



fourth most significant mortality factor in the world, with 3.2 million deaths a year worldwide [4, 5].

Another study suggests that there is a lower likelihood of health problems among people engaging in regular physical activity than among those leading a sedentary lifestyle. Furthermore, there is convincing evidence that regular physical activity increases life expectancy and reduces the likelihood of developing coronary and cardiovascular problems, of suffering a stroke or developing colon cancer [6].

Inactive and sedentary lifestyles directly affect metabolism, bone mineral composition, and magnify the health effects of cardiovascular disease [7]. Furthermore, there is epidemiological evidence to suggest that a sedentary lifestyle increases the risk of cancer, obesity, metabolic and psychosocial problems [8].

According to OECD data, the average life expectancy of Hungarians at birth in 2016 was 76 years, which is 4 years below the OECD average, actually, one of the lowest on the list. For men, this value is 72.6 years, for women 79.7 years, both showing an increasing trend [9].

In recent years, the Hungarian government has made a number of efforts to bring about significant changes in the inactive lifestyle of the Hungarian population. These include measures to increase the number of physical education lessons and to improve the conditions in PE lessons at school; also the development and construction of sports facilities, increased funding for sports associations, and even the use of corporate tax incentives for sporting purposes [10]. While improving the conditions alone does not result in a change in the attitudes of the population towards sport, it is certainly a prerequisite [11].

Procedures that quantify the burden on the Hungarian economy resulting from physical inactivity are one of the ways of measuring the effectiveness of state intervention [10, 12]. This study aims to contribute to this body of research and proposes to analyse a longer time spectrum.

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To analyze the economic burden of physical inactivity, we need to start with the burden of diseases on the national economy, as physical inactivity plays a vital role in the onset of several diseases and leads to various causes of death. At a national level, diseases have direct and indirect costs.

Direct costs of diseases include treatments, medications, sick-pay allowances and associated ancillary costs that are directly related to the illness. The direct costs in Hungary are mainly financed by the National Health Insurance Fund (NHIF) - since 2017 it is called the National Health Insurance Fund Administration (NHIFA) - but we must not disregard the cost of sick leave and private costs outside of NHIF/NHIFA financing, the latter of which are directly borne by members of society.

Among the indirect burdens we include items that constitute a loss to the economy or to society as a result of the loss of work caused by a disease. There was a significant change in this area during the research period. While in 2005 and 2009 there was a long-term loss of production only in jobs on the skills-shortage list or in very special cases, by 2014 the number of job vacancies in Hungary reached 34 thousand, while by July 2017 this number rose to 73 thousand people, which is 2.4% of the workforce [13]. Our calculations were based on the fol-

RR: relative risk describes the risk associated with a sedentary lifestyle.

When using the index, it is necessary to break down the population into physically active and inactive sections, and then, by determining the relative risk rate, we can estimate the number and cost of illnesses stemming from a physically inactive lifestyle [18].

The physical activity indicators of the Hungarian population showed fluctuations during the period under review. The situation was the worst in 2009, when we saw 77% of the

— 1 The cumulative relative risk rate and PAR values for the examined disease types in 2009–2017

Disease types	RR	PAR 2009	PAR 2014	PAR 2017
Heart and coronary diseases	1.9	40.9	35.8	37.6
Stroke	1.4	23.5	19.9	21.1
Hypertension	1.4	23.5	19.9	21.1
Colon cancer	1.4	23.5	19.9	21.1
Type 2 diabetes	1.4	23.5	19.9	21.1
Osteoporosis	1.6	31.6	27.1	28.7
Depression	1.2	13.3	11.0	11.8
Gastrointestinal complications	1.4	23.5	19.9	21.1
Obesity	1.1	7.1	5.8	6.3
High triglycerides	1.4	23.5	19.9	21.1
Deliberate self-harm	1.1	7.1	5.8	6.3

Source: Kócska et al., 2000; Árkai et al., 1998; Eötvös et al., 2003; Árkai et al., 2000; Csécsényi et al., 2018

domestic producer and consumer price index of the Hungarian Central Statistical Office (HCSO) [24].

At 2017 prices, the economic burden of illnesses amounted to more than 3753 billion forints (HUF) in 2005, of which the direct burden was 3173 billion forints. Direct costs accounted for 85% of the burden of illnesses and the 144 billion HUF sickness benefit represented just over 4.6% of total direct costs. Indirect burden represented a significantly lower percentage amounting to over 741 billion HUF. The economic burden imposed by sickness in 2005 was 11.2% of Hungary’s GDP.

By 2009, the economic burden of diseases fell to 3611 billion HUF at 2017 prices. Direct costs accounted for 85.8% of the total burden of illnesses that year, less than 4% of which, amounting to 122 billion HUF, was for sickness allowance expenditures. Indirect burdens decreased to 644 billion HUF. The burden of sickness amounted to 11.4% of the GDP in 2009.

By 2014, the economic burden of diseases fell to 2906 billion HUF at 2017 prices. Direct costs accounted for 86% of the total burden that year and 2.8% of it were sick allowances, amounting to 70 billion forints. Indirect burdens fell to 519 billion HUF. The burden of sickness decreased to 8.7% of the GDP in 2014.

By 2017, the economic burden of illnesses increased compared to 2014, but it was still below the initial 2005 figure (HUF 3220 billion) and it decreased in comparison with the GDP. The share of direct costs dropped significantly to 78%, within which the sickness benefit represented 3.8% - to the value of 95 billion forints. At the same time, indirect burdens increased significantly to 910 billion HUF. All in all, the burden of sickness decreased to 8.4% of the GDP in 2017.

