

111. Garber, C.E., et al. "American College of Sports Medicine Position Stand. Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults: Guidance for Prescribing Exercise." *Medicine and Science in Sports and Exercise*, vol. 43, no. 7, 2011, pp. 1334-1359.

112. Ghadieh, A.S., and B. Saab. "Evidence for Exercise Training in the Management of Hypertension in Adults." *Canadian Family Physician*, vol. 61, no. 3, 2015, pp. 233-239.

113. GIllman, M.W., et al. "Relationships of Physical Activity with Dietary Behaviors among Adults." *Preventive Medicine*, vol. 32 no. 3, 2001, pp. 295-301.

114. Glaros, N.M., and C.M. Janelle. "Varying the Mode of Cardiovascular Exercise to Increase Adherence." *Journal of Sport Behavior*, vol. 24, no. 1, 2001, pp. 42-62.

115. Glazer, N.L., et al. "Sustained and Shorter Bouts of Physical Activity are Related to Cardiovascular Health." *Medicine and Science in Sports and Exercise*, vol. 45, no. 1, 2013, pp. 109-115.

116. Gleeson, M. "Immune Function in Sport and Exercise." *Journal of Applied Physiology*, vol. 103, no. 2, 2007, pp. 693-699.

117. Gleeson, M., et al. *Exercise Immunology*, Routledge, 2013.

118. Goedecke, J.H., and L.K. Micklesfield. "The Effect of Exercise on Obesity, Body Fat Distribution and Risk for Type 2 Diabetes," in: Goedecke, J.H., and E.O. Ojuka, editors. *Diabetes and Physical Activity*, Karger Publishers, 20114, pp. 82-93.

119. Gomes-Osman, J., et al. "Exercise for Cognitive Brain Health in Aging: A Systematic Review for an Evaluation of Dose." *Neurology: Clinical Practice*, vol. 8, no. 3, 2018, pp. 257-265.

120. Gonzalo-Encabo, P., et al. "Dose-Response Effects of Exercise on Bone Mineral Density and Content in Post-Menopausal Women." *Scandinavian Journal of Medicine & Science in Sports*, vol. 29 no. 8, 2019, pp. 1121-1129.

121. Gouvernement du Québec. *À part entière : pour un véritable exercice du droit à l'égalité. Politique gouvernementale pour accroître la participation des personnes handicapées*, 2009.

122. Guadalupe-Grau, A., et al. "Exercise and Bone Mass in Adults." *Sports Medicine*, vol. 39, no. 6, 2009, pp. 439-468.

123. Guiraud, T., et al. "High-Intensity Interval Training in Cardiac Rehabilitation." *Sports Medicine*, vol. 42, no. 7, 2012, pp. 587-605.

124. Hagger-Johnson, G., et al. "Sitting Time, Fidgeting, and All-Cause Mortality in the UK Women's Cohort Study." *American Journal of Preventive Medicine*, vol. 50, no. 2, 2016, pp. 154-160.

125. Hagger, M.S. "Theoretical Integration in Health Psychology: Unifying Ideas and Complementary Explanations." *British Journal of Health Psychology*, vol. 14, no. 2, 2009, pp. 189-194.

126. Hall, A., et al. "The Effectiveness of Tai Chi for Chronic Musculoskeletal Pain Conditions. A Systematic Review and Meta-Analysis." *Arthritis Care & Research*, vol. 61, no. 6, 2009, pp. 717-724.

127. Halliwill, J.R. "Mechanisms and Clinical Implications of Post-Exercise Hypotension in Humans." *Exercise and Sport Sciences Review*, vol. 29, no. 2, 2001, pp. 65-70.

128. Hamel, D., et al. *Étude des blessures subiesies lors de la pratique d'activités récréatives et sportives au Québec en 2015-2016*, Institut national de santé publique du Québec, 2019.

129. Hamer, M., et al. "The "Weekend Warrior" Physical Activity Pattern: How Little Is Enough?" vol. 51, no. 19, 2017, pp. 1384-1385.

130. Hamer, M., et al. "Dose-Response Relationship Between Physical Activity and Mental Health: The Scottish Health Survey." *British Journal of Sports Medicine*, vol. 43, no. 14, 2009, pp. 1111-1114.

131. Harmon, K.G., et al. "Incidence of Sudden Cardiac Death in Athletes: A State-of-the-Art Review." *Heart*, vol. 100, no. 16, 2014, pp. 1227-1234.

132. Hausswirth, C., and I. Mujika. *Recovery for Performance in Sport*, Human Kinetics, 2013.

133. Healy, G.N., et al. "Breaks in Sedentary Time: Beneficial Associations with Metabolic Risk." *Diabetes Care*, vol. 31, no. 4, 2008, pp. 661-666.

134. Healy, G.N., et al. "Sedentary Time and Cardio-Metabolic Biomarkers in US Adults: NHANES 2003-06." *European Heart Journal*, vol. 32, no. 5, 2011, pp. 590-597.

135. Healy, G.N., et al. "Objectively Measured Sedentary Time, Physical Activity, and Metabolic Risk: The Australian Diabetes, Obesity and Lifestyle Study (AusDiab)." *Diabetes Care*, vol. 31, no. 2, 2008, pp. 369-371.

136. Herbert, R.D., et al. "Stretching to Prevent or Reduce Muscle Soreness After Exercise." *Cochrane Database of Systematic Reviews*, no. 7, 2011, p. CD004577.

137. Herbert, R.D., et al. "Effects of Stretching Before and After Exercising on Muscle Soreness and Risk of Injury: Systematic Review." *British Medical Journal*, vol. 325, no. 7362, 2002, p. 468.

138. Heroux, M. et al. "Dietary Patterns and the Risk of Mortality: Impact of Cardiorespiratory Fitness." *International Journal of Epidemiology*, vol. 39, no. 1, 2009, pp. 197-209.

139. Herting, M.M., and B.J. Nagel. "Aerobic Fitness Relates to Learning on a Virtual Morris Water Task and Hippocampal Volume in Adolescents." *Behavioural Brain Research*, vol. 233, no. 2, 2012, pp. 517-525.

140. Herting, M.M., and B.J. Nagel. "Differences in Brain Activity During a Verbal Associative Memory Encoding Task in High- and Low-Fit Adolescents." *Journal of Cognitive Neuroscience*, vol. 25, no. 4, 2013, pp. 595-612.

141. Hillman, C.H., and J.R. Biggan. "A Review of Childhood Physical Activity, Brain, and Cognition: Perspectives on the Future." *Pediatric Exercise Science*, vol. 29 no. 2, 2017, pp. 170-176.

142. Hillman, C.H., et al. "Run for Your Life! Childhood Physical Activity Effects on Brain and Cognition." *Kinesiology Review*, vol. 6, no. 1, 2017, pp. 12-21.

143. Hoang, T.D., et al. "Effect of Early Adult Patterns of Physical Activity and Television Viewing on Midlife Cognitive Function." *JAMA Psychiatry*, vol. 73, no. 1, 2016, pp. 73-79.

144. Hoffman-Goetz, L., and J. Quadrilatero. "Treadmill Exercise in Mice Increases Intestinal Lymphocyte Loss Via Apoptosis," *Acta Physiologica*, vol. 179 no. 3, 2003, pp. 289-297.

145. Holley, J., et al. "The Effects of Physical Activity on Psychological Well-Being for Those with Schizophrenia: A Systematic Review." *British Journal of Clinical Psychology*, vol. 50, no. 1, 2011, pp. 84-105.

146. Holmen, T., et al. "Physical Exercise, Sports, and Lung Function in Smoking Versus Nonsmoking Adolescents." *European Respiratory Journal*, vol. 19, no. 1, 2002, pp. 8-15.

