3 The burden of insufficient physical activity

Increasing physical activity levels in the population can have a considerable impact on population health and on health care expenditures. This chapter quantifies the burden of current physical activity levels, and shows the potential impact of meeting recommended activity levels. It looks at life expectancy, incidence of non-communicable diseases, per capita and total health care expenditure, among other metrics. Two scenarios are modelled: meeting the minimum recommended physical activity level of 150 minutes of moderate-intensity activity per week, as well as meeting the higher level of 300 minutes per week.

Key messages

- Policies to increase physical activity levels can have a considerable impact on population health: if everyone were to meet the minimum guidelines of 150 minutes of moderate-intensity physical activity per week, this would prevent more than 10 000 premature deaths per year across 27 EU Member States.
- Moreover, the life expectancy in people who are insufficiently active would increase by 7.5 months, increasing the average life expectancy for the total population by nearly 2 months.
- Increasing physical activity levels to 150 minutes of moderate-intensity physical activity per week would prevent 11.5 million new cases of NCDs by 2050, including 3.8 million cases of cardiovascular disease, 3.5 million cases of depression, nearly 1 million cases of type 2 diabetes and more than 400 000 cases of cancer.
- Policies to increase physical activity levels would also have a positive impact on health care expenditure, saving EU Member States nearly EUR PPP 8 billion per year, or 0.6% of their total health care budget on average.
- Meeting the higher guidelines of 300 minutes of moderate-intensity physical activity per week would result in 2-3 times higher impacts on the population level: increasing the life expectancy of physically inactive people by nearly 16 months; preventing 30 000 premature deaths per year and 27 million new cases of NCDs over 30 years; and reducing health care expenditure by EUR PPP 17 billion per year.

Infographic 3.1. The population health and economic benefits of physical activity

The Population Health and Economic Benefits of Physical Activity

Meeting the WHO guidelines of 150 minutes of moderate-intensity physical activity per week across 27 European countries would:

Increase the life expectancy of **people who are insufficiently active** by **7.5 months**

Increase average **life expectancy** by **2 months**

Prevent over **10 000 premature deaths** per year

Save **EUR PPP 14 per capita** in **healthcare expenditure** – a total of **EUR PPP 8 billion** per year

Reduce **total health expenditure** by **0.6%**

Avoid **11.5 million** cases of **non-communicable diseases** over the next three decades, including:

- **3.5 million** cases of **depression**
- **3.8 million** cases of **cardiovascular disease**
- **400 000** cases of **cancer**

Quantifying the burden of insufficient physical activity makes a strong case for investing in prevention

Insufficient physical activity and related non-communicable diseases increase the burden on health systems. In this chapter, the Strategic Public Health Planning for Non-Communicable Diseases (SPHeP-NCDs) model is used to calculate the impact of insufficient physical activity on non-communicable diseases and their health care expenditure for the 27 EU Member States (EU27).

The OECD has developed the SPHeP-NCDs model to quantify the impact of major risk factors on population health and the economy. To calculate the burden of insufficient physical activity, the OECD SPHeP-NCDs model is run for two scenarios. The "baseline" scenario is based on current levels of insufficient physical activity. The "no insufficient physical activity" scenario reflects a hypothetical state in which everyone achieves a sufficient level of physical activity. By comparing the outputs of these two scenarios, the burden of current insufficient physical activity levels can be calculated. Note that this analysis aims to capture the total existing burden of insufficient physical activity, rather than the potential impact of reductions in physical inactivity (e.g. the target in the WHO's Global Action Plan on Physical Activity 2018-30 to reduce physical inactivity by 10% by 2025, and 15% by 2030 (WHO, 2018[1])).

To model a "no insufficient physical activity" scenario, a cut-off value for insufficient physical activity first needs to be defined. This is based on the recently published WHO guidelines for physical activity (WHO, 2020[2]) (see Chapter 1). For adults, the general recommendation is to engage in at least 150-300 minutes of moderate-intensity aerobic physical activity; or at least 75-150 minutes of vigorous-intensity aerobic physical activity per week, or a combination.

To be able to compare different types of physical activity, the OECD SPHeP-NCDs model measures physical activity as MET-minutes per week (see Box 3.1), using an average value of 4 METs for moderate-intensity physical activity and 8 METs for vigorous physical activity (WHO, n.d.[3]).

Box 3.1. Metabolic equivalent of task, or METs

Metabolic equivalent of task (METs) is a measure to reflect the intensity of physical activities, and allows comparison between them. One MET is the energy equivalent expended per unit of time by an individual while seated at rest. More intense activities, which cost more energy expenditure than being seated at rest, are attributed higher METs:

Light-intensity physical activity (LPA) is between 1.5 and <3 METs. This includes driving a car, ironing, light cleaning activities, or other incidental activities that do not result in a substantial increase in heart rate or breathing rate.

Moderate-intensity physical activity (MPA) is between 3 and <6 METs. This includes activities such as gardening, dancing or brisk walking.

Vigorous-intensity physical activity (VPA) is 6 or more METs. This includes activities such as fast swimming (training or competition) or running (at least 8 km per hour).

This paper follows the commonly used average values of 4 METs for MPA and 8 METs for VPA. For example, 60 minutes of moderate-intensity physical activity translate into 240 MET-minutes (4 METs x 60 minutes), as does 30 minutes of vigorous-intensity physical activity (8 METs x 30 minutes).

Source: WHO (2020[2]), WHO guidelines on physical activity and sedentary behaviour, https://www.who.int/publications/i/item/9789240015128; WHO (n.d.[3]), Global Physical Activity Questionnaire (GPAQ) Analysis Guide, http://www.who.int/chp/steps/GPAQ/en/index.html.

Following the WHO guidelines, for this report two scenarios of "no insufficient physical activity" are modelled:

- **Scenario 1: "150 minutes per week"** In this hypothetical scenario, everyone in the population meets the minimum recommendation of 150 minutes of moderate-intensity[1] exercise per week (equivalent of 600 MET-minutes per week). Technically, this means that in the model the physical activity levels of people doing less than 600 MET-minutes per week are increased to 600 MET-minutes per week. For people who already do more than 600 MET-minutes per week, their level of physical activity remains unchanged.
- **Scenario 2**: **"300 minutes per week"** As the WHO guidelines indicate, higher levels of physical activity provide additional health benefits (WHO, 2020[2]). The upper limit of the recommendations is to do twice as much (i.e. more than 300 minutes of moderate-intensity activity per week), and the cut-off value can therefore be set at 1 200 MET-minutes per week. Again, technically this means that everyone doing less than 1 200 MET-minutes per week sees their physical activity level increased to this level. For people who already do more than 1 200 MET-minutes per week, their level of physical activity remains unchanged.

The choice was made to present two scenarios because 150 minutes of moderate intensity exercise, or 600 MET-minutes per week, is a commonly used cut-off value for insufficient physical activity in the literature (see Box 3.2). However, it is a conservative scenario, where only the bare minimum recommendations are met. By also including the 300 minutes (1 200 MET-minutes per week) scenario the greater potential of physical activity can be explored.

Box 3.2. Defining insufficient physical activity

A large number of studies looking at the impact of low physical activity use a cut-off of 600 MET-minutes per week, albeit under different formulations (e.g. 5×30 minutes of MPA; 150 minutes of MPA; 600 MET-minutes/week; 150 min MPA or 75 min VPA/week or combinations) (Ding et al., 2017[4]). Other cut-off values used include "3×20 min VPA" (480 MET-minutes per week), "≥1 200 MET-minutes per week" (considered as high physical activity), as well as minutes of exercise without a MET-value specified.

Rather than MET-minutes, some studies use energy expenditure (e.g. ≥1.5 kcal/kg/day) to measure physical activity levels (Ding et al., 2017[4]). Another commonly used measure in burden studies is "any leisure time physical activity", "any VPA", "exercised in the past 2 weeks", or variations thereof. These approaches cannot be used in the OECD SPHeP-NCD model, which uses MET-minutes per week to quantify physical activity.

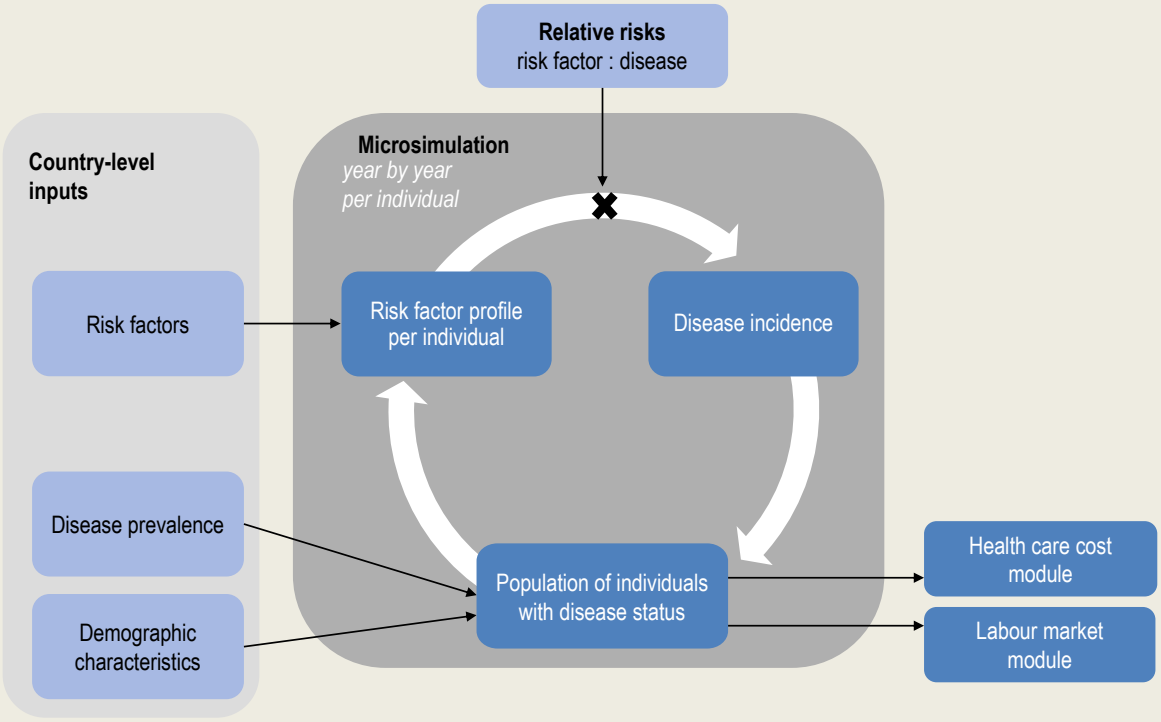
For information on the OECD SPHeP-NCDs model, and how it is used to model insufficient physical activity, please see Box 3.3, as well as the online technical documentation available at: http://oecdpublichealthexplorer.org/ncd-doc.