Between 2005 and 2017, the economic burden of diseases fell by 533 billion HUF, which is a total decrease of 14.2%, corresponding to an average annual decrease of 1.2% and, in the meantime, the country’s GDP increased significantly (altogether 70% at current prices). Obviously, the decrease is due to a number of reasons, but the effect of the increase in physical activity is an important factor among them. (Table 2).

In the 3 years examined, in the case of disease groups linked to physical inactivity the burden of illnesses on the state budget - excluding sickness allowance - amounted to 230,6 billion HUF and 286,8 billion HUF, respectively, of which the lowest value was in 2014. (However, only a part of these can be directly linked to physical inactivity, as many other risk factors play a role in the development of these diseases.) As regards the relative weight of each disease group, cardiovascular disease is the biggest burden, followed by hypertension. At the same time, type 2 diabetes was only ranked the fifth for costs in the first year, but by 2017 it became the third largest item, only slightly behind high blood pressure. Expenditure on stroke, obesity and deliberate self-harm were almost negligible compared to other disease groups. (Table 3).

Based on the results, it can be stated that in 2014 the expenditures in the state budget for the 11 disease groups examined drastically decreased by approximately 39 billion HUF, compared to the initial starting position of 269.8 billion HUF, but by 2017 the expenditures had surpassed the base total from 2009 by more than 16.9 billion HUF. Compared to 2009, only type two diabetes and osteoporosis showed an increase (31 and 82%, respectively, compared to 2009, although the latter is due to the relatively low total expenditure). For all other disease groups, the level of expenditure declined in absolute terms, resulting in a significant decrease of 39.2 billion HUF in total expenditure.

However, in the case of 2017, the picture is more varied if we examine the relative position of certain disease groups compared to 2009. Type 2 diabetes showed the most significant increase to the tune of more than 34 billion HUF. The other diseases lag behind in terms of expenditure; cardiovascular diseases and colon cancer are next with an increase of 6–6 billion forints. In addition, there is an increase in the costs associated with osteoporosis. Stagnation or decrease was observed for the other disease groups, but this could not compensate for the increase in the costs of the aforementioned diseases. The most significant drop in expenditure is observed in hypertension (15.3 billion HUF) and high triglyceride diseases (10.3 billion HUF). (Table 4).

Focusing on the direct burden of physical inactivity, we can conclude that 24–28% of the total expenditure of the 11 disease groups is directly attributable to physical

inactivity. The major part is the cost of cardiovascular diseases and hypertension, and these were closely followed by Type 2 diabetes by 2017. Due to the fact that the total expenditure for stroke, obesity and deliberate self-harm was also insignificant compared to other disease groups, their expenditure related to physical inactivity is insignificant. In the case of deliberate self-

At the level of the individual disease groups, the amounts vary, the most significant decline in absolute terms is in the high blood pressure and high triglyceride-related illness groups. However, the burden of type 2 diabetes increased significantly and there was an increase in colon cancer and osteoporosis disease groups. The direction and extent of the changes are mostly comparable to the total expenditure amounts at the overall level of the disease groups, although the changes in the physical inactivity rate naturally lead to differences in the specific values. This is so much so that the total expenditure amounts increased

study of economic development over the past century has concluded that the advancement of the population's health status is responsible for about 30–40% of economic growth [28–30].

In our comparative study, we used four sampling points between 2005 and 2017, to demonstrate the burden of diseases at the level of the national economy for the various load-carriers. In the period under review, the economic burden decreased significantly overall; from 11.2% of the GDP to 8.4%. The weight of indirect burden increased, however, as in the currently demand-dominated labor-market it is more difficult to replace lost workforce. In the period of analysis the number of employees in Hungary increased with 20% which increased the amount of sick leave and number of sickness days but their GDP contribution was significantly higher. Although associated costs and burdens increased in nominal terms, they decreased in relation to the GDP.

A large part of diseases' burdens are borne by the state and society (64%), followed by households (20%) and employers (16%). The proportions are similar to Ding et al. in European countries (included Hungary) [31], although we estimate that the burdens on employers are higher and the burdens on households are lower in Hungary.

Since 2009, the physical activity rate of the Hungarian population has been fluctuating, but overall there is an improving tendency, which is also apparent in the savings potential of the examined expenditures categories compared to the GDP. The amount of spending depends heavily, apart from the physical inactivity rate, on the number of employees as well, as those people who are not employed

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attributed to the combined effect of two factors: changes in total expenditure on specific disease groups (which showed an increase in the period under review) and changes in the physical activity levels of the Hungarian population (which showed an improvement over the period under review). Initiatives in Hungary aimed at encouraging an active lifestyle from childhood onwards should be continued since – beyond the initial impact that has already been felt to some extent in recent years - these initiatives will come to their full fruition in the coming decades.

#### Abbreviations

CT: Computed Tomography; GDP: Gross Domestic Product; HCSO: Hungarian Central Statistical Office; HUF: Hungarian Forint; MRI: Magnetic Resonance Imaging; NHIF: National Health Insurance Fund; NHIFA: National Health Insurance Fund Administration; OECD: Organisation for Economic Co-operation and Development; PAR: Population Attributable Risk; RR: Relative Risk; VD: Veneral Disease; WHO: World Health Organization

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#### About this supplement

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#### Authors' contributions

PA was the leader of the complete research, coordinated the different co-authors' work, systematized the dataset, summarised the literature related to the Relative Risk ratios of illnesses, calculated the PAR indices and contributed to the conclusions. DP has made calculations of PAR indices, the direct costs of



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