

DECADE OF THE ECONOMIC BURDEN OF SCLEROSIS MULTIPLEX IN SLOVAKIA: A PERSPECTIVE ON DIRECT COSTS ASSOCIATED WITH THE PATIENTS' ACCOUNTS

Ekonomická záťaž sklerózy multiplex na Slovensku: perspektíva priamych nákladov spojených s vykazovaním cez účty pacientov

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Abstract

Introduction. Multiple sclerosis (MS) is a chronic, progressive, and debilitating neurological condition that imposes a significant economic burden on individuals, healthcare systems, and society. In Slovakia, the economic impact of MS has raised concerns due to increasing incidence rates and the substantial healthcare costs associated with its management. This study aims to examine the direct healthcare costs associated with MS in Slovakia from the third-party payer and societal perspectives over a ten-year period.

Methods. A retrospective, prevalence-based cost-of-illness analysis was conducted using patient account data from the National Health Information Center (NCZI). The analysis covered the period from 2013 to 2022 and included data on outpatient and inpatient care, pharmacotherapy, diagnostic procedures, transportation, and dietary foods covered by insurance. Costs were calculated for each year and expressed as total and average annual cost per patient. Out-of-pocket expenses, non-medical costs, and premature mortality costs were excluded from the analysis.

Results. The study revealed a steady increase in MS incidence in Slovakia, rising from 1,644 cases in 2013 to 2,161 cases in 2022, with a compound annual growth rate (CAGR) of 3.15%. However, the prevalence of MS fluctuated during this period, decreasing from 20,268 cases in 2013 to 16,197 in 2022. Direct healthcare expenditures over the decade totaled €318.09 million, with drugs and therapy accounting for 89.49% of the total costs. Inpatient care showed variability, while outpatient care experienced steady growth, contributing 5.71% to the overall healthcare expenditure.

Conclusion. This study highlights the significant financial burden associated with the treatment and management of MS in Slovakia, with a substantial portion of the costs driven by pharmacotherapy. The rising incidence, particularly among women, and the fluctuating prevalence emphasize the need for continued investment in cost-effective management strategies to reduce the economic burden on the healthcare system (Tab. 5, Ref. 12). Text in PDF www.lekarskyobzor.sk.

Abstrakt

Úvod do problematiky. Sclerosis multiplex (SM) je chronické, progresívne a oslabujúce neurologické ochorenie, ktoré predstavuje výraznú ekonomickú záťaž pre jednotlivcov, zdravotnícke systémy a spoločnosť. Na Slovensku ekonomický dopad SM vzbudzuje obavy z dôvodu rastúcej incidencie a značných nákladov spojených s jej liečbou. Táto štúdia si kladie za cieľ analyzovať priame náklady na zdravotnú starostlivosť spojené so SM na Slovensku z pohľadu platieb zdravotných poisťovní a spoločnosti v priebehu desaťročia.

Metodika. Retrospektívna, prevalenčne založená analýza nákladov na ochorenie bola vykonaná pomocou údajov o účtoch pacientov z Národného centra zdravotníckych informácií (NCZI). Analýza pokrývala obdobie od roku 2013 do roku 2022 a zahŕňala údaje o ambulantej a hospitalizačnej starostlivosti, farmakoterapii, diagnostických postupoch, doprave a diietických potravinách hrazených poisťovňami. Náklady boli vypočítané pre každý rok a vyjadrené ako celkové a priemerné ročné náklady na pacienta. Do analýzy neboli zahrnuté náklady z vrecka pacientov, nemedicínske náklady a náklady na predčasnú úmrtnosť.

Výsledky. Štúdia odhalila neustály nárast incidencie SM na Slovensku, ktorá vzrástla z 1 644 prípadov v roku 2013 na 2 161 prípadov v roku 2022, s priemerným ročným rastom (CAGR) 3,15 %. Prevalencia SM však počas tohto obdobia kolísala, pričom poklesla z 20 268 prípadov v roku 2013 na 16 197 v roku 2022. Priame náklady na zdravotnú starostlivosť za desaťročie dosiahli 318,09 milióna EUR, pričom farmakoterapia predstavovala 89,49% celkových nákladov. Hospitalizačná starostlivosť vykazovala variabilitu, zatiaľ čo ambulanta starostlivosť zaznamenala stabilný rast, ktorý prispel 5,71% k celkovým nákladom na zdravotnú starostlivosť.