Box 3.3. Modelling insufficient physical activity in the OECD SPHeP-NCDs model

The OECD SPHeP-NCDs model is an advanced systems modelling tool for public health policy and strategic planning. It is used to predict the health and economic outcomes of the population of a country or a region up to 2050. The model includes a comprehensive set of key behavioural and physiological risk factors (e.g. body mass index (BMI), physical activity, alcohol consumption, blood pressure) and their associated non-communicable diseases (NCDs) and other medical conditions. The model covers 53 countries, including OECD member countries, G20 countries, EU27 countries and OECD accession and selected partner countries. Note that the model does not take into account the impact of risk factors on communicable diseases.

For each country, the model uses demographic and risk factor characteristics by age- and sex-specific population groups from international databases. These inputs are used to generate synthetic populations, in which each individual is assigned demographic characteristics and a risk factor profile (see Figure 3.1). Based on these characteristics, an individual has a certain risk of developing a disease each year. For each year, a cross-sectional representation of the population can be obtained, to calculate health status indicators such as life expectancy, disease prevalence and disability-adjusted life years using disability weights.

Figure 3.1. Schematic overview of the OECD SPHeP-NCDs model



Note: This schematic is highly simplified and focuses on the disease component – it does not reflect some other components of the model (including births, immigration, emigration, death, remission and fatality).
Source: OECD (2019[5]), SPHeP-NCDs Technical Documentation, http://oecdpublichealthexplorer.org/ncd-doc.

The OECD SPHeP-NCDs model uses country-specific data on physical activity prevalence from the Institute for Health Metrics and Evaluation (IHME) (IHME, n.d.[6]). IHME data on physical activity is measured in total metabolic equivalent of task minutes per week (MET-minutes per week). While the

data from IHME is provided in four categories, in the OECD SPHeP-NCDs model physical activity is modelled as a continuous variable. A piecewise linear function is assumed to model the cumulative distribution, calibrated in order to match the prevalence of the four available physical activity categories. A lower bound of 200 MET-minutes/week and an upper bound of 10 000 MET-minutes/week are applied in order to retain plausibility.

In the model, six diseases are directly related to insufficient physical activity through a relative risk: breast cancer, colon cancer, depression, type 2 diabetes, ischaemic heart disease and ischaemic stroke. As physical activity has an impact on BMI, a link between the two risk factors is modelled, indirectly linking physical activity to another six diseases: dementia, back pain, liver cancer, oesophageal cancer, atrial fibrillation, and haemorrhagic stroke (see 0 for details on the methodology behind this link, and Annex 3.B for results without the link). Physical activity is not linked to any potential increase in injuries, nor to any benefits in secondary prevention. The model takes into account the fact that individuals who do not develop a physical activity-related disease may develop other diseases.

Health care costs of disease treatment are estimated based on a per-case annual cost, which is extrapolated from national health-related expenditure data. The additional cost of multimorbidity is also calculated and applied. The extra cost of end-of-life care is also taken into account. In the model, people not dying from a physical activity-related disease continue to consume medical care for other conditions and incur medical costs.

Results are presented as annual averages or cumulative numbers for the period 2022-50. Single-year estimates are not used as they are affected by noise in the model. Since the scenario is introduced as a "shock" in 2022, rather than gradually over time, the annual average over 2022-50 reflects the impact in any of the years covered.

Previous estimates of the burden of insufficient physical activity primarily use a population attributable fraction (PAF) approach (Ding et al., 2017[4]; Lee et al., 2012[7]). PAF is the proportional reduction in population disease or mortality would occur if exposure to a risk factor were reduced. The benefit of the OECD SPHeP-NCDs model's microsimulation approach is that it takes into account all major NCDs, instead of being limited to the diseases for which a physical activity PAF is calculated. This means that it takes into account the effect of changes in morbidity and mortality on diseases not directly associated with physical activity (e.g. if people live longer due to being physically active, they can go on to develop other diseases). Moreover, the effect of multiple morbidities in one individual can be modelled.

Nevertheless, the results presented here are subject to limitations. Firstly, the impact of physical activity is limited to a set of 12 major diseases that are linked directly or indirectly to the prevalence of physical activity. However, there is emerging evidence of the impact of physical activity on a wider range of diseases and other health and well-being outcomes. Secondly, data on physical activity levels is generally self-reported, which has been shown to overestimate actual activity levels (Cerin et al., 2016[8]; Dyrstad et al., 2014[9]).

For more information on the OECD SPHeP-NCDs model, see the SPHeP-NCDs Technical Documentation, available at: http://oecdpublichealthexplorer.org/ncd-doc.

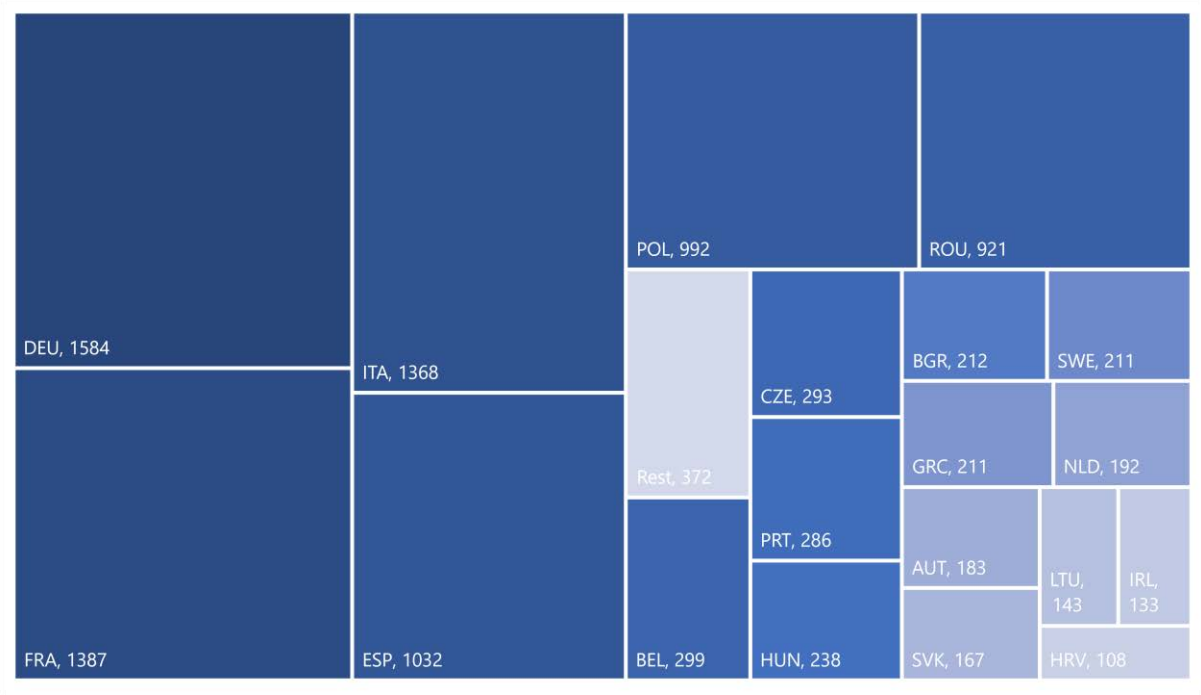
The burden of insufficient physical activity on population health

Physical activity could prevent more than 10 000 premature deaths per year

If everyone in the 27 countries would do at least 150 minutes of moderate-intensity exercise per week, 10 331 premature deaths (defined as deaths of people aged 30 to 70 years) would be avoided every year. This is similar to the number of deaths due to COVID-19 in that same age group in France and Germany combined in 2020. The five countries with the largest burden (Germany, France, Italy, Spain and Poland) make up three-fifths (62%) of the total burden across the 27 countries (Figure 3.2). While these are all countries with large populations, some smaller countries like Belgium and the Czech Republic also make up a considerable share of the total premature mortality burden. If the higher recommendations of 300 minutes of physical activity per week were met by everyone, nearly 30 000 premature deaths could be avoided per year.