147. Howard, P. "Functional and Physiological Effects of Yoga in Women with Rheumatoid Arthritis: A Pilot Study." *Alternative Therapies in Health and Medicine*, vol. 15, no. 4, 2009, p. 24.

148. Hubert, H.B., et al. "Lifestyle Habits and Compression of Morbidity." *The Journals of Gerontology*: *Series A*, vol. 57, no. 6, 2002, pp. M347-M351.

149. Imbeault, P., et al. "Acute Effects of Exercise on Energy Intake and Feeding Behaviour." *British Journal of Nutrition*vol. 77, no. 4, 1997, pp. 511-521.

150. "Espérance de vie." *Institut national de la statistique et des études économiques*, www.insee.fr/fr/metadonnees/definition/c1374. Accessed 12 June 2018.

151. "Espérance de vie en bonne santé (EVBS)," *Institut national de la statistique et des études économiques*, www.insee.fr/fr/metadonnees/definition/c2017. Accessed 12 June 2018.

152. Institut national de santé publique du Québec. *Analyse des liens entre l'usage de la cigarette et les habitudes alimentaires, l'activité physique de loisir et le poids corporel chez les élèves québécois* : *2010-2011*, Direction du développement des individus et des communautés, 2016.

153. Ismail, I., et al. "A Systematic Review and Meta-Analysis of the Effect of Aerobic Vs. Resistance Exercise Training on Visceral Fat." *Obesity Reviews*, vol. 13, no. 1, 2012, pp. 68-91.

154. Janssen, I. "Health Care Costs of Physical Inactivity in Canadian Adults." *Applied Physiology, Nutrition, and Metabolism*, vol. 37, no. 4, 2012, pp. 803-806.

155. Jelleyman, C., et al. "The Effects of High-Intensity Interval Training on Glucose Regulation and Insulin Resistance: A Meta-Analysis." *Obesity Reviews*, vol. 16, no. 11, 2015, pp. 942-961.

156. Joosten, M.M., et al. "Combined Effect of Alcohol Consumption and Lifestyle Behaviors on Risk of Type 2 Diabetes." *The American Journal of Clinical Nutrition*, vol. 91, no. 6, 2010, pp. 1777-1783.

157. Juvancic-Heltzel, J.A., et al. "The Effect of Variety on Physical Activity: A Cross-Sectional Study." *The Journal of Strength & Conditioning Research*, vol. 27, no. 1, 2013, pp. 244-251.

158. Karlsson, M.K., and B.E. Rosengren. "Physical Activity as a Strategy to Reduce the Risk of Osteoporosis and Fragility Fractures." *International Journal of Endocrinology and Metabolism*, vol. 10, no. 3, 2012, pp. 527-536.

159. Katzmarzyk, P.T., et al. "Sitting Time and Mortality From All Causes, Cardiovascular Disease, and Cancer." *Medicine and Science in Sports and Exercise*, vol. 41, no. 5, 2009, pp. 998-1005.

160. Katzmarzyk, P.T., et al. "The Economic Burden of Physical Inactivity in Canada." *Canadian Medical Association Journal*, vol. 163, no. 11, 2000, pp. 1435-1440.

161. Katzmarzyk, P.T., et al. "The Economic Costs Associated with Physical Inactivity and Obesity in Canada: An Update." *Canadian Journal of Applied Physiology*, vol. 29, no. 1, 2004, pp. 90-115.

162. Kay, S., and F. Singh. "The Influence of Physical Activity on Abdominal Fat: A Systematic Review of the Literature." *Obesity Reviews*, vol. 7, no. 2, 2006, pp. 183-200.

163. Kell, R.T., et al. "Musculoskeletal Fitness, Health Outcomes and Quality of Life." *Sports Medicine*, vol. 31, no. 12, 2001, pp. 863-873.

164. Kennedy, G., et al. "How Does Exercise Reduce the Rate of Age-Associated Cognitive Decline?" *Journal of Alzheimer's Disease*, vol. 55, no. 1, 2017, pp. 1-18.

165. Kessler, H.S., et al. "The Potential for High-Intensity Interval Training to Reduce Cardiometabolic Disease Risk." *Sports Medicine*, vol. 42, no. 6, 2012, pp. 489-509.

166. Khan, N.A., and C.H. Hillman. "The Relation of Childhood Physical Activity and Aerobic Fitness to Brain Function and Cognition: A Review." *Pediatric Exercise Science*, vol. 26, no. 2, 2014, pp. 138-146.

167. Kim, Y., et al. "Independent and Joint Associations of Grip Strength and Adiposity with All-Cause and Cardiovascular Disease Mortality in 403,199 Adults: The UK Biobank Study." *The American Journal of Clinical Nutrition*, vol. 106, no. 3, 2017, pp. 773-782.

168. King, N.A., and J. Blundell. "High-Fat Foods Overcome the Energy Expenditure Induced by High-Intensity Cycling or Running." *European Journal of Clinical Nutrition*, vol. 49, no. 2, 1995, pp. 114-123.

169. Kirk-Sanchez, N.J., and E.L. McGough. "Physical Exercise and Cognitive Performance in the Elderly: Current Perspectives. Clinical interventions in aging." vol. 9, 2014, pp. 51-62.

170. Kjeldsen, J.S., et al. "Effect of Different Doses of Exercise on Sleep Duration, Sleep Efficiency and Sleep Quality in Sedentary, Overweight Men." *Bioenergetics*, vol. 2, no. 1, 2012, p. 108.

171. Kline, C.E., et al. "The Effect of Exercise Training on Obstructive Sleep Apnea and Sleep Quality: A Randomized Controlled Trial." *Sleep*, vol. 34, no. 12, 2011, pp. 1631-1640.

172. Kodama, S., et al. "Cardiorespiratory Fitness as a Quantitative Predictor of All-Cause Mortality and Cardiovascular Events in Healthy Men and Women: A Meta-Analysis." *JAMA*, vol. 301, no. 19, 2009, pp. 2024-2035.

173. Kohl III, H., et al. "Physical Activity, Physical Fitness, and Sudden Cardiac Death." *Epidemiologic Reviews*, vol. 14, no. 1, 1992, pp. 37-58.

174. Kokkinos, P., et al. "Exercise Capacity and Mortality in Older Men: A 20-Year Follow-Up Study." *Circulation*, vol. 122, no. 8, 2010, pp. 790-797.

175. Kontis, V., et al. "Future Life Expectancy in 35 Industrialised Countries: Projections with a Bayesian Model Ensemble." *The Lancet*, vol. 389, no. 10076, 2017, pp. 1323-1335.

176. Kosola, J., et al. "Elevated Concentration of Oxidized LDL Together with Poor Cardiorespiratory and Abdominal Muscle Fitness Predicts Metabolic Syndrome in Young Men." *Metabolism-Clinical and Experimental*, vol. 62, no. 7, 2013, pp. 992-999.

177. Krueger, H., et al. "The Economic Benefits of Risk Factor Reduction in Canada: Tobacco Smoking, Excess Weight and Physical Inactivity." *Cananadian Journal of Public Health*, vol. 105, no. 1, 2014, pp. e69-e78.

178. Ku, P.-W., et al. "A Cut-Off of Daily Sedentary Time and All-Cause Mortality in Adults: A Meta-Regression Analysis Involving More Than 1 Million Participants." *BMC Medicine*, vol. 16, no. 1, 2018, p. 74.

179. Kujala, U.M., et al. "Physical Activity in Adolescence and Smoking in Young Adulthood: A Prospective Twin Cohort Study." *Addiction*, vol. 102, no. 7, 2007, pp. 1151-1157.