Záver. Táto štúdia zdôrazňuje významnú finančnú záťaž spojenú s liečbou a manažmentom SM na Slovensku, pričom podstatnú časť nákladov poháňa farmakoterapia. Rastúca incidencia, najmä u žien, a kolísajúca prevalencia zdôrazňujú potrebu pokračujúceho investovania do nákladovo efektívnych

KEYWORDS: Multiple sclerosis, Economic burden, Direct healthcare costs, Incidence and prevalence, Slovakia, Pharmacotherapy.

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stratégií riadenia na zníženie ekonomickej záťaže na zdravotnícky systém (tab. 5, lit. 12). Text v PDF www.lekarskyobzor.sk. **KLÚČOVÉ SLOVÁ:** skleróza multiplex, ekonomická záťaž, priame náklady na zdravotnú starostlivosť, incidencia a prevalencia, Slovensko, farmakoterapia.

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Introduction

Multiple sclerosis is a chronic, progressive, and debilitating neurological condition that imposes a significant economic burden on individuals, healthcare systems, and society. In Slovakia, as in many other countries, the economic impact of multiple sclerosis has been a growing concern, particularly in the context of the patients' perspectives on the associated costs (1). Incidence of the disease has remained high in the country over the past decade, necessitating a comprehensive evaluation of the economic burden to inform healthcare policies and resource allocation (1, 2, 3, 4). The prevalence of musculoskeletal conditions, which often co-occur with multiple sclerosis, further compounds the economic impact and highlights the need for a multifaceted approach to address the burden of neurological diseases in Slovakia (2).

The prevalence and incidence of MS vary across the geographical region, but the disease imposes a substantial economic burden in all affected countries (1). Since MS is typically diagnosed between 20 and 50 years of age, it affects education, career, and family life, limiting the ability to engage in paid work and contributing to significant indirect costs (2, 4). The direct costs of medical care, such as hospitalization, rehabilitation, and medication, can also be substantial, especially when considering the chronic and progressive nature of the disease (1, 2, 4).

Multiple sclerosis is a leading cause of disability among working-age adults, and its prevalence is expected to increase with the aging of the population (4). The substantial clinical and societal burden of musculoskeletal conditions, such as multiple sclerosis, has been well-documented, highlighting the importance of research funding and the need to address the increasing burden of these conditions.

The economic burden of multiple sclerosis is multifaceted, encompassing direct healthcare costs, indirect costs associated with lost productivity, and intangible costs related to the impact on the patient's quality of life. Direct costs may include expenses for medical care, hospitalization, and medication, while indirect costs may arise from reduced employment, absenteeism, and the need for caregiving.

This research paper aims to examine the economic burden of multiple sclerosis in Slovakia over the past decade, focusing on the costs experienced by patients and their accounts.

Methodology

Analysis Framework and Data Sources

This retrospective, prevalence-based cost-of-illness analysis for multiple sclerosis (MS) in Slovakia was conducted from both the third-party payer and societal perspectives. From the third-party payer perspective, the analysis accounted for all direct medical costs covered by health insurance companies. Patient co-payments and out-of-pocket expenses were excluded from the analysis. The study covered a 10-year period, from 2013 to 2022 (including), with costs expressed as total and average annual cost per patient for each respective year. All costs were presented in euros, without applying discounting.

The costs associated with healthcare were derived from the National Health Information Center (NCZI) based on data from the patient's account (5). This account aggregates information from regular reports submitted by each patient's health insurance company. Only healthcare expenses reported by the insurance companies with a value greater than 0 EUR were included in the overall cost analysis. This means that items such as drugs or services with a 0 EUR tag, drugs purchased through public procurement, or any other resources with no net cost were excluded from the analysis.

MS was defined according to the WHO ICD-10 classification (code G35), with patients categorized by disease severity. Data on the prevalence of MS in Slovakia for the years 2013 to 2022 were obtained from the NCZI. Mortality data were obtained from Slovak Statistics Office (6).

The data sets included on top of the outpatient care, hospitalizations and medical therapy costs, the costs of outpatient diagnostic, medical procedures, transportation, dietary foods covered by insurance.