Figure 3.2. Annual premature deaths due to insufficient physical activity

The impact of insufficient physical activity (defined as less than 150 minutes per week) on annual premature mortality (defined as deaths of people aged 30 to 70), average over 2022-50

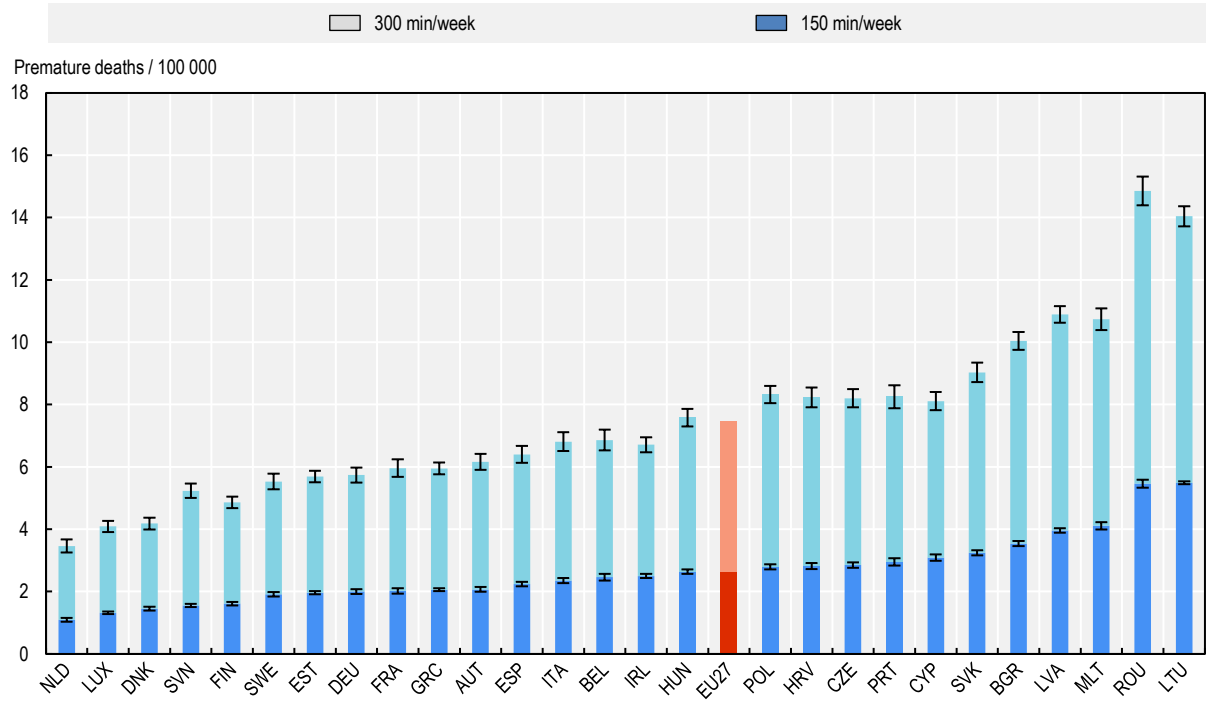


Note: Rest includes FIN (92), DNK (88), LVA (70), CYP (41), SVN (31), EST (24), MLT (17) and LUX (9); the numbers in the labels indicate the number of premature deaths per year.
Source: OECD SPHeP-NCDs model, 2022.

The premature mortality rate due to insufficient physical activity is the lowest in Northern European countries, where between 2022 and 2050 less than 2 people per 100 000 inhabitants will die prematurely every year due to the effects of insufficient physical activity (less than 150 minutes per week) (Figure 3.3). The premature mortality rate is considerably higher in Romania and Lithuania, where for every 100 000 inhabitants more than 5 people will die prematurely due to insufficient physical activity. On average in the 27 EU Member States, doing 150 minutes of moderate intensity physical activity per week would prevent 2.6 premature deaths per 100 000 inhabitants – and doing at least 300 minutes per week would prevent an additional 4.8 premature deaths per 100 000 inhabitants.

Figure 3.3. Premature mortality rate due to insufficient physical activity

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on annual premature mortality (defined as deaths of people aged 30 to 70) per 100 000 inhabitants, average over 2022-50, with 95% confidence intervals



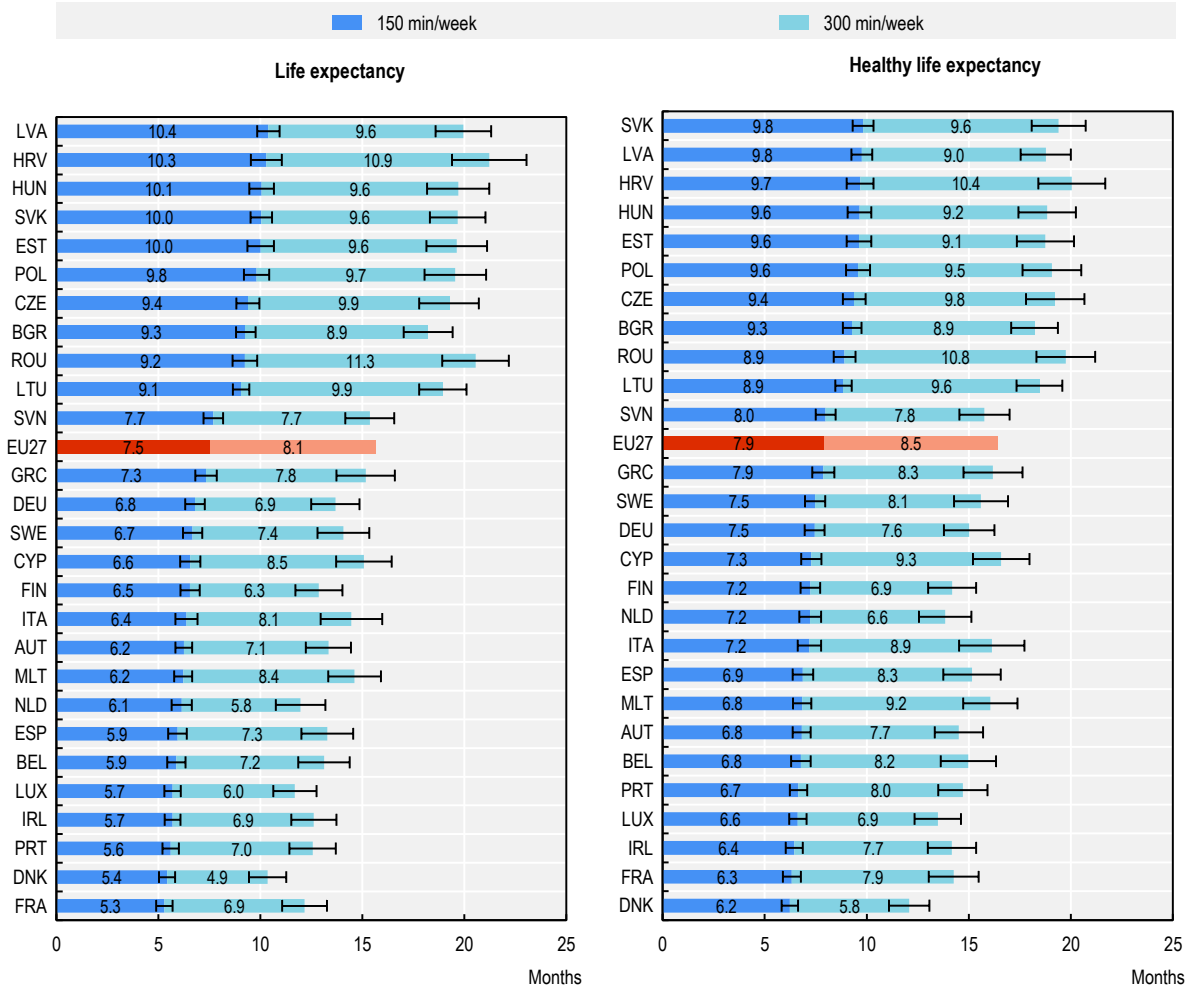
Source: OECD SPHeP-NCDs model, 2022.

People who are currently insufficiently active could increase their life expectancy by 7.5 months by moving more

If people who currently do less than 150 minutes of physical activity per week were to increase their physical activity to this target, their life expectancy would increase by 7.5 months (Figure 3.4). Their healthy life expectancy, which takes into account years lived with diseases (Box 3.4), would increase by 7.9 months. If everyone who is now doing less than 300 minutes of physical activity per week would increase their activity to this level, their life expectancy would increase by more than a year (15.7 months).

Figure 3.4. The impact of insufficient physical activity on life expectancy in the insufficiently active population

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on the life expectancy or healthy life expectancy of people who are insufficiently active (months), average over 2022-50, with 95% confidence intervals



Note: The label for the 300 minutes per week scenario indicates the additional months as compared to the 150 minutes scenario, e.g. for Latvia, meeting the 150 minutes per week guidelines would increase life expectancy of inactive people by 10.4 months, while meeting the 300 minutes guidelines would save another 9.6 months, for a total increase in life expectancy of 20.0 months.
Source: OECD SPHeP-NCDs model, 2022.

Box 3.4. Life expectancy and healthy life expectancy

Life expectancy is a measure of mortality, as it reflects the age at which individuals are expected to die. Healthy life expectancy combines mortality with morbidity. It uses disease-specific disability weights to measure a disability-adjusted life expectancy.

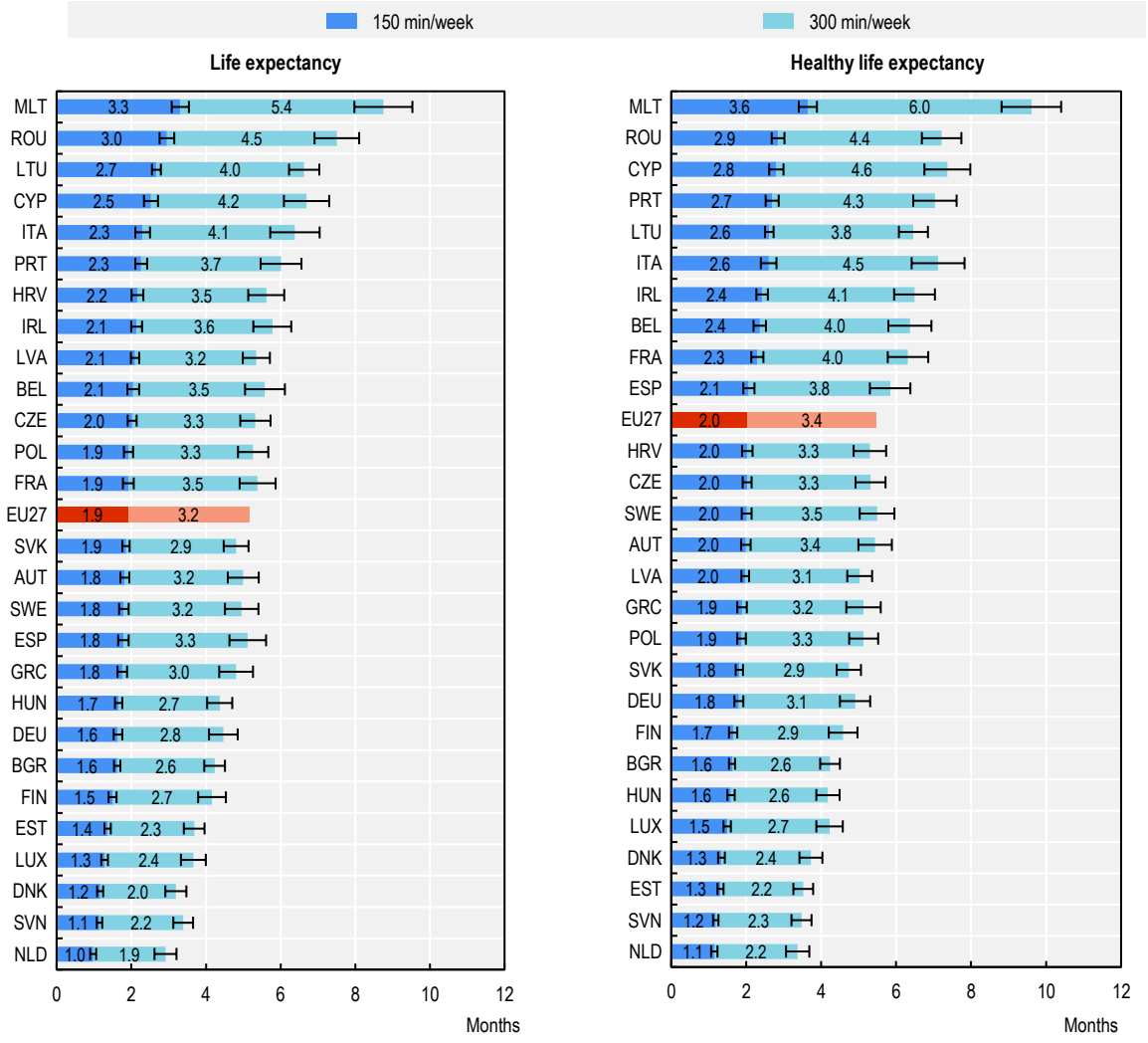
For example, if someone is expected to die at the age of 60 years (life expectancy is 60 years), but they spend the last 10 years of their life with a disease that has a disability weight of 0.5, their healthy life expectancy is 55 years (50 years in full health + 10 years at 50% reduced health).

Note that while healthy life expectancy is per definition lower than life expectancy, the *change* in life expectancy (as presented in Figure 3.4 and Figure 3.5) can be greater than the *change* in healthy life expectancy. This is because the disability weights can "discount" life-years gained. Going back to the previous example, if the same person lives to 70 years in the "no insufficient physical activity" scenario, this would be a gain of 10 life years. However, if there is no change in the onset of disease and these additional years are also spent with a 0.5 disability weight disease, the gain in healthy life expectancy would be only 5 years.

At a population level, insufficient physical activity reduces the average life expectancy in the 27 EU Member States by 1.9 months (Figure 3.5). When assuming a higher cut-off of 300 minutes, insufficient physical activity reduces life expectancy by 5.1 months. In other words, if everyone in the 27 countries would do at least 300 minutes of moderate-intensity physical activity per week, the average life expectancy of the total population would increase by nearly half a year. In comparison, EU Member States saw an average increase in life expectancy of 2.4 months per year between 2005 and 2018, due to advancements in health care, improvements in working and living conditions, healthier lifestyles and other factors (OECD/European Union, 2020[10]).

Figure 3.5. The impact of insufficient physical activity on population average life expectancy

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on the average life expectancy or healthy life expectancy of the total population (months), average over 2022-50, with 95% confidence intervals



Note: The label for the 300 minutes per week scenario indicates the additional months as compared to the 150 minutes scenario, e.g. for Malta, meeting the 150 minutes per week guidelines would increase life expectancy by 3.3 months, while meeting the 300 minutes guidelines would save another 5.4 months, for a total increase in life expectancy of 8.7 months.
Source: OECD SPHeP-NCDs model, 2022.

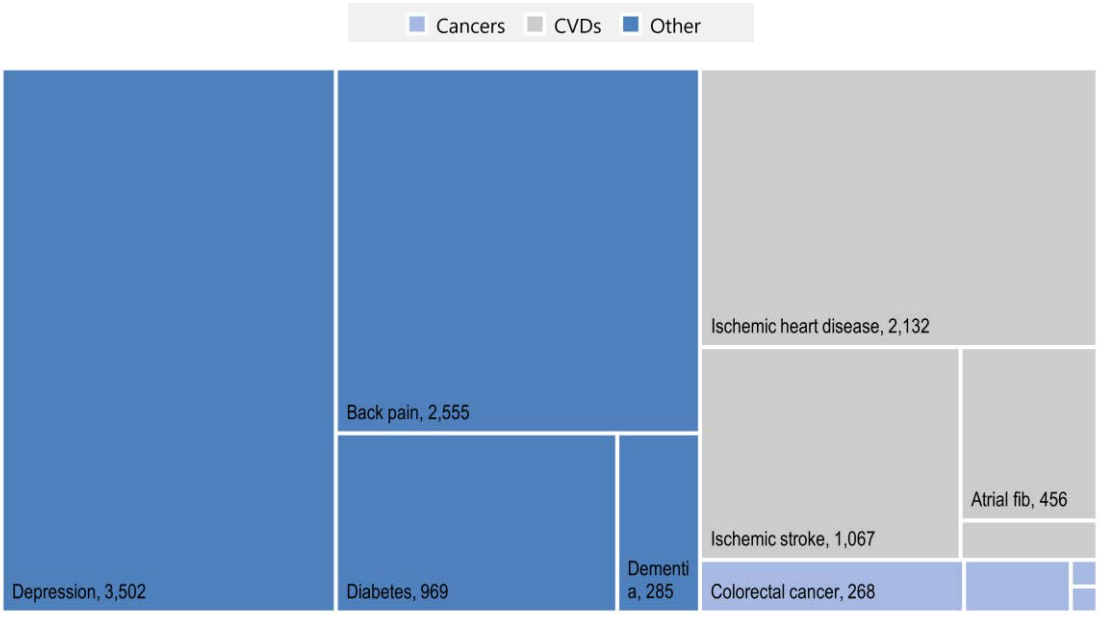
Countries with a high level of insufficient physical activity generally see a large impact on the average life expectancy of the population. On the other hand, countries such as Finland or the Netherlands have a lower level of insufficient physical activity, and the impact on the average life expectancy of the total population is therefore small.

Increasing physical activity could prevent 11.5 million new NCD cases by 2050

In the 27 countries, doing less than 150 minutes of moderate-intensity exercise per week is linked to 3.5 million new cases of depression between 2022 and 2050, as well as 3.8 million new cases of cardiovascular disease, nearly 1 million new cases of type 2 diabetes and over 400 000 new cancers (Figure 3.6). Across the 12 diseases affected by physical activity in the model, doing at least 150 minutes of physical activity could prevent 11.5 million new NCDs over the next 29 years. Meeting the target of 300 minutes of physical activity per week would prevent a further 16 million cases.

Figure 3.6. The burden of disease due to insufficient physical activity

The impact of insufficient physical activity (defined as less than 150 minutes per week) on number of new disease cases (thousands), total over 2022-50 and for all the 27 EU Member States