180. Kushi, L.H., et al. "American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention: Reducing the Risk of Cancer With Healthy Food Choices and Physical Activity." *CA: a cancer journal for clinicians*, vol. 62, no. 1, pp. 30-67.

181. Lamb, S.E., et al. "Dementia And Physical Activity (DAPA) Trial of Moderate to High Intensity Exercise Training for People with Dementia: Randomised Controlled Trial." *British Medical Journal*, vol. 361, 2018, p. k1675.

182. Lang, C., et al. "The Relationship Between Physical Activity and Sleep from Mid Adolescence to Early Adulthood. A Systematic Review of Methodological Approaches and Meta-Analysis." *Sleep Medicine Reviews*, vol. 28, 2016, pp. 32-45.

183. Laukkanen, J.A., et al. "Long-Term Change in Cardiorespiratory Fitness and All-Cause Mortality: A Population-Based Follow-Up Study." *Mayo Clinic Proceedings*, vol. 91, no. 9, 2016, pp. 1183-1188.

184. Lawlor, D.A., and S.W. Hopker. "The Effectiveness of Exercise as an Intervention in the Management of Depression: Systematic Review and Meta-Regression Analysis of Randomised Controlled Trials." *British Medical Journal*, vol. 322, no. 7289, 2001, pp. 763-767.

185. Leasure, J.L., et al. "Exercise and Alcohol Consumption: What We Know, What We Need to Know, and Why it is Important." *Frontiers in Psychiatry*, vol. 6, 2015, p. 156.

186. Lee, D.-C., et al. "Mortality Trends in the General Population: The Importance of Cardiorespiratory Fitness." *Journal of Psychopharmacology*, vol. 24, no. 4, 2010, pp. 27-35.

187. Lee, I.-M. "Physical Activity and Cancer Prevention – Data from Epidemiologic Studies." *Medicine and Science in Sports and Exercise*, vol. 35, no. 11, 2003, pp. 1823-1827.

188. Lee, I.-M., et al. "The "Weekend Warrior" and Risk of Mortality." *American Journal of Epidemiology*, vol. 160, no. 7, 2004, pp. 636-641.

189. Lee, I.-M., and P.J. Skerrett. "Physical Activity and All-Cause Mortality: What Is the Dose-Response Relation?" *Medicine and Science in Sports and Exercise*, vol. 33, no. 6, 2001, pp. S459-S471.

190. Lees, C., and J. Hopkins. "Effect of Aerobic Exercise on Cognition, Academic Achievement, and Psychosocial Function in Children: A Systematic Review of Randomized Control Trials." *Preventing Chronic Disease*, vol. 10, 2013, p. E174.

191. Lenroot, R.K., and J.N. Giedd. "Brain Development in Children and Adolescents: Insights from Anatomical Magnetic Resonance Imaging." *Neuroscience & Biobehavioral Reviews*, vol. 30, no. 6, 2006, pp. 718-729.

192. Leskinen, T., et al. "Change in Physical Activity and Accumulation of Cardiometabolic Risk Factors." *Preventive Medicine*, vol. 112, 2018, pp. 31-37.

193. Létourneau, D. *Le sport et quelques mots pour le dire*, Office de la langue française, Direction des sports, ministère des Affaires municpales, Gouvernement du Québec, 1994.

194. Leveille, S.G., et al. "Aging Successfully Until Death in Old Age: Opportunities for Increasing Active Life Expectancy." *American Journal of Epidemiology*, vol. 149, no. 7, 1999, pp. 654-664.

195. Levine, J.A., and J. Miller. "The Energy Expenditure of Using a "Walk-and-Work" Desk for Office Workers with Obesity." *British Journal of Sports Medicine*, vol. 41, 2007, pp. 558-561.

196. Lewis, J. "A Systematic Literature Review of the Relationship Between Stretching and Athletic Injury Prevention." *Orthopaedic Nursing*, vol. 33, no. 6, 2014, pp. 312-320.

197. Little, J.P., et al. "Low-Volume High-Intensity Interval Training Reduces Hyperglycemia and Increases Muscle Mitochondrial Capacity in Patients with Type 2 Diabetes." *Journal of Applied Physiology*, vol. 111, no. 6, 2011, pp. 1554-1560.

198. Liu, C.J., and N.K. Latham. "Progressive Resistance Strength Training for Improving Physical Function in Older Adults." *Cochrane Database of Systematic Reviews*, no. 3, 2009, p. CD002759.

199. Lynch, B.M., et al. "Associations of Objectively Assessed Physical Activity and Sedentary Time with Biomarkers of Breast Cancer Risk in Postmenopausal Women: Findings from NHANES (2003-2006)." *Breast Cancer Research and Treatment*, vol. 130, no. 1, 2011, pp. 183-194.

200. Macewen, B.T., et al. "A Systematic Review of Standing and Treadmill Desks in the Workplace." *Preventive Medicine*, vol. 70, 2015, pp. 50-58.

201. Macpherson, H., et al. "A Life-Long Approach to Physical Activity for Brain Health." *Frontiers in Aging Neuroscience*, vol. 9, 2017, p. 147.

202. Martin, B.-J., et al. "Cardiovascular Fitness and Mortality After Contemporary Cardiac Rehabilitation." *Mayo Clinic Proceedings*, vol. 88, no. 5, 2013, pp. 455-463.

203. Martins, C., et al. "Short-Term Appetite Control in Response to a 6-Week Exercise Programme in Sedentary Volunteers." *British Journal of Nutrition*, vol. 98, no. 4, 2007, pp. 834-842.

204. McLafferty, C.L., Jr., et al. "Resistance Training is Associated with Improved Mood in Healthy Older Adults." *Perceptual and Motor Skills*, vol. 98, no. 3, 2004, pp. 947-957.

205. McNamara, L., et al. "School Recess, Social Connectedness and Health: A Canadian Perspective." *Health Promotion International*, vol. 32, no. 2, 2017, pp. 392-402.

206. McNeil, J., et al. "The Effects of a Single Bout of Aerobic or Resistance Exercise on Food Reward." *Appetite*, vol. 84, 2015, pp. 264-270.

207. McTiernan, A. "Mechanisms Linking Physical Activity with Cancer." *Nature Reviews Cancer*, vol. 8, no. 3, 2008, pp. 205-211.

208. Medeiros, D., and C. Lima. "Influence of Chronic Stretching on Muscle Performance: Systematic Review." *Human Movement Science*, vol. 54, 2017, pp. 220-229.

209. Melanson, E.L., et al. "Resistance to Exercise-Induced Weight Loss: Compensatory Behavioral Adaptations." *Medicine and Science in Sports and Exercise*, vol. 45, no. 8, 2013, pp. 1600-1609.

210. Michael, S.L., et al. "Variety, Enjoyment, and Physical Activity Participation among High School Students." *Journal of Physical Activity and Health*, vol. 13, no. 2, 2016, pp. 223-230.

211. Middleton, L.E., et al. "Physical Activity over the Life Course and its Association with Cognitive Performance and Impairment in Old Age." *Journal of the American Geriatrics Society*, vol. 58, no. 7, 2010, pp. 1322-1326.

212. Miles, M.P., et al. "Effects of Resistance Training on Resting Immune Parameters in Women." *European Journal of Applied Physiology*, vol. 87, no. 6, 2002, pp. 506-508.

213. Ministère de l'Éducation, du Loisir et du Sport. *Le goût et le plaisir de bouger: vers une politique nationale du sport, du loisir et de l'activité physique*, Gouvernement du Québec, 2013.

214. Ministère de l'Éducation et de l'Enseignement supérieur. *Politique de l'activité physique, du sport et du loisir – Au Québec, on bouge!*, Gouvernement du Québec, 2017.

215. Ministère de la Santé et des Services sociaux. *Pour une vision commune des environnements favorables à la saine alimentation, à un mode de vie physiquement actif et à la prévention des problèmes reliés au poids*, Gouvernement du Québec, 2012.

216. "Problèmes de santé et problèmes psychosociaux : santé mentale (maladie mentale)." *Ministère de la Santé et des Services sociaux* , http://sante.gouv.qc.ca/problemes-de-sante/sante-mentale/#cestquoi. Accessed 12 June 2018.

217. Molanorouzi, K., et al. "Motives for Adult Participation in Physical Activity: Type of Activity, Age, and Gender." *BMC Public Health*, vol. 15, no. 1, 2015, p. 66.

218. Monda, V., et al. "Exercise Modifies the Gut Microbiota with Positive Health Effects." *Oxidative Medicine and Cellular Longevity*, vol. 2017, 2017, pp. 1-8.

219. Moore, M.A., and R.S. Hutton. "Electromyographic Investigation of Muscle Stretching Techniques." *Medicine and Science in Sports and Exercise*, vol. 12, no. 5, 1980, pp. 322-329.

220. Moore, S.C., et al. "Association of Leisure-Time Physical Activity with Risk of 26 Types of Cancer in 1.44 million Adults," *JAMA Internal Medicine*, vol. 176, no. 6, 2016, pp. 816-825.

221. Moreira, L.D.F., et al. "Physical Exercise and Osteoporosis: Effects of Different Types of Exercises on Bone and Physical Function of Postmenopausal Women." *Arquivos Brasileiros de Endocrinologia & Metabologia*vol. 58, no. 5, 2014, pp. 514-522.

222. Morin, P., et al. "Relationship Between Eating Behaviors and Physical Activity among Primary and Secondary School Students: Results of a Cross-Sectional Study." *Journal of School Health*, vol. 83, no. 9, 2013, pp. 597-604.

223. Mueller, N., et al. "Health Impact Assessment of Active Transportation: A Systematic Review." *Preventive Medicine*, vol. 76, 2015, pp. 103-114.

224. Mukamal, K.J., et al. "Alcohol Consumption and Risk for Coronary Heart Disease in Men with Healthy Lifestyles." *Archives of Internal Medicine*, vol. 166, no. 19, 2006, pp. 2145-2150.

225. Nagamatsu, L.S., et al. "Physical Activity Improves Verbal and Spatial Memory in Older Adults with Probable Mild Cognitive Impairment: A 6-Month Randomized Controlled Trial." *Journal of Aging Research*, vol. 2013, 2013, pp. 1-10.

226. National Heart Lund and Blood Institute. *Your Guide to Healthy Sleep*. U.S. Department of Health and Human Services, National Institutes of Health, National Heart Lung and Blood Institute, 2011.

227. National Sleep Foundation. *2013 Sleep in America Poll Exercise and Sleep: Summary of Findings*. 2013.

228. Nazare, J.-A., et al. "Changes in Both Global Diet Quality and Physical Activity Level Synergistically Reduce Visceral Adiposity in Men with Features of Metabolic Syndrome." *The Journal of Nutrition*, vol. 143, no. 7, 2013, pp. 1074-1083.

229. Nieman, D.C., et al. "Upper Respiratory Tract Infection is Reduced in Physically Fit and Active Adults." *British Journal of Sports Medicine*, vol. 45, no. 12, 2011, pp. 987-992.

230. Nieman, D.C., and B.K. Pedersen. "Exercise and Immune Function." *Sports Medicine*, vol. 27, no. 2, 1999, pp. 73-80.

231. Norton, S., et al. "Potential for Primary Prevention of Alzheimer's Disease: An Analysis of Population-Based Data." *The Lancet Neurology*, vol. 13, no. 8, 2014, pp. 788-794.

232. O'Connor, P.J., et al. "Mental Health Benefits of Strength Training in Adults." *American Journal of Lifestyle Medicine*, vol. 4, no. 5, 2010, pp. 377-396.

233. O'Donovan, G., et al. "Relationships Between Exercise, Smoking Habit and Mortality in More Than 100,000 Adults." *International Journal of Cancer*, vol. 140, no. 8, 2017, pp. 1819-1827.

234. O'Donovan, G., et al. "Association of "Weekend Warrior" and Other Leisure Time Physical Activity Patterns with Risks for All-Cause, Cardiovascular Disease, and Cancer Mortality." *JAMA Internal Medicine*, vol. 177, no. 3, 2017, pp. 335-342.

235. Oberlin, L.E., et al. "White Matter Microstructure Mediates the Relationship Between Cardiorespiratory Fitness and Spatial Working Memory in Older Adults." *NeuroImage*, vol. 131, 2016, pp. 91-101.

236. Öhman, H., et al. "Effect of Physical Exercise on Cognitive Performance in Older Adults with Mild Cognitive Impairment or Dementia: A Systematic Review." *Dementia and Geriatric Cognitive Disorders*, vol. 38, nos. 5-6, 2014, pp. 347-365.

237. Organisation mondiale de la santé. *Recommandations mondiales sur l'activité physique pour la santé*, 2010.

238. Organisation mondiale de la santé. *Plan d'action global pour la santé mentale 2013-2020*, 2013.

239. Owen, N. "Emergence of Research on Sedentary Behavior and Health," in: Zhu, W., and N. Owen, editors. *Sedentary Behavior and Health: Concepts, Assessments, and Interventions*. Human Kinetics, 2017, pp. 3-12.

240. Paffenbarger, R.S., et al. "Physical Activity and Incidence of Cancer in Diverse Populations: A Preliminary Report." *The American Journal of Clinical Nutrition*, vol. 45, no. 1, 1987, pp. 312-317.

241. Page, P. "Current Concepts in Muscle Stretching for Exercise and Rehabilitation." *International Journal of Sports Physical Therapy*, vol. 7, no. 1, 2012, pp. 109-119.

242. Paluska, S.A., and T.L. Schwenk. "Physical Activity and Mental Health." *Sports Medicine*, vol. 29, no. 3, 2000, pp. 167-180.

243. Paoli, A., et al. "High-Intensity Interval Resistance Training (HIRT) Influences Resting Energy Expenditure and Respiratory Ratio in Non-Dieting Individuals." *Journal of Translational Medicine*, vol. 10, no. 1, 2012, p. 237.

244. Paradis, J.-G. *Manuel pratique d'hygiène, anatomie et physiologie. Rédigé conformément aux règlements refondus du Comité catholique du Conseil de l'Instruction publique*, 5th ed., La Cie J.-A. Langlais & Fils Libraires-Éditeurs, 1915.

245. Pawlowski, T., et al. "Subjective Well-Being in European Countries – On the Age-Specific Impact of Physical Activity." *European Review of Aging and Physical Activity*, vol. 8, no. 2, 2011, pp. 93-102.

246. Peake, J.M., et al. "Recovery of the Immune System After Exercise." *Journal of Applied Physiology*, vol. 122, no. 5, 2016, pp. 1077-1087.

247. Peck, E., et al. "The Effects of Stretching on Performance." *Current Sports Medicine Reports*, vol. 13, no. 3, 2014, pp. 179-185.

248. Perreault, K., et al. "Does Physical Activity Moderate the Association Between Alcohol Drinking and All-Cause, Cancer and Cardiovascular Diseases Mortality? A Pooled Analysis of Eight British Population Cohorts." *British Journal of Sports Medicine*, vol. 51, no. 8, 2017, pp. 651-657.

249. Piazza-Gardner, A.K., and A.E. Barry. "Examining Physical Activity Levels and Alcohol Consumption: Are People Who Drink More Active?" *American Journal of Health Promotion*, vol. 26, no. 3, 2012, pp. e95-e104.

250. Piercy, K.L., et al. "The Physical Activity Guidelines for Americans." *JAMA*, vol. 320, no. 19, 2018, pp. 2020-2028.

251. Pivarnik, J.M., et al. "Seasonal Variation in Adult Leisure-Time Physical Activity." *Medicine and Science in Sports and Exercise*, vol. 35, no. 6, 2003, pp. 1004-1008.

252. Podewils, L.J., et al. "Physical Activity, APOE Genotype, and Dementia Risk: Findings from the Cardiovascular Health Cognition Study." *American Journal of Epidemiology*, vol. 161, no. 7, 2005, pp. 639-651.

253. Poirier, P., et al. "The Atlantic Rift: Guidelines for Athletic Screening – Where Should Canada Stand?" *Canadian Journal of Cardiology*, vol. 32, no. 4, 2016, pp. 400-406.

254. Prapavessis, H., et al. "The Effects of Exercise and Nicotine Replacement Therapy on Smoking Rates in Women." *Addictive Behaviors*, vol. 32, no. 7, 2007, pp. 1416-1432.

255. Pressman, S.D., et al. "Association of Enjoyable Leisure Activities with Psychological and Physical Well-Being." *Psychosomatic Medicine*, vol. 71, no. 7, 2009, pp. 725-732.

256. Priori, S.G., et al. "2015 ESC Guidelines for the Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: The Task Force for the Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death of the European Society of Cardiology (ESC). Endorsed by: Association for European Paediatric and Congenital Cardiology (AEPC)." *European Heart Journal*, vol. 17, no. 11, 2015, pp. 1601-1687.

257. Proper, K.I., et al. "Sedentary Behaviors and Health Outcomes among Adults: A Systematic Review of Prospective Studies." *American Journal of Preventive Medicine*, vol. 40, no. 2, 2011, pp. 174-182.

258. Qu, S., et al. "Rapid Gene Expression Changes in Peripheral Blood Lymphocytes Upon Practice of a Comprehensive Yoga Program." *PLOS ONE*, vol. 8, no. 4, 2013, p. e61910.

259. Québec en forme. "Les aménagements pour l'activité physique de loisir." *Faits saillants de la recherche*, 2011, pp. 1-6.

260. Raichlen, D.A., and G.E. Alexander. "Adaptive Capacity: An Evolutionary Neuroscience Model Linking Exercise, Cognition, and Brain Health." *Trends in Neuroscience*, vol. 40, no. 7, 2017, pp. 408-421.

261. Rall, L.C., et al. "Effects of Progressive Resistance Training on Immune Response in Aging and Chronic Inflammation." *Medicine and Science in Sports and Exercise*, vol. 28, no. 11, 1996, pp. 1356-1365.

262. Rao, D.P., et al. "Physical Activity and Non-Movement Behaviours: Their Independent and Combined Associations with Metabolic Syndrome." *International Journal of Behavioral Nutrition and Physical Activity*, vol. 13, no. 1, 2016, p. 26.

263. Rasberry, C.N., et al. "The Association Between School-Based Physical Activity, Including Physical Education, and Academic Performance: A Systematic Review of the Literature." *Preventive Medicine*, vol. 52, 2011, pp. S10-S20.

264. Rasmussen, M.G., et al. "Changes in Cycling and Incidence of Overweight and Obesity among Danish Men and Women." *Medicine and Science in Sports and Exercise*, vol. 50, no. 7, 2018, pp. 1413-1421.

265. Redolfi, S., et al. "Attenuation of Obstructive Sleep Apnea by Compression Stockings in Subjects with Venous Insufficiency." *American Journal of Respiratory and Critical Care Medicine*, vol. 184, no. 9, 2011, pp. 1062-1066.

266. Redolfi, S., et al. "Attenuation of Obstructive Sleep Apnea and Overnight Rostral Fluid Shift by Physical Activity." *American Journal of Respiratory and Critical Care Medicine*, vol. 191, no. 7, 2015, pp. 856-858.

267. Reed, J., and D.S. Ones. "The Effect of Acute Aerobic Exercise on Positive Activated Affect: A Meta-Analysis." *Psychology of Sport and Exercise*, vol. 7, no. 5, 2006, pp. 477-514.

268. Richardson, C.R., et al. "Integrating Physical Activity into Mental Health Services for Persons with Serious Mental Illness." *Psychiatric Services*, vol. 56, no. 3, 2005, pp. 324-331.

269. Robling, A.G., et al. "Recovery Periods Restore Mechanosensitivity to Dynamically Loaded Bone." *Journal of Experimental Biology*, vol. 204, no. 19, 2001, pp. 3389-3399.

270. Rodriguez, D., and J. Audrain-McGovern. "Team Sport Participation and Smoking: Analysis with General Growth Mixture Modeling." *Journal of Pediatric Psychology*, vol. 29, no. 4, 2004, pp. 299-308.

271. Rosenbaum, S., et al. "The Role of Sport, Exercise, and Physical Activity in Closing the Life Expectancy Gap for People with Mental Illness: An International Consensus Statement by Exercise and Sports Science Australia, American College of Sports Medicine, British Association of Sport and Exercise Science, and Sport and Exercise Science New Zealand." *Translational Journal of the American College of Sports Medicine*, vol. 3, no. 10, 2018, pp. 72-73.

272. Rosenbaum, S., et al. "Physical Activity in the Treatment of Post-Traumatic Stress Disorder: A Systematic Review and Meta-Analysis." *Psychiatry Research*, vol. 230, no. 2, 2015, pp. 130-136.

273. Ross, R., et al. "Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign: A Scientific Statement from the American Heart Association." *Circulation*, vol. 134, no. 24, 2016, pp. e653-e699.

274. Ross, R., and A.J. Bradshaw. "The Future of Obesity Reduction: Beyond Weight Loss." *Nature Reviews Endocrinology*, vol. 5, no. 6, 2009, pp. 319-325.

275. Ross, R., et al. "Reduction in Obesity and Related Comorbid Conditions after Diet-Induced Weight Loss or Exercise-Induced Weight Loss in Men: A Randomized, Controlled Trial." *Annals of Internal Medicine*, vol. 133 no, 2, 2000, pp. 92-103.

276. Ross, R., et al. "Exercise-Induced Reduction in Obesity and Insulin Resistance in Women: A Randomized Controlled Trial." *Obesity*, vol. 12, no. 5, 2004, pp. 789-798.

277. Rovio, S., et al. "The Effect of Midlife Physical Activity on Structural Brain Changes in the Elderly." *Neurobiology of Aging*, vol. 31, no. 11, 2010, pp. 1927-36.

278. Rowell, L.B. *Human Cardiovascular Control*, Oxford University Press, 1993.

279. Ruiz, J.R., et al. "Association Between Muscular Strength and Mortality in Men: Prospective Cohort Study." *British Medical Journal*, vol. 337, 2008, p. a439.

280. Ryan, R.M., and E.L. Deci. "The Darker and Brighter Sides of Human Existence: Basic Psychological Needs as a Unifying Concept." *Psychological Inquiry*, vol. 11, no. 4, 2000, pp. 319-338.

281. Sady, S.P., et al. "Flexibility Training: Ballistic, Static or Proprioceptive Neuromuscular Facilitation?" *Archives of Physical Medicine and Rehabilitation*, vol. 63, no. 6, 1982, pp. 261-263.