Costs

The analysis considered direct medical costs associated with MS patients. Direct medical costs included inpatient care (hospital stays longer than 48 hours where MS, ICD-10 code G35.XX, was the primary diagnosis, as well as procedures reimbursed on top of hospitalization fees and reimbursed spa stays), pharmacotherapy, and diagnostic and medical procedures. The cost of treatment included all drugs reimbursed for MS patients, either independently or in combination with hospitalization. Outpatient diagnostic and medical procedures analyzed in the study included MRI scans, cerebrospinal fluid tests, visual evoked potentials, PET

scans, blood and cerebrospinal fluid tests, differential diagnostic tests, and rehabilitation. Due to a lack of available data, the analysis did not cover non-medical direct costs such as formal or informal care in residential settings. Additionally, premature mortality costs were excluded, as MS's impact on mortality was deemed relatively small and difficult to assess.

Data Analysis

The retrospective analysis was conducted using aggregated electronic health insurance data on the level of patients' accounts. Data from all Slovak health insurance companies, which collectively cover the entire population and are reported to NCZI were included in the study. Patients received either outpatient or inpatient care, or both. Out-of-pocket costs related to drug co-payments and caregiving responsibilities were excluded, as no available database captured these expenses. Furthermore, no published research exists that tracks out-of-pocket expenses for MS patients in Slovakia. The data owners relied on the accuracy of diagnosis and cost information provided by healthcare providers through monthly claims. Visits to specialists were included as part of reimbursed care.

Results

The Table 1 presents an analysis of multiple sclerosis (MS) incidence and prevalence trends in Slovakia over the period 2013 to 2022, segmented by gender and standardized per 100,000 inhabitants. The data reveals fluctuations in both incidence and prevalence of MS, alongside notable trends in mortality related to the disease.

From 2013 to 2022, the incidence of MS (G35) shows a general upward trend, starting at 1,644 cases in 2013 and peaking at 2,161 cases in 2022. The lowest incidence was recorded in 2016, with 1,556 cases. This indicates an increasing number of newly diagnosed MS patients over time. Gender-specific data highlights that, throughout the entire period, women consistently had higher incidence rates than men. For instance, in 2015, the incidence for women was 1,307 cases compared to 548 for men. This trend is also reflected in the incidence per 100,000 population, where the incidence among

women peaked at 51.3 in 2022, compared to 27.7 for men in the same year.

The prevalence of MS follows a similar pattern of variability. The highest prevalence was observed in 2013 with 20,268 cases, while the lowest point was in 2017, with 11,347 cases. Interestingly, after a decline between 2013 and 2017, the prevalence rebounded, reaching 20,777 cases in 2021 before a slight decrease in 2022 to 16,197 cases. This fluctuation suggests that while new cases are rising, factors such as patient survival rates, recovery, or other external factors are influencing the total number of active MS cases over time.

The incidence of MS in Slovakia demonstrates a steady upward trend from 1,644 cases in 2013 to 2,161 cases in 2022, with a Compound Annual Growth Rate (CAGR) of 3.15% over the 9-year period. This increase highlights the rising number of newly diagnosed cases each year. In contrast, the prevalence of MS exhibits more variability, with a decrease from 20,268 cases in 2013 to 16,197 cases in 2022, corresponding to a negative CAGR of -2.32%. This decline in prevalence, despite the rising incidence, suggests a reduction in the total number of active MS cases, potentially influenced by improvements in treatment and management.

Part of our analysis is the death-to-incidence ratio (i.e., percentage of MS patients who died out of newly diagnosed cases each year). This ratio shows considerable fluctuation, ranging from a low of 1.25% in 2022 to a high of 2.96% in 2016. The lower percentage in recent years suggests a potential improvement in MS management and patient survival, possibly reflecting advancements in MS treatment and care in Slovakia. In the broader international context, these figures align with global trends indicating improvements in MS survival rates due to better diagnostic tools and therapeutic options, such as disease-modifying therapies (DMTs). Globally, the mortality rate for MS is typically reported as 2-3%, with notable variations across countries depending on access to healthcare and treatment options, which makes Slovakia's declining mortality figures comparable to other countries with developed healthcare systems (7). Table 1 also reveals a rising trend in the incidence of MS in Slovakia, especially among women, and a fluctuating prevalence of the disease. The data

Table 1. Trends in Incidence, Prevalence, and Mortality Rates of Multiple Sclerosis (G35) in Slovakia (2013–2022) (5,6).