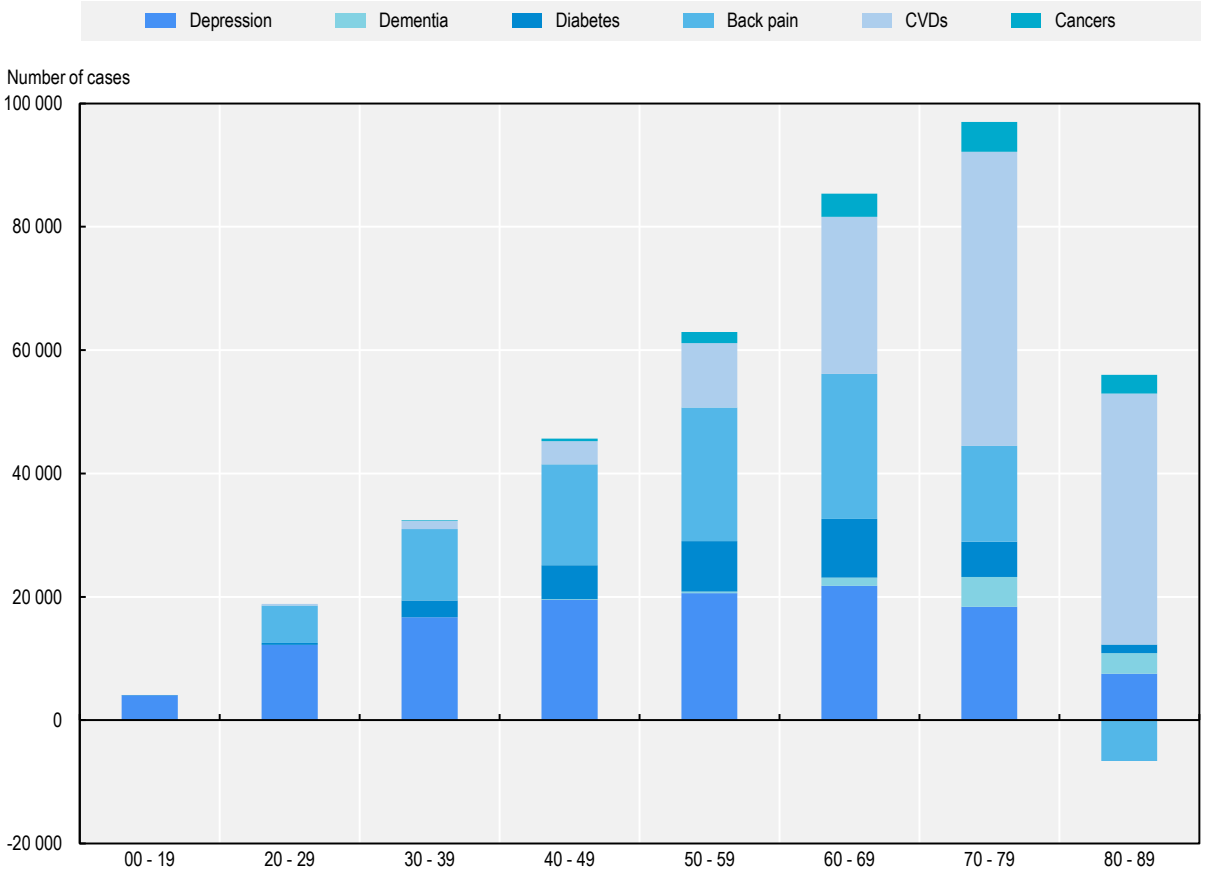


Note: Not (fully) labelled are breast cancer (108), haemorrhagic stroke (104), oesophageal cancer (14) and liver cancer (13). Graph is limited to diseases included in the OECD SPHeP-NCDs model and may not capture all diseases linked to physical inactivity. The numbers in the labels indicate the number of new disease cases due to insufficient physical activity in thousands over 2022-50.
Source: OECD SPHeP-NCDs model, 2022.

The majority of disease cases due to insufficient physical activity affect people between the age of 50 and 79 years (Figure 3.7). Cardiovascular diseases account for 40% of all diseases due to insufficient physical activity in people aged 60 to 79 years, and nearly three-fourths of the burden for people over 80 years old. While cancers and cardiovascular diseases are rarer in the younger age groups, insufficient physical activity does cause a considerable burden of depression and back pain in this population. Notably, in the over-80 age group there is a decrease in back pain issues due to insufficient physical activity. This is likely the result of the decrease in life expectancy associated with insufficient physical activity, which reduces the number of people in this age group and consequently the number of diseases they develop.

Figure 3.7. The burden of disease due to insufficient physical activity by age group

Number of new disease cases per year by age group due to insufficient physical activity (defined as less than 150 minutes per week), average over 2022-50 and for all the 27 EU Member States



Source: OECD SPHeP-NCDs model, 2022.

If everyone were to meet the minimum physical activity guidelines of at least 150 minutes of moderate-intensity physical activity per week, 3.9% of all new type 2 diabetes cases would be avoided between 2022 and 2050, as well as 2.3% of cardiovascular disease cases. Meeting the upper guidelines of 300 minutes of physical activity per week would prevent nearly 10% of new diabetes cases, 5.2% of new cardiovascular disease cases, and around 4% of new cancer cases.

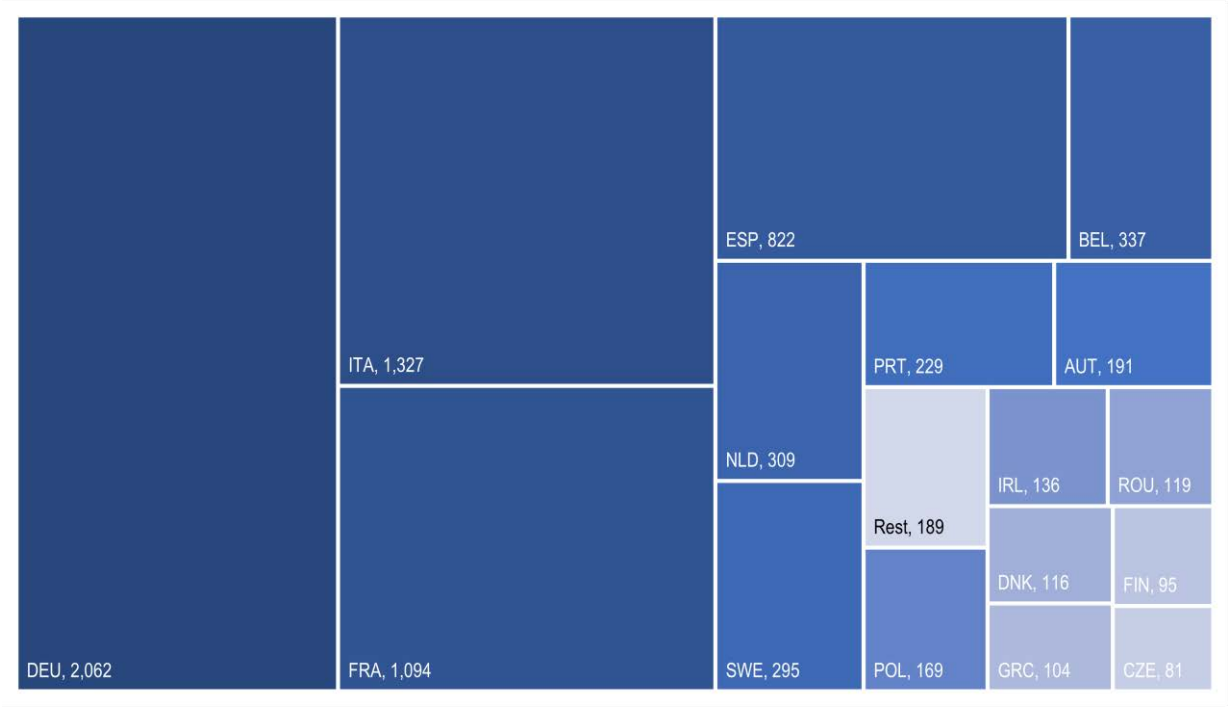
The burden of insufficient physical activity on health care expenditure

Increasing physical activity can save nearly EUR PPP 8 billion per year in health care expenditure

If everyone were to do at least 150 minutes of physical activity per week, a total of EUR PPP[2] 7.7 billion per year could be saved in health care expenditure across the 27 countries (Figure 3.8) – more than the total annual health care expenditure of Lithuania and Luxembourg combined. A large part of the burden is in countries with large populations and high health care expenditure levels, such as Germany, Italy and France.

Figure 3.8. Health care expenditure due to insufficient physical activity

The impact of insufficient physical activity (defined as less than 150 minutes per week) on total annual health care expenditure in EUR PPP (millions), average over 2022-50

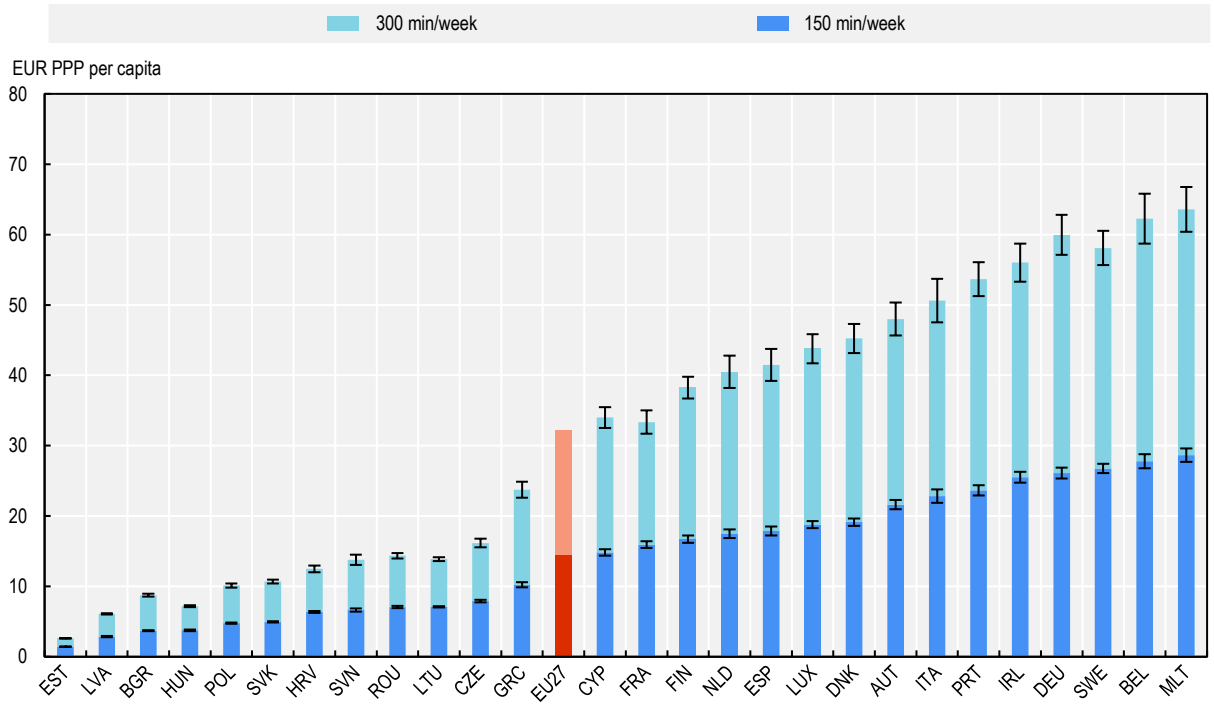


Note: Rest includes HUN (34), SVK (25), HRV (24), BGR (22), CYP (20), LTU (18), LUX (13), SVN (13), MLT (12), LVA (5) and EST (2); the numbers in the labels indicate the total annual health care expenditure in millions of EUR PPP.
Source: OECD SPHeP-NCDs model, 2022.

Countries with higher health care expenditures in general tend to spend more on treating diseases linked to insufficient physical activity, and vice versa (Figure 3.9). However, the prevalence of insufficient physical activity also plays an important role: while per capita health care expenditure in Malta, Portugal and Italy is around the EU average, the high prevalence of insufficient physical activity in these countries means that the associated health care expenditure is higher than the average. The 27 countries included in the analysis could save on average EUR PPP 14.4 per capita per year between 2022 and 2050 if everyone met at least the minimum physical activity guidelines of 150 minutes of exercise per week. Meeting the guidelines of 300 minutes per week would save another EUR PPP 17.7 per capita, for a total of EUR PPP 32.2 per capita, per year.

Figure 3.9. Health care expenditure per capita due to insufficient physical activity

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on annual per capita health care expenditure in EUR PPP, average over 2022-50, with 95% confidence intervals



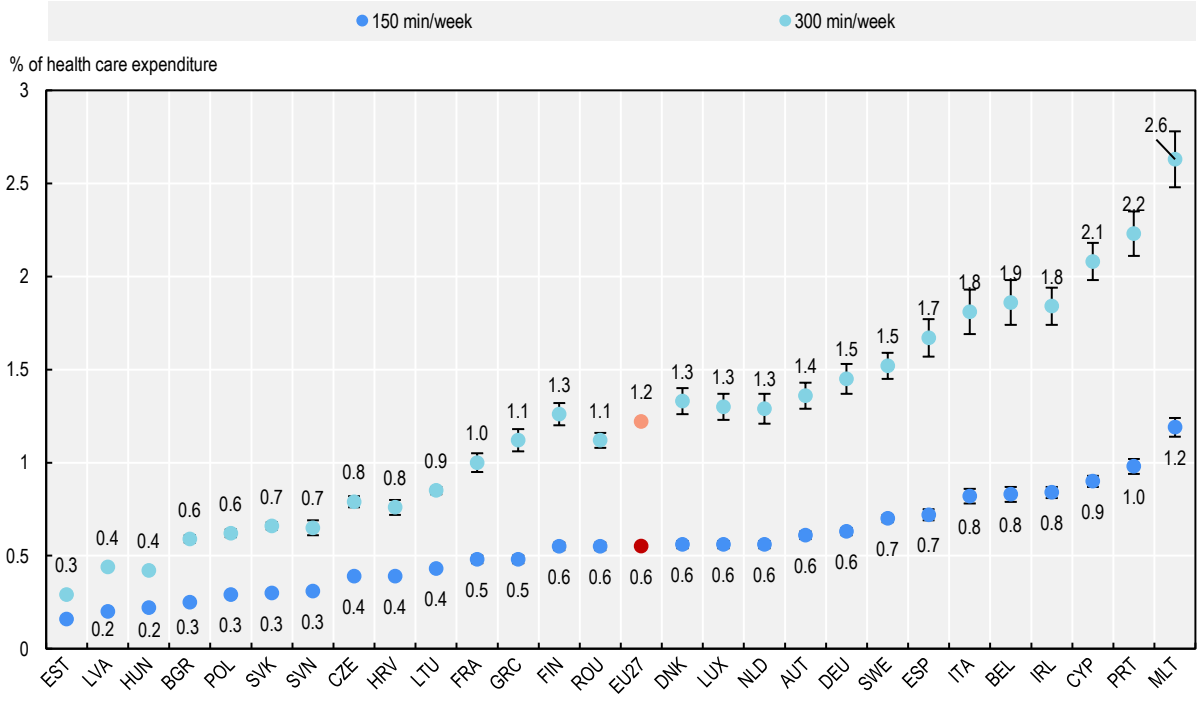
Source: OECD SPHeP-NCDs model, 2022.

EU Member States could on average save 0.6% of their health care expenditure by increasing physical activity

EU Member States could save on average 0.6% of their health care expenditure if everyone did at least 150 minutes of physical activity per week (Figure 3.10). If everyone were to meet the 300 minutes guidelines, this would save 1.2% of total health care expenditure. The potential savings from doing at least 150 minutes of physical activity range from 0.16% of total health care expenditure in Estonia, to 1.2% in Malta.

Figure 3.10. Health care expenditure attributable to insufficient physical activity

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on annual health care expenditure as a percentage of total health care expenditure, average over 2022-50, with 95% confidence intervals



Note: Missing label for Estonia (150 min/week) is 0.16.
Source: OECD SPHeP-NCDs model, 2022.

References

Cerin, E. et al. (2016), "Correlates of Agreement between Accelerometry and Self-reported Physical Activity", *Medicine & Science in Sports & Exercise*, Vol. 48/6, pp. 1075-1084, https://doi.org/10.1249/mss.0000000000000870. [8]

Ding, D. et al. (2017), *The economic burden of physical inactivity: A systematic review and critical appraisal*, BMJ Publishing Group, https://doi.org/10.1136/bjsports-2016-097385. [4]

Dyrstad, S. et al. (2014), "Comparison of Self-reported versus Accelerometer-Measured Physical Activity", *Medicine & Science in Sports & Exercise*, Vol. 46/1, pp. 99-106, https://doi.org/10.1249/mss.0b013e3182a0595f. [9]

Hall KD, S. (2011), "Quantification of the effect of energy imbalance on bodyweight", *Lancet*, Vol. 378/9793, pp. 826-837, https://doi.org/10.1016/S0140-6736(11)60812-X. [13]

IHME (n.d.), *Epi Visualization*, https://vizhub.healthdata.org/epi/ (accessed on 15 October 2021). [6]

Jette, M., K. Sidney and G. Blumchen (1990), "Metabolic Equivalents (METS) in Exercise Testing, Exercise Prescription, and Evaluation of Functional Capacity", *Clinical Cardiology*, Vol. 13, pp. 555-565. [14]

Lee, I. et al. (2012), "Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy", *The Lancet*, Vol. 380/9838, pp. 219-229, https://doi.org/10.1016/s0140-6736(12)61031-9. [7]

OECD (2019), *SPHeP-NCDs Technical Documentation*, OECD, Paris, http://oecdpublichealthexplorer.org/ncd-doc. [5]

OECD (2019), *The Heavy Burden of Obesity: The Economics of Prevention*, OECD Health Policy Studies, OECD Publishing, Paris, https://doi.org/10.1787/67450d67-en. [15]

OECD/European Union (2020), *Health at a Glance: Europe 2020: State of Health in the EU Cycle*, OECD Publishing, Paris, https://doi.org/10.1787/82129230-en. [10]

Stensel, D., J. King and A. Thackray (2016), "Role of physical activity in regulating appetite and body fat", *Nutrition Bulletin*, Vol. 41/4, pp. 314-322, https://doi.org/10.1111/nbu.12234. [12]

Swift, D. et al. (2014), "The Role of Exercise and Physical Activity in Weight Loss and Maintenance", *Progress in Cardiovascular Diseases*, Vol. 56/4, pp. 441-447, https://doi.org/10.1016/j.pcad.2013.09.012. [11]

WHO (2020), *WHO guidelines on physical activity and sedentary behaviour*, World Health Organization, https://apps.who.int/iris/handle/10665/336656. [2]

WHO (2018), *Global action plan on physical activity 2018-2030*, World Health Organization, https://apps.who.int/iris/handle/10665/272722. [1]

WHO (n.d.), *Global Physical Activity Questionnaire (GPAQ) Analysis Guide*, http://www.who.int/chp/steps/GPAQ/en/index.html (accessed on 29 January 2021). [3]

Annex 3.A. Linking physical activity to BMI in the OECD SPHeP-NCDs model

In addition to providing protective effects for a range of diseases, increased physical activity can also contribute to modest weight loss (Swift et al., 2014[11]; Stensel, King and Thackray, 2016[12]). As this lowers a person's body-mass index (BMI), physical activity can reduce the risk of developing diseases associated with a high BMI. To capture this effect, the OECD SPHeP-NCDs model includes a link between physical activity (PA) and BMI.

The PA/BMI link is based on the widely used energy balance model developed by Hall et al. (2011[13]). An interactive version of this model is available in the form of the Body Weight Planner on the website of the National Institute of Diabetes and Digestive and Kidney Diseases (https://www.niddk.nih.gov/bwp). By varying the inputs (age, sex, weight, height, starting level of physical activity), the Body Weight Planner was used to generate a dataset to train an algorithm for the OECD SPHeP-NCDs model.

For each data entry, calorie intake was set to remain at the baseline level. The level of physical activity was assumed to change on day one, which resulted in a change in calorie output. METs were converted to calories using the following formula (Jette, Sidney and Blumchen, 1990[14]):

$$\frac{MET\ value * 3.5 * body\ weight\ in\ kg}{200} = calories\ per\ minute$$

Based on this formula, the increase in daily calorie expenditure was converted to MET-minutes per week as follows:

$$\frac{Calories\ per\ day * 200}{3.5 * body\ weight\ in\ kg} * 7\ days = METminutes\ per\ week$$

The resulting change in BMI was measured after one year. At this point, roughly half of the weight loss will have taken place. Reaching a bodyweight plateau is estimated to take around 10 years (Hall KD, 2011[13]), but the simulator does not go beyond 500 days. The estimated weight loss is therefore an underestimation compared to the theoretical maximum. However, in reality it can be argued that few people would maintain the increased level of physical activity and the constant level of calorie intake consistently over 10 years.

A regression analysis was used to understand how BMI is affected by changes in physical activity, as well as by age, sex, starting BMI and starting level of physical activity. Age, sex and starting BMI were all not significant, nor was an interaction term between age and changes in physical activity. This is consistent with the fact that the relative contribution of these variables to the change in BMI was also small. The interaction effect between sex and changes in physical activity was significant, as were starting physical activity level, changes in physical activity and the square function of the change in physical activity. The final algorithm used in the model is therefore:

$$\Delta BMI = -0.0001\,046 * \Delta PA + 0.0000\,000\,204 * \Delta PA^2 +$$

$$0.00000\,313 * sex * \Delta PA + 0.0174\,877 * PA_{start} - 0.0245613.$$

With

$$\Delta BMI = change\ in\ BMI\ in\ percentage$$

$$\Delta PA = change\ in\ physical\ activity\ in\ METs/week$$

$$sex = (1, male)(2, female)$$

$$PA_{start} = starting\ level\ of\ physical\ activity\ (as\ per\ below)$$

The level of physical activity in the Body Weight Planner is indicated by a number between 1.4 and 2.5, with a value of 1.4 representing a sedentary person. Using the "estimate your level" function in the Planner, the levels were approximately matched to the categories in the OECD SPHeP-NCDs model as follows:

Annex Table 3.A.1. Levels of physical activity in the Body Weight Planner and the OECD SPHeP-NCDs model

Leisure time physical activity	Body weight planner	OECD SPHeP-NCDs model
No exercise	1.4	Inactive (below 600 METs/week)
Walking/non-strenuous exercise once a week	1.5	Low level of activity (between 600 and 3 999 METs/week)
Regular activities more than once a week	1.7	Moderately active (between 4 000 and 7 999 METs/week)
Strenuous activities several times a week	1.9	Highly active (8 000 METs/week)

Note: The level of physical activity in the Body Weight Planner's "estimate my level" was done only based on exercise-related physical activity, while the physical activity levels in the OECD SPHeP-NCDs model include also other types of physical activity, such as transport, work, gardening and housework.

Based on the algorithm, an inactive, healthy-weight man who starts to do moderate-intensity exercise twice a week for 30 minutes (delta MET minutes per week = 240) can expect to lose 1.5 kg after one year (assuming his calorie intake and non-exercise physical activity stay the same). If an overweight woman with a low level of physical activity starts to do vigorous-intensity exercise for 30 minutes, three times per week, she would lose just under 5 kg after one year.

It is important to note that the PA/BMI link in the OECD SPHeP-NCDs model is a hypothetical link to estimate the theoretical burden of disease. In this scenario, all insufficient physical activity is artificially eliminated and this increase in physical activity is linked to a change in BMI for all affected individuals. In reality however, people might not lose weight as they may increase their calorie intake or subconsciously reduce their energy expenditure in unstructured physical activity (Stensel, King and Thackray, 2016[12]).

Annex 3.B. The burden of insufficient physical activity without the link with BMI

The results presented in the main report consider the direct impact of insufficient physical activity on health, as well as the impact of insufficient physical activity on BMI and its subsequent impact on health. As high BMI is an important risk factor for a number of diseases, this link results in a substantial increase in the burden of disease. Alternatively, it is possible to model only the direct impact of insufficient physical activity on health.

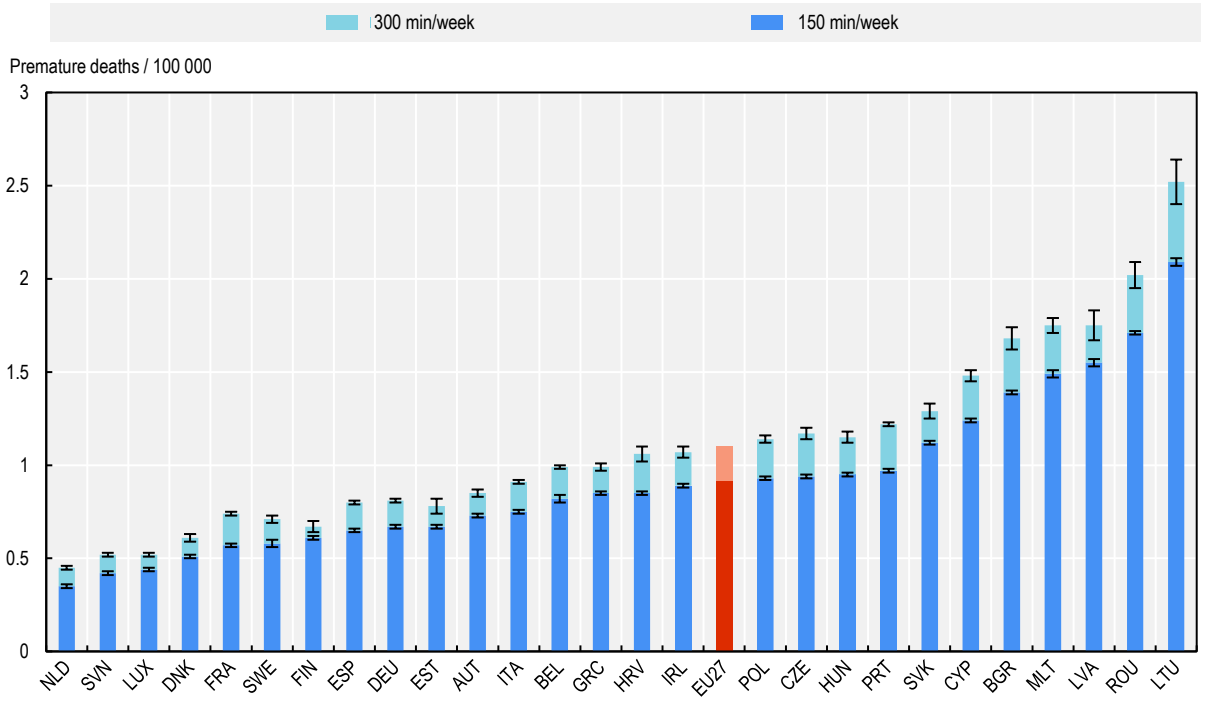
One of the reasons not to include a link between physical activity and BMI is that this makes the results directly comparable to previous OECD work on the burden of obesity (OECD, 2019[15]), as both would consider only one risk factor and its consequences. However, it has to be noted that this is more of an academic exercise. In reality, insufficient physical activity does have an impact on BMI, and this adds to the burden on health and the economy. For policy makers who want to understand the impact of insufficient physical activity, and promote policies to increase activity levels, it is important to have a picture of the full extent of the issue.

Below are the results of the OECD SPHeP-NCDs model on the burden of insufficient physical activity, without the link between physical activity and BMI (PA/BMI link).

When only considering the direct impact of insufficient physical activity on premature mortality, 0.9 deaths can be avoided per 100 000 inhabitants by meeting the guidelines of 150 minutes of physical activity per week (Annex Figure 3.B.1). The additional effect of meeting the higher guidelines of 300 minutes per week is only 0.2 deaths per 100 000 inhabitants more. This is because the largest relative risks of developing disease are associated with doing less than 150 minutes per week. Including the PA/BMI link increases the impact of the 150 minutes scenario nearly three-fold (from 0.9 per 100 000 to 2.6 per 100 000).

Annex Figure 3.B.1. Premature mortality rate due to insufficient physical activity (no PA/BMI link)

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on annual premature mortality (defined as deaths of people aged 30 to 70) per 100 000 population, average over 2022-50, with 95% confidence intervals

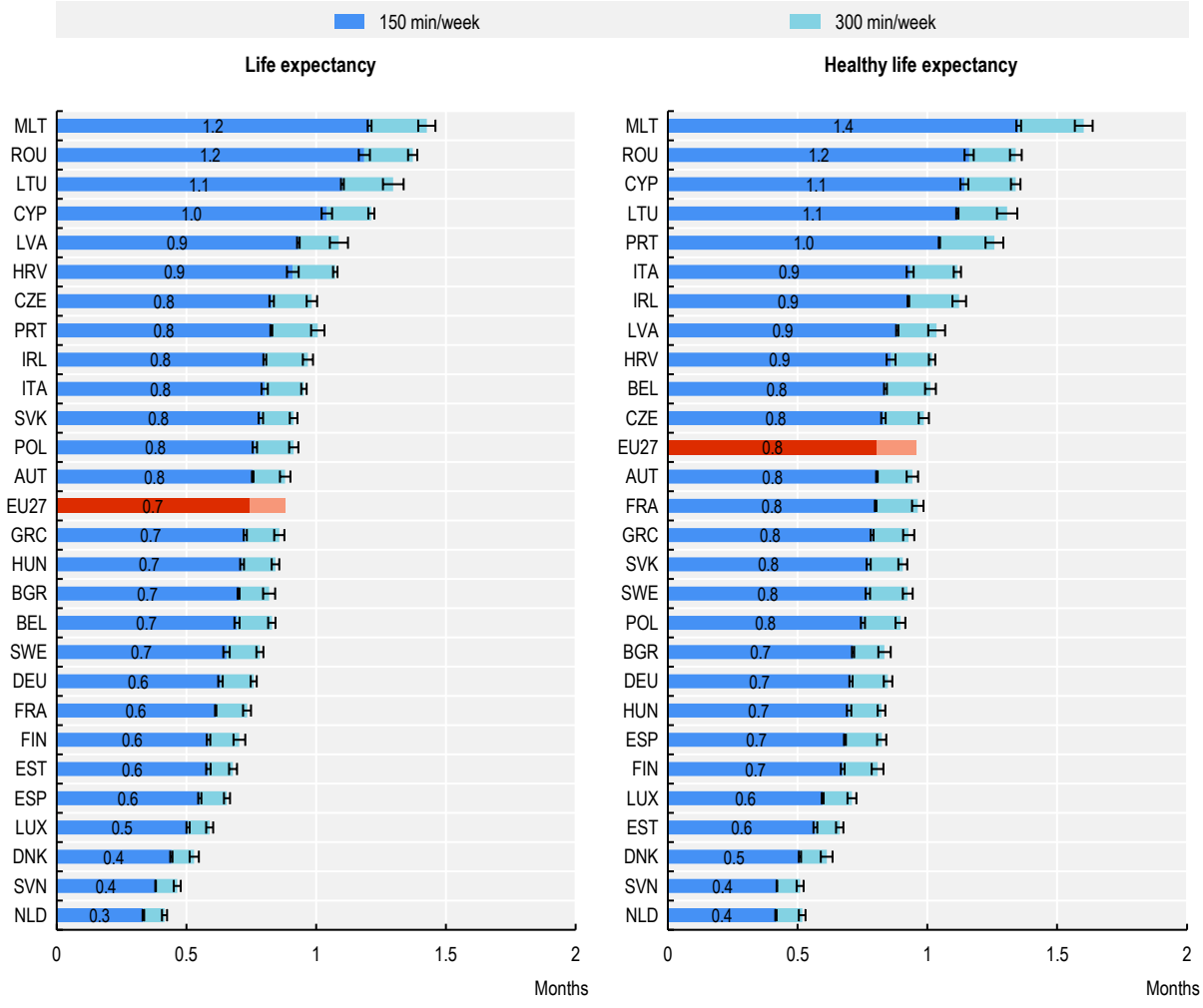


Source: OECD SPHeP-NCDs model, 2022.

Average life expectancy in the 27 countries decreases by 0.7 months due to the effects of insufficient physical activity, when not including the link between physical activity and BMI (Annex Figure 3.B.2). Again, the additional benefit of doing 300 minutes per week versus 150 minutes per week is small – adding only 0.1 months of life expectancy. The impact with the PA/BMI link is more than twice as large, at 1.9 months for the 150 minutes scenario. The ranking of the countries from low to high impact does not change much with the exclusion of the PA/BMI link.

Annex Figure 3.B.2. The impact of insufficient physical activity on population average life expectancy (no PA/BMI link)

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on the average life expectancy or healthy life expectancy of the total population (months), average over 2022-50, with 95% confidence intervals

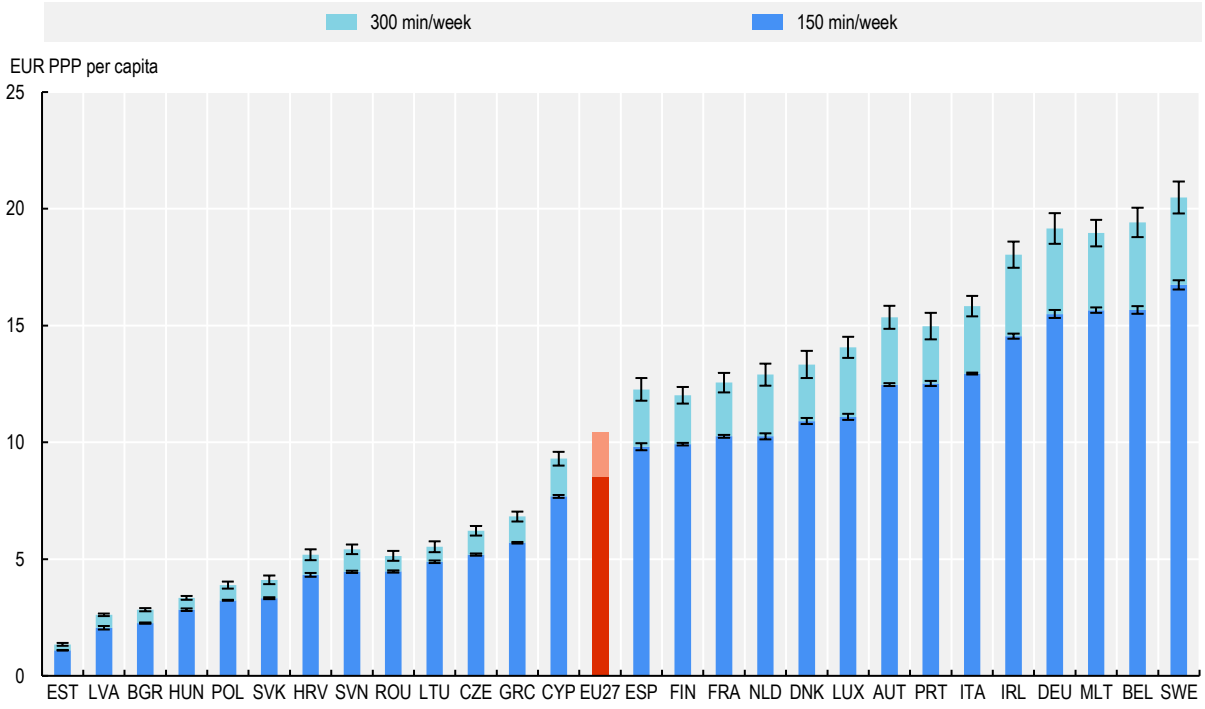


Note: The label indicates the impact for the 150 minutes per week scenario.
Source: OECD SPHeP-NCDs model, 2022.

When looking only at the direct effects of insufficient physical activity on health care expenditure, meeting the guidelines of 150 minutes per week would save on average EUR PPP 8.5 per capita per year across the 27 EU Member States (Annex Figure 3.B.3). This is about 40% lower than when the effect of physical activity on BMI is included, in which case the impact is EUR PPP 14.4 per capita per year. Again, there is not much change in the specific countries with relatively high and low impacts.

Annex Figure 3.B.3. Health care expenditure per capita due to insufficient physical activity (no PA/BMI link)

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on annual per capita health care expenditure in EUR PPP, average over 2022-50, with 95% confidence intervals

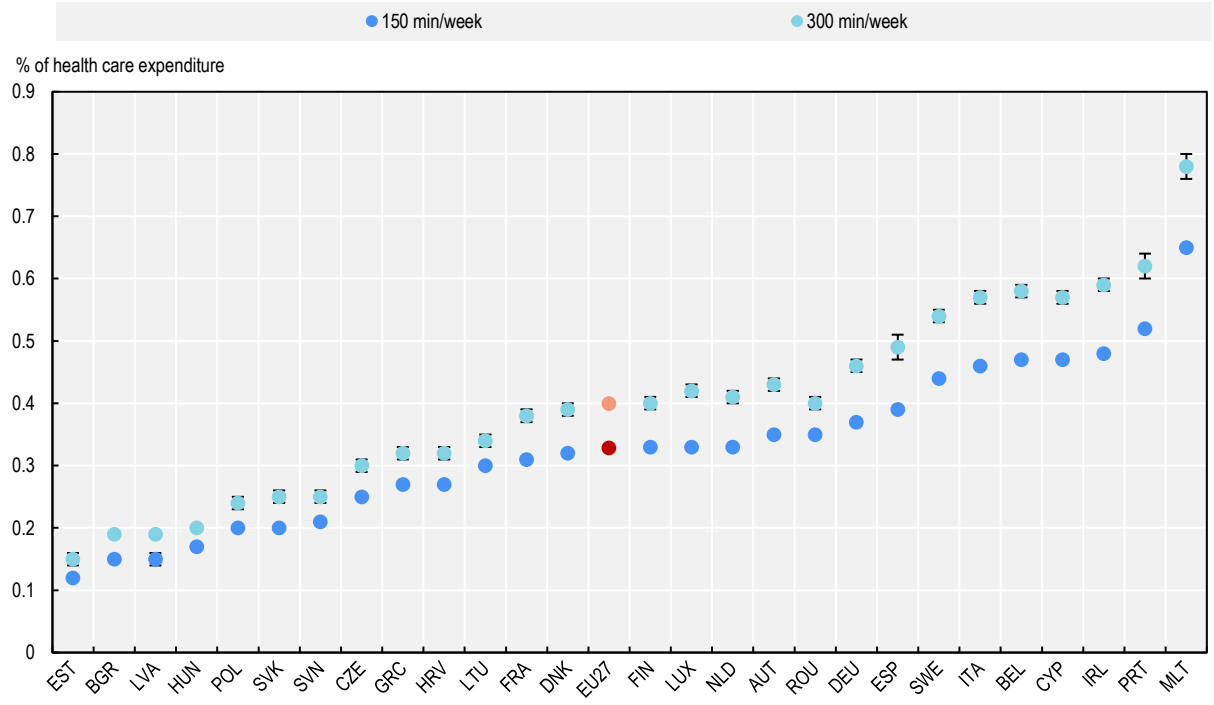


Source: OECD SPHeP-NCDs model, 2022.

EU Member States could save 0.3% of their health care expenditure if everyone did at least 150 minutes of physical activity per week – when looking only at the direct impact of physical activity (Annex Figure 3.B.4). This is again about 40% lower than when the effect of physical activity on BMI is taken into account.

Annex Figure 3.B.4. Health care expenditure attributable to insufficient physical activity (no PA/BMI link)

The impact of insufficient physical activity (defined as less than 150 minutes per week or 300 minutes per week) on annual health care expenditure as a percentage of total health care expenditure, average over 2022-50, with 95% confidence intervals



Source: OECD SPHeP-NCDs model, 2022.

Notes

[1] Going forward in this chapter, for readability, physical activity levels will be expressed only in minutes of moderate-intensity activity, without the vigorous intensity-equivalent. Note that 150 minutes of moderate-intensity exercise and 75 minutes of vigorous exercise (the lower bound recommendations) both translate into 600 MET-minutes; and 300 minutes of moderate exercise and 150 minutes of vigorous exercise (the higher bound recommendations) both translate into 1 200 MET-minutes.

[2] Purchasing power parities (PPPs) are the rates of currency conversion that try to equalise the purchasing power of different currencies, by eliminating the differences in price levels between countries.