282. Saint-Maurice, P.F., et al. "Association of Leisure-Time Physical Activity across the Adult Life Course with All-Cause and Cause-Specific Mortality." *Journal of the American Medical Association*, vol. J2, no. 3, 2019, p. e190355.

283. Sallis, J.F., et al. "An Ecological Approach to Creating Active Living Communities." *Annual Review of Public Health*, vol. 27, 2006, pp. 297-322.

284. Sallis, J.F., and B.E. Saelens. "Assessment of Physical Activity by Self-Report: Status, Limitations, and Future Directions." *Research Quarterly for Exercise and Sport*, vol. 71, no. sup2, 2000, pp. 1-14.

285. Salthouse, T. "Consequences of Age-Related Cognitive Declines." *Annual Review of Psychology*, vol. 63, 2012, pp. 201-226.

286. Salthouse, T.A. "When Does Age-Related Cognitive Decline Begin?" *Neurobiology of Aging*, vol. 30, no. 4, 2009, pp. 507-514.

287. Samitz, G., et al. "Domains of Physical Activity and All-Cause Mortality: Systematic Review and Dose-Response Meta-Analysis of Cohort Studies." *International Journal of Epidemiology*, vol. 40, no. 5, 2011, pp. 1382-1400.

288. Santos-Lozano, A., et al. "Physical Activity and Alzheimer Disease: A Protective Association." *Mayo Clinic Proceedings*, vol. 91, no. 8, 2016, pp. 999-1020.

289. Sari, N. "Physical Inactivity and Its Impact on Healthcare Utilization." *Health Economics*, vol. 18, no. 8, 2009, pp. 885-901.

290. Saxena, S., et al. "Mental Health Benefits of Physical Activity." *Journal of Mental Health*, vol. 14, no. 5, 2005, pp. 445-451.

291. Schaeffer, D.J., et al. "An 8-Month Exercise Intervention Alters Frontotemporal White Matter Integrity in Overweight Children." *Psychophysiology*, vol. 51, no. 8, 2014, pp. 728-733.

292. Schmid, S.M., et al. "Short-Term Sleep Loss Decreases Physical Activity under Free-Living Conditions But Does Not Increase Food Intake under Time-Deprived Laboratory Conditions in Healthy Men." *The American Journal of Clinical Nutrition*, vol. 90, no. 6, 2009, pp. 1476-1482.

293. Scholz, J., et al. "Training Induces Changes in White-Matter Architecture." *Nature Neuroscience*, vol. 12, no. 11, 2009, pp. 1370-1371.

294. Schuch, F.B., et al. "Exercise as a Treatment for Depression: A Meta-Analysis Adjusting for Publication Bias." *Journal of Psychiatric Research*, vol. 77, 2016, pp. 42-51.

295. Schwartz, L.B., et al. "Exercise-Induced Hypersensitivity Syndromes in Recreational and Competitive Athletes: A PRACTALL Consensus Report (What the General Practitioner Should Know About Sports and Allergy)." *Allergy*, vol. 63, no. 8, 2008, pp. 953-961.

296. Sexton, C.E., et al. "A Systematic Review of MRI Studies Examining the Relationship Between Physical Fitness and Activity and the White Matter of the Ageing Brain." *NeuroImage*, vol. 131, 2016, pp. 81-90.

297. Shah, R.V., et al. "Association of Fitness in Young Adulthood with Survival and Cardiovascular Risk: The Coronary Artery Risk Development in Young Adults (CARDIA) Study." *JAMA Internal Medicine*, vol. 176, no. 1, 2016, pp. 87-95.

298. Shaw, K.A., et al. "Exercise for Overweight or Obesity." *Cochrane Database of Systematic Reviews*, no. 4, 2006, p. CD003817.

299. Shephard, R.J., et al. "The Impact of Exercise on the Immune System: NK Cells, Interleukins 1 and 2, and Related Responses." *Exercise and Sport Sciences Reviews*, vol. 23, no. 1, 1995, pp. 215-242.

300. Sherk, V.D., et al. "Bone Loss Over One Year of Training and Competition in Female Cyclists." *Clinical Journal of Sport Medicine*, vol. 24, no. 4, 2014, pp. 331-336.

301. Shiroma, E.J., et al. "Physical Activity Patterns and Mortality: The Weekend Warrior and Activity Bouts." *Medicine and Science in Sports and Exercise*, vol. 51, no. 1, 2019, pp. 35-40.

302. Shohamy, D., and N.B. Turk-Browne. "Mechanisms for Widespread Hippocampal Involvement in Cognition." *Journal of Experimental Psychology: General*, vol. 142, no. 4, 2013, pp. 1159-1170.

303. Shrier, I. "Stretching Before Exercise Does Not Reduce the Risk of Local Muscle Injury: A Critical Review of the Clinical and Basic Science Literature." *Clinical Journal of Sports Medicine*, vol. 9, no. 4, 1999, pp. 221-227.

304. Shrier, I. "When and Whom to Stretch? Gauging the Benefits and Drawbacks for Individual Patients." *The Physician and Sportsmedicine*, vol. 33, no. 3, 2005, pp. 22-26.

305. Silva, A.P., et al. "Measurement of the Effect of Physical Exercise on the Concentration of Individuals with ADHD." *PLOS ONE*, vol. 10, no. 3, 2015, p. e0122119.

306. Sim, A.Y., et al. "Effects of High-Intensity Intermittent Exercise Training on Appetite Regulation." *Medicine and Science in Sports and Exercise*, vol. 47, no. 11, 2015, pp. 2441-2449.

307. Sims, T.H. "Tobacco as a Substance of Abuse." *Pediatrics*, vol. 124, no. 5, 2009, p. e1045-e1053.

308. Singh-Manoux, A., et al. "Effects of Physical Activity on Cognitive Functioning in Middle Age: Evidence from the Whitehall II Prospective Cohort Study." *American Journal of Public Health*, vol. 95, no. 12, 2005, pp. 2252-2258.

309. Singh, A.S., et al. "Effects of Physical Activity Interventions on Cognitive and Academic Performance in Children and Adolescents: A Novel Combination of a Systematic Review and Recommendations from an Expert Panel." *British Journal of Sports Medicine*, vol. 53, no. 10, 2019, pp. 640-647.

310. Slater, M.D., et al. "A Cluster Analysis of Alcohol-Related Attitudes and Behaviors in the General Population." *Journal of Studies on Alcohol*, vol. 60, no. 5, 1999, pp. 667-674.

311. Slentz, C.A., et al. "Exercise, Abdominal Obesity, Skeletal Muscle, and Metabolic Risk: Evidence for a Dose Response." *Obesity*, vol. 17, no. S3, 2009, pp. S27-S33.

312. Smith, P.J., et al. "Aerobic Exercise and Neurocognitive Performance: A Meta-Analytic Review of Randomized Controlled Trials." *Psychosomatic Medicine*, vol. 72, no. 3, 2010, pp. 239-252.

313. Smith, T.W., and J.M. Ruiz. "Psychosocial Influences on the Development and Course of Coronary Heart Disease: Current Status and Implications for Research and Practice." *Journal of Consulting and Clinical Psychology*, vol. 70, no. 3, 2002, pp. 548-568.

314. Smith, U. "Abdominal Obesity: A Marker of Ectopic Fat Accumulation." *The Journal of Clinical Investigation*, vol. 125, no. 5, 2015, pp. 1790-1792.

315. Société Canadienne de physiologie de l'exercice. *Directives canadiennes en matière d'activité physique*. 2011.

316. "Directives canadiennes en matière de mouvement sur 24 heures : une approche intégrée regroupant l'activité physique, le comportement sédentaire et le sommeil." *Société Canadienne de physiologie de l'exercice*, http://csepguidelines.ca/fr/. Accessed 12 June 2018.

317. Soedamah-Muthu, S.S., et al. "Joint Associations of Alcohol Consumption and Physical Activity with All-Cause and Cardiovascular Mortality." *The American Journal of Cardiology*, vol. 112, no. 3, 2013, pp. 380-386.

318. Song, M., et al. "Enhanced Physical Activity Improves Selected Outcomes in Children with ADHD: Systematic Review." *Western Journal of Nursing Research*, vol. 38, no. 9, 2016, pp. 1155-1184.

319. Spagnuolo, P., and L. Hoffman-Goetz. "Effect of Dextran Sulfate Sodium and Acute Exercise on Mouse Intestinal Inflammation and Lymphocyte Cytochrome c Levels." *Journal of Sports Medicine and Physical Fitness*, vol. 49, no. 1, 2009, pp. 112-121.

320. St-Louis-Deschênes, M., and D. Ellemberg. "Acute Exercise and Cognitive Performance in Children and Adolescents." *Science & Sports*, vol. 28, no. 2, 2013, pp. 57-64.

321. Stamatakis, E., et al. "Does Strength Promoting Exercise Confer Unique Health Benefits? A Pooled Analysis of Eleven Population Cohorts with All-Cause, Cancer, and Cardiovascular Mortality Endpoints." *American Journal of Epidemiology*, vol. 187, no. 5, 2017, pp. 1102-1112.

322. Steele, J., et al. "A Higher Effort-Based Paradigm in Physical Activity and Exercise for Public Health: Making the Case for a Greater Emphasis on Resistance Training." *BMC Public Health*, vol. 17, no. 1, 2017, p. 300.

323. Strath, S.J., et al. "Guide to the Assessment of Physical Activity: Clinical and Research Applications: A Scientific Statement from the American Heart Association." *Circulation*, vol. 128, no. 20, 2013, pp. 2259-2279.

324. Strickland, J.C., and M.A. Smith. "The Anxiolytic Effects of Resistance Exercise." *Frontiers in Psychology*, vol. 5, 2014, p. 753.

325. Suls, J., and J. Bunde. "Anger, Anxiety, and Depression as Risk Factors for Cardiovascular Disease: The Problems and Implications of Overlapping Affective Dispositions." *Psychological Bulletin*, vol. 131, no. 2, 2005, pp. 260-300.

326. Swain, D.P. "Moderate or Vigorous Intensity Exercise: Which Is Better for Improving Aerobic Fitness?" *Preventive Cardiology*, vol. 8, no. 1, 2005, pp. 55-58.

327. Swain, D.P., and C.A. Brawner. *ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription*. 7th ed., Lippincott Williams & Wilkins, 2012.

328. Swain, D.P., and B.A. Franklin. "VO2 Reserve and the Minimal Intensity for Improving Cardiorespiratory Fitness." *Medicine and Science in Sports and Exercise*, vol. 34, no. 1, 2002, pp. 152-157.

329. Swain, D.P., and B.A. Franklin. "Comparison of Cardioprotective Benefits of Vigorous Versus Moderate Intensity Aerobic Exercise." *The American Journal of Cardiology*, vol. 97, no. 1, 2006, pp. 141-147.

330. Tambalis, K., et al. "Responses of Blood Lipids to Aerobic, Resistance, and Combined Aerobic with Resistance Exercise Training: A Systematic Review of Current Evidence." *Angiology*, vol. 60, no. 5, 2009, pp. 614-632.

331. Tanasescu, M., et al. "Exercise Type and Intensity in Relation to Coronary Heart Disease in Men." *JAMA*, vol. 288, no. 16, 2002, pp. 1994-2000.

332. Taylor, A.H., et al. "The Acute Effects of Exercise on Cigarette Cravings, Withdrawal Symptoms, Affect and Smoking Behaviour: A Systematic Review." *Addiction*, vol. 102, no. 4, 2007, pp. 534-543.

333. Taylor, H.L., et al. "Death Rates among Physically Active and Sedentary Employees of the Railroad Industry." *American Journal of Public Health and the Nations Health*, vol. 52, no. 10, 1962, pp. 1697-1707.

334. Thacker, S.B., et al. "The Impact of Stretching on Sports Injury Risk. A Systematic Review of the Literature." *Medicine and Science in Sports and Exercise*, vol. 36, no. 3, 2004, pp. 371-378.

335. The Conference Board of Canada. *Activons-nous! L'incidence économique d'une réduction de l'inactivité et de la sédentarité*, 2014.

336. The Conference Board of Canada. *Activons-nous! Agir pour réduire l'inactivité physique et la sédentarité*, 2015.

337. Thibault, G., et al. "Exercice physique et santé cardiovasculaire : intensité «modérée»?" *Les actualités du coeur; Le bulletin de l'Alliance québécoise pour la santé du cœur*, vol. 11, no. 3, 2008, pp. 6-7.

338. Thompson, P.D., et al. "Exercise and Physical Activity in the Prevention and Treatment of Atherosclerotic Cardiovascular Disease: A Statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity)." *Circulation*, vol. 107, no. 24, 2003, pp. 3109-3116.

339. Thompson, W.R. "Worldwide Survey of Fitness Trends for 2019." *ACSM's Health & Fitness Journal*, vol. 22, no. 6, 2018, pp. 10-17.

340. Tremblay, A., et al. "Effect of Intensity of Physical Activity on Body Fatness and Fat Distribution." *The American Journal of Clinical Nutrition*, vol. 51, no. 2, 1990, pp.153-157.

341. Tremblay, A., et al. "Dietary Medium-Chain Triglyceride Supplementation Has No Effect on Apolipoprotein B-48 and Apolipoprotein B-100 Kinetics in Insulin-Resistant Men." *The American Journal of Clinical Nutrition*, vol. 99, no. 1, 2014, pp. 54-61.

342. Tremblay, M.S., et al. "Sedentary Behavior Research Network (SBRN) - Terminology Consensus Project Process and Outcome." *International Journal of Behavioral Nutrition and Physical Activity*, vol. 14, no. 1, 2017, p. 75.

343. Tremblay, M.S., et al. "Physiological and Health Implications of a Sedentary Lifestyle." *Applied Physiology, Nutrition, and Metabolism*, vol. 35, no. 6, 2010, pp. 725-740.

344. Tricco, A.C., et al. "Comparisons of Interventions for Preventing Falls in Older Adults: A Systematic Review and Meta-Analysis." *JAMA*, vol. 318, no. 17, 2017, pp. 1687-1699.

345. Trombold, J. R., et al. "Acute High-Intensity Endurance Exercise Is More Effective Than Moderate-Intensity Exercise for Attenuation of Postprandial Triglyceride Elevation." *Journal of Applied Physiology*, vol. 114, no. 6, 2013, pp. 792-800.

346. Trudeau, F., and R.J. Shephard. "Physical Education, School Physical Activity, School Sports and Academic Performance." *International Journal of Behavioral Nutrition and Physical Activity*, vol. 5, no. 1, 2008, p. 10.

347. Tseng, B.Y., et al. "White Matter Integrity in Physically Fit Older Adults." *NeuroImage*, vol. 82, 2013, pp. 510-516.

348. Tucker, P., and J. Gilliland. "The Effect of Season and Weather on Physical Activity: A Systematic Review." *Public Health*, vol. 121, no. 12, 2007, pp. 909-922.

349. Turmel, J., et al. *L'asthme chez l'athlète : comment devenir expert dans la prise en charge de son asthme*. Presses de l'Université Laval, 2017.

350. "2008 Physical Activity Guidelines for Americans: Be Active, Healthy, and Happy!" *U.S. Department of Health and Human Services*, https://health.gov/paguidelines/. Accessed 12 June 2018.

351. U.S. Department of Health and Human Services. *Physical Activity Guidelines for Americans*. 2nd ed., U.S. Department of Health and Human Services, 2018.

352. Ussher, M.H., et al. "Exercise Interventions for Smoking Cessation." *Cochrane Database of Systematic Reviews*, vol. 8, 2014, p. CD002295.

353. Van der Ploeg, H.P., et al. "Sitting Time and All-Cause Mortality Risk in 222,497 Australian Adults." *Archives of Internal Medicine*, vol. 172, no. 6, 2012, pp. 494-500.

354. Van Praag, H. "Neurogenesis and Exercise: Past and Future Directions." *Neuromolecular Medicine*, vol. 10, no. 2, 2008, pp. 128-140.

355. Vancampfort, D., et al. "Sedentary Behavior and Physical Activity Levels in People with Schizophrenia, Bipolar Disorder and Major Depressive Disorder: A Global Systematic Review and Meta-Analysis." *World Psychiatry*, vol. 16, no. 3, 2017, pp. 308-315.

356. Vancampfort, D., et al. "Considering a Frame of Reference for Physical Activity Research Related to the Cardiometabolic Risk Profile in Schizophrenia." *Psychiatry Research*, vol. 177, no. 3, 2010, pp. 271-279.

357. Vancampfort, D., et al. "Physical Fitness in People with Posttraumatic Stress Disorder: A Systematic Review." *Disability and Rehabilitation*, vol. 39, no. 24, 2017, pp. 2461-2467.

358. Vanhees, L., et al. "Importance of Characteristics and Modalities of Physical Activity and Exercise in the Management of Cardiovascular Health in Individuals with Cardiovascular Risk Factors: Recommendations from the EACPR (Part II)." *European Journal of Preventive Cardiology*, vol. 19, no. 5, 2012, pp. 1005-1033.

359. Vaz-Patto, M., et al. "Association Between Handgrip Strength, Walking, Age-Related Illnesses and Cognitive Status in a Sample of Portuguese Centenarians." *European Review of Aging and Physical Activity*, vol. 14, no. 1, 2017, p. 9.

360. Veliz, P., et al. "Competitive Sports Participation in High School and Subsequent Substance Use in Young Adulthood: Assessing Differences Based on Level of Contact." *International Review for the Sociology of Sport*, vol. 52, no. 2, 2017, pp. 240-259.

361. Verburgh, L., et al. "Physical Exercise and Executive Functions in Preadolescent Children, Adolescents and Young Adults: A Meta-Analysis." *British Journal of Sports Medicine*, vol. 48, no. 12, 2013, pp. 973-979.

362. Vissers, D., et al. "The Effect of Exercise on Visceral Adipose Tissue in Overweight Adults: A Systematic Review and Meta-Analysis." *PLOS ONE*, vol. 8, no. 2, 2013, p. e56415.

363. Vita, A. et al. "Aging, Health Risks, and Cumulative Disability." *New England Journal of Medicine*, vol. 338, no. 15, 1998, pp. 1035-1041.

364. Vlachopoulos, S.P., and S. Michailidou. "Development and Initial Validation of a Measure of Autonomy, Competence, and Relatedness in Exercise: The Basic Psychological Needs in Exercise Scale." *Measurement in Physical Education and Exercise Science*, vol. 10, no. 3, 2006, pp. 179-201.

365. Voelcker-Rehage, C., and C. Niemann. "Structural and Functional Brain Changes Related to Different Types of Physical Activity Across the Life Span." *Neuroscience & Biobehavioral Reviews*, vol. 37, no. 9, 2013, pp. 2268-2295.

366. Von Stengel, S., et al. "Differential Effects of Strength Versus Power Training on Bone Mineral Density in Postmenopausal Women: A 2-Year Longitudinal Study." *British Journal of Sports Medicine*, vol. 41, no. 10, 2007, pp. 649-655.

367. Voss, M.W., et al. "Fitness, But Not Physical Activity, Is Related to Functional Integrity of Brain Networks Associated with Aging." *NeuroImage*, vol. 131, 2016, pp. 113-125.

368. Walseth, K. "*International Review for the Sociology of Sport*, vol. 41, nos. 3-4, 2006, pp. 447-464.

369. Wang, B.W.E., et al. "Postponed Development of Disability in Elderly Runners: A 13-Year Longitudinal Study." *Archives of Internal Medicine*, vol. 162, no. 20, 2002, pp. 2285-2294.

370. Warburton, D.E., et al. "Health Benefits of Physical Activity: The Evidence." *Canadian Medical Association Journal*, vol. 174, no. 6, 2006, pp. 801-809.

371. Weggemans, R.M., et al. "The 2017 Dutch Physical Activity Guidelines." *International Journal of Behavioral Nutrition and Physical Activity*, vol. 15, no. 1, 2018, p. 58.

372. Wen, C.P., et al. "Minimum Amount of Physical Activity for Reduced Mortality and Extended Life Expectancy: A Prospective Cohort Study." *The Lancet*, vol. 378, no. 9798, 2011, pp. 1244-1253.

373. Wen, C.P., and X. Wu. "Stressing Harms of Physical Inactivity to Promote Exercise." *The Lancet*, vol. 380, no. 9838, 2012, pp. 192-193.

374. Wenger, H.A., and G.J. Bell. "The Interactions of Intensity, Frequency and Duration of Exercise Training in Altering Cardiorespiratory Fitness." *Sports Medicine*, vol. 3, no. 5, 1986, pp. 346-356.

375. Weston, K.S., et al. "High-Intensity Interval Training in Patients with Lifestyle-Induced Cardiometabolic Disease: A Systematic Review and Meta-Analysis." *British Journal of Sports Medicine*, vol. 48, no. 16, 2014, pp. 1227-1234.

376. White, L.H., et al. "Effect of Below-the-Knee Compression Stockings on Severity of Obstructive Sleep Apnea." *Sleep Medicine*, vol. 16, no. 2, 2015, pp. 258-264.

377. WHOQOL Group. "The World Health Organization Quality of Life Assessment (WHOQOL): Position Paper from the World Health Organization." *Social Science & Medicine*, vol. 41, no. 10, 1995, pp. 1403-1409.

378. Wichstrom, T., and L. Wichstrom. "Does Sports Participation During Adolescence Prevent Later Alcohol, Tobacco and Cannabis Use?" *Addiction*, vol. 104, no. 1, 2009, pp. 138-149.

379. Williams, M.A., et al. "Resistance Exercise in Individuals with and without Cardiovascular Disease: 2007 Update: A Scientific Statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism." *Circulation*, vol. 116, no. 5, 2007, pp. 572-584.

380. Williams, P.T. "Physical Fitness and Activity As Separate Heart Disease Risk Factors: A Meta-Analysis." *Medicine and Science in Sports and Exercise*, vol. 33, no. 5, 2001, pp. 754-761.

381. Wilmore, J.H., et al. *Physiologie du sport et de l'exercice*, 6th ed., De Boeck Superieur, 2017.

382. World Health Organization. *Global Action Plan on Physical Activity 2018-2030: More Active People for a Healthier World*, 2018.

383. Zschucke, E., et al. "Exercise and Physical Activity in Mental Disorders: Clinical and Experimental Evidence." *Journal of Preventive Medicine and Public Health*, vol. 46, no. suppl. 1, 2013, pp. S12-S21.

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