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Incidence G35 (total)	1644	1608	1855	1556	1639	1632	1748	1821	2018	2161
Incidence G35 Men (total)	517	498	548	492	511	492	534	579	661	737
Incidence G35 Women (total)	1127	1110	1307	1064	1128	1140	1214	1242	1357	1424
Deaths G35/Incidence G35 (%)	2.07	1.68	2.48	2.96	2.68	2.08	2.17	2.75	1.68	1.25
Incidence G35 per 100,000 Population	30.4	29.7	34.3	28.7	30.2	30.0	32.1	33.4	37.0	39.7
Incidence G35 per 100,000 Population - Men	19.6	18.9	20.7	18.6	19.3	18.5	20.1	21.7	24.8	27.7
Incidence G35 per 100,000 Population - Women	40.6	40.0	47.0	38.3	40.5	40.9	43.5	44.5	48.6	51.3
Prevalence G35 (total)	20268	19673	18286	15158	113470	16888	17752	19360	20777	16197
Prevalence G35 per 100,000 Population	375.0	363.2	337.3	279.3	208.8	310.3	325.7	354.7	380.5	298.0

also suggests improvements in patient outcomes, as indicated by the decreasing death-to-incidence ratio over the analyzed period, in line with global advancements in MS care.

Our analysis additionally provides a comparison of multiple sclerosis (MS) prevalence in Slovakia reported by WHO to prevalence rates in WHO European countries, along with an estimation of prevalence growth (Tab. 2). The data covers the period from 2013 to 2022, revealing steady increases in prevalence both in Slovakia and across European countries.

For the WHO European countries, the MS prevalence per 100,000 population rises consistently, starting at 108.3 in 2013 and reaching 154.6 in 2022. This indicates a steady growth in MS prevalence across Europe. The growth rate of prevalence, set at an annual rate of 4.046%, is applied to provide an estimated increasing trend in MS cases per 100,000 population over the years, from a baseline of 100.0 in 2013 to 142.9 in 2022.

The estimated prevalence in Slovakia by WHO also follows a consistent upward trend, growing from 5,857 cases in 2013 to 8,392 cases in 2022. This growth suggests that, in line with European trends, MS prevalence in Slovakia has been increasing steadily over the past decade, with the highest jump occurring between 2020 and 2021, when the number of cases rose from 7,794 to 8,096.

Globally, the prevalence of MS varies significantly by region. According to the Atlas of MS (2020) by the Multiple Sclerosis International Federation (MSIF), the global average prevalence is around 35.9 per 100,000 population, with Europe reporting the highest prevalence rates, averaging 108 per 100,000 (8). In this context, Slovakia, with a prevalence rate of 298 per 100,000 in 2022 (from previous table), is significantly above the global average and aligns more closely with high-prevalence countries in Europe. This positions Slovakia as one of the countries with a high burden of MS, reflecting similar trends seen in other European nations. The increasing prevalence in Slovakia, comparable to Western European countries, may be linked to better diagnostic capabilities, improved patient survival, and broader access to MS treatments.

The data reflects an overall pattern of rising MS prevalence both in Slovakia and across Europe, highlighting the increasing burden of the disease on healthcare systems. This could be attributed to better diagnostic capabilities, improved survival rates due to advanced treatments, or other environmental and genetic factors.

Detailed breakdown of healthcare expenditures related to multiple sclerosis (MS) in Slovakia over a ten-

-year period, from 2013 to 2022 are in the Table 3. The categories analyzed include outpatient and inpatient healthcare, drugs and therapy, medical aids, transportation, and dietetic foods. A thorough examination of trends, peaks, and growth rates across each category reveals significant insights into the financial burden of MS on the healthcare system. Additionally, each category's contribution to the total expenditure is analyzed as a percentage.

Outpatient Healthcare expenditures have shown a steady increase over the period. Starting at €1.52 million in 2013, the amount reached its peak in 2022 at €2.13 million. The lowest expenditure occurred in 2013, and there was a consistent upward trend, with notable increases in 2015 and 2021. The Compound Annual Growth Rate (CAGR) for outpatient healthcare expenditures is calculated as 3.6%. Over the ten-year period, outpatient care expenses accumulated to €18.15 million, representing 5.71% of the total healthcare expenditure for MS.

Inpatient Healthcare shows variability in expenditures, with fluctuations occurring throughout the ten-year period. Beginning at €993,083 in 2013, the expenditure peaked in 2022 at €1.52 million, reflecting the highest annual expenditure in the decade. The lowest point was in 2015, with €1.07 million spent on inpatient care. The trend suggests increased demand for inpatient services from 2016 onwards, particularly in 2017 and 2022. The CAGR for inpatient healthcare stands at 4.6%, with a total expenditure of €12.74 million, accounting for 4.00% of the total sum.

Drugs and Therapy represent the largest portion of the total expenditures, with significant increases each year. In 2013, €18.93 million was spent, rising steadily to reach €31.41 million in 2022. The expenditure on drugs and therapy consistently grew, with the highest increase between 2016 and 2017, marking an annual peak of €33.58 million in 2021. The CAGR for this category is calculated at 5.2%, reflecting the steady rise in treatment costs. Drugs and therapy constitute 89.49% of the total expenditure, amounting to €284.69 million over the ten years.

Medical Aids expenditures experienced some fluctuation over the period. Starting at €171,013 in 2013, the lowest spending was recorded in 2022 at €96,954, while the peak occurred in 2015 with €185,503 spent. After a rise in the first half of the decade, there was a downward trend from 2016 onwards, suggesting reduced spending on medical aids. The CAGR for this category shows a negative growth of -5.7%, and medical aids account for 0.49% of total MS expenditures, with a sum of €1.57 million.

Table 2. Comparison of Multiple Sclerosis (MS) Prevalence in Slovakia and WHO European Countries (2013–2022) (5, 9).

Prevalence	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Prevalence per 100,000 WHO European countries	108.3	112.6	117.2	121.9	126.8	131.9	137.3	142.8	148.6	154.6
Prevalence in Slovakia estimated by WHO (total number of cases)	5,857	6,099	6,352	6,615	6,893	7,182	7,482	7,794	8,096	8,392

Transportation costs, which include travel expenses related to healthcare access, show a steady increase. In 2013, €60,922 was spent, rising gradually to a peak of €74,388 in 2022. The trend shows relatively stable growth, with notable increases in 2017 and 2019. The CAGR for transportation is 2.0%, and the total expenditure over the period was €654,703, representing 0.21% of the total.

Dietetic Foods expenditures remained relatively small compared to other categories, with a general upward trend followed by a slight decline. The expenditure started at €28,683 in 2013, peaked in 2016 with €31,048, and ended at €24,493 in 2022. This category showed moderate growth until 2017, followed by stabilization and a slight decline towards the end of the period. The CAGR for dietetic foods was calculated as -1.6%, with total expenditures of €290,565, contributing 0.09% to the overall costs.

In total, healthcare expenditures for MS in Slovakia between 2013 and 2022 amounted to €318.09 million. Of this, drugs and therapy contributed the vast majority, accounting for 89.49% of the total costs. Outpatient care was the second-largest contributor with 5.71%, followed by inpatient care at 4.00%. The remaining categories—medical aids, transportation, and dietetic foods—together accounted for just 0.79% of the total expenditure. This distribution highlights the significant financial burden associated with MS treatment, particularly the cost of drugs and therapies, which is the dominant factor in the overall healthcare expenditures.

The main driver of the total healthcare costs related to multiple sclerosis (MS) in Slovakia from 2013 to 2022 was drugs and therapy. This category accounted for €284.69 million, representing a significant 89.49% of the total expenditures over the ten-year period. The consistent rise in costs associated with MS treatments, especially between 2016 and 2021, reflects the growing demand for therapeutic interventions, likely driven by advances in disease-modifying therapies (DMTs) and their wider availability to patients.

Table 4 presents the healthcare costs related to multiple sclerosis (MS) in Slovakia, disaggregated by gender over the period 2013 to 2022. The data reveals a clear trend of increasing costs for both men and women, with the costs for women consistently higher than for men across all years.

For men, the costs started at €6.62 million in 2013 and peaked in 2019 at €11.33 million, before experiencing a slight decline to €11.13 million by 2022. The overall trend shows a steady increase, with an annual Compound Annual Growth Rate (CAGR) of 5.3%, reflecting the rising healthcare needs and expenditures for male MS patients.

For women, costs were significantly higher, starting at €15.09 million in 2013 and reaching their peak of €25.51 million in 2021. The costs slightly decreased to €24.12 million in 2022. The growth for women is also substantial, with a CAGR of 5.7%. The higher costs for women can be attributed to the higher prevalence of MS among women, as indicated by previous tables, which aligns with global trends showing a higher incidence of MS in females compared to males.

The healthcare costs for women are consistently about twice that for men throughout the decade. This disparity underscores the greater burden of MS among women in terms of healthcare resource utilization and associated costs. The results emphasize the need for targeted healthcare policies and resource allocation strategies that account for the gendered differences in MS prevalence and cost burdens.

In Table 5 we look at the percentage-based distribution of healthcare costs for multiple sclerosis (MS) patients in Slovakia, categorized by age groups over the period 2013 to 2022. The growth column indicates the relative increase or decrease in the percentage of costs for each age group between 2013 and 2022.

The younger age groups (15 ≤ age < 20) and (20 ≤ age < 25) show a consistent decrease in their share of total costs, with declines of 33% and 41%, respectively, by 2022 compared to 2013. Similarly, the 25 ≤ age

Table 3. Breakdown of Healthcare Expenditures for Multiple Sclerosis (MS) in Slovakia by Category (2013–2022) (in Euro) (5).

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Outpatient healthcare	1522413	1614988	1708672	1794093	1736243	1853438	1909458	1866160	2005692	2136584	18147741
Inpatient healthcare	993083	1080225	1066955	1236691	1390059	1467608	1453574	1327433	1208487	1515411	12739526
Drugs and therapy	18933734	21649465	24601909	27927356	29529071	31229138	32824896	33014150	33577184	31407368	284694271
Medical aids	171013	166001	185503	152574	182134	183179	152493	165519	115501	96954	1566871
Transportation	60922	62011	61500	58741	65392	71115	72791	63448	64396	74388	654703
Dietetic foods	28683	28579	27431	31048	31435	31231	30860	29598	27207	24493	290565
Total	21709848	24601268	27651970	31200502	32934334	34835709	36444073	36462307	36998467	35255198	318093677

Table 4. Healthcare Costs for Multiple Sclerosis (MS) in Slovakia by Gender (2013–2022) (in Euro) (5).

Costs by Gender	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Men	6619500	7601436	8546691	9735456	10189136	10777749	11326933	11148011	11487488	11135707
Women	15090347	16999831	19105278	21465045	22745198	24057959	25117139	25314295	25510977	24119489

< 30 group saw a significant decline in cost share by 48% over the same period. This indicates that fewer healthcare resources are being allocated to younger patients, likely due to a lower incidence of MS in these age brackets.

For middle-aged groups, such as $30 \leq \text{age} < 35$ and $35 \leq \text{age} < 40$, the cost shares have also decreased by 17% and 26%, respectively. However, these age brackets still constitute a substantial portion of the total MS healthcare costs, reflecting the higher incidence of MS among individuals in this age range.

In contrast, the older age groups $45 \leq \text{age} < 50$, $50 \leq \text{age} < 55$, $55 \leq \text{age} < 60$, $60 \leq \text{age} < 65$, and $65 \leq \text{age} < 70$ exhibit an increasing share of costs over time. The most significant increases are observed in the age groups $60 \leq \text{age} < 65$ (with a growth of 118%) and $65 \leq \text{age} < 70$ (with a growth of 200%). This suggests that as the MS population ages, more resources are needed to manage the disease in older patients, possibly due to the increased complexity and severity of symptoms with age.

The distribution of healthcare costs for MS is shifting towards older age groups, while younger and middle-aged patients are consuming a smaller share of healthcare resources over time.

Discussion

The findings of our research provide significant insights into the economic burden of multiple sclerosis (MS) in Slovakia, with important implications for healthcare resource allocation and policy planning. Our analysis suggests a rising incidence of MS, consistent with global trends, but a fluctuating prevalence, which may indicate advancements in the treatment and management of the disease. However, the substantial economic costs, particularly related to drugs and therapies, underscore the need for continued focus on cost-efficient management of MS.

Supporting Evidence

One of the key findings of our study is the increasing incidence of MS, which aligns with data from the

broader European region. The World Health Organization (WHO) has documented similar upward trends in MS incidence across Europe, where better diagnostic tools and more comprehensive reporting systems have contributed to the rise in recorded cases (9). In Slovakia, the increase in incidence may also reflect an enhanced ability to diagnose MS earlier, combined with heightened public awareness of neurological disorders. Supporting this, a study by Browne et al. (2014) highlighted the role of improved diagnostic techniques in explaining the rising incidence rates globally (10).

With respect to the substantial costs associated with MS, our analysis corroborates findings from other Central European countries. A study of the economic burden of MS in the Czech Republic found that indirect costs, such as productivity losses and disability, accounted for the majority of total costs, similar to our observations in the Slovak context. Furthermore, the disproportionately higher costs for women versus men align with research from Poland, where the authors noted the significant economic impact of MS, particularly the substantial contribution of indirect costs (11).

Moreover, the consistently higher prevalence of MS among women in Slovakia is reflective of global patterns. Studies across Europe have reported higher incidence and prevalence rates of MS among women, which some researchers attribute to a combination of genetic, hormonal, and environmental factors (9). Compston and Coles (2008) noted that MS predominantly affects women, with the female-to-male ratio increasing in most regions (12). This gender disparity in disease prevalence underscores the importance of gender-sensitive healthcare policies that address the specific needs of female MS patients.

Our research also indicates that healthcare expenditures on MS in Slovakia have been predominantly driven by the cost of drugs and therapies, which accounted for almost 90% of the total expenditure over the ten-year period. This mirrors findings in other European countries, where disease-modifying therapies (DMTs) have been identified as the primary cost drivers in MS treatment(13). Kobelt et al. (2017) found that

Table 5. Age Distribution of Multiple Sclerosis (MS) Healthcare Costs in Slovakia (2013–2022) (5).

Age Distribution of Costs (%)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Growth 2022 vs 2013 (%)
15 ≤ age < 20	0.9	0.9	0.8	0.9	1.0	1.0	0.8	0.7	0.8	0.6	-33
20 ≤ age < 25	5.2	5.3	4.8	3.8	3.4	3.3	3.4	3.6	3.3	3.1	-41
25 ≤ age < 30	11.7	10.4	11.2	11.5	10.5	8.7	8.0	7.3	6.4	6.0	-48
30 ≤ age < 35	14.8	13.6	12.8	12.8	13.9	14.5	12.3	12.0	12.5	12.2	-17
35 ≤ age < 40	17.9	19.1	18.2	17.3	16.9	16.0	14.3	13.3	13.2	13.3	-26
40 ≤ age < 45	15.7	15.7	15.6	16.4	16.2	16.5	18.1	16.9	17.0	17.2	10
45 ≤ age < 50	13.2	12.8	13.0	12.1	12.7	13.4	14.4	15.2	15.8	15.4	17
50 ≤ age < 55	9.9	11.0	11.0	11.6	11.1	11.0	11.4	11.8	11.1	11.2	13
55 ≤ age < 60	6.2	6.1	7.0	7.7	7.9	8.3	9.3	9.9	10.1	9.9	59
60 ≤ age < 65	2.9	3.3	3.8	4.0	4.2	4.2	4.9	5.8	5.8	6.4	118
65 ≤ age < 70	1.1	1.0	1.1	1.4	1.4	2.2	2.2	2.4	3.0	3.3	200

DMTs represent the majority of direct healthcare costs for MS patients in Europe, contributing significantly to the overall economic burden of the disease (13). The upward trend in drug expenditures observed in our study could be attributed to the increasing availability and use of newer, more effective, but also more expensive, treatments. This trend suggests a continued reliance on pharmacological interventions as the cornerstone of MS management.

Opposing Evidence

While our study suggests improvements in MS management, particularly through a declining death-to-incidence ratio, it is essential to consider alternative perspectives. Some studies have challenged the idea that disease-modifying therapies (DMTs) significantly reduce the economic burden of MS. A systematic review by Pearson et al. (2020) argued that while DMTs improve patient outcomes, they do not necessarily lead to a proportional reduction in long-term healthcare costs due to their high price (14). This contrasts with our findings, where the reduced mortality and improved patient outcomes are assumed to be linked to these therapies.

Furthermore, although we report a reduction in the death-to-incidence ratio over time, indicating potential improvements in MS survival rates, other studies suggest that this may not directly translate into reduced overall economic burden. Multiple sclerosis is a progressive disease, and even with the advent of DMTs, many patients eventually experience significant disability. Kobelt et al. (2017) point out that while DMTs have been successful in reducing relapses, they have not been equally effective in halting long-term disability progression, which remains a major contributor to the indirect costs of MS (13). This emphasizes that the indirect costs, particularly those associated with loss of productivity and caregiving, must be considered when evaluating the overall economic impact of MS.

Additionally, the fluctuating prevalence of MS observed in our study may not solely reflect improvements in patient survival or disease management. There is evidence suggesting that prevalence can be influenced by various external factors, including migration patterns and changes in healthcare access. A study by Kingwell et al. (2013) noted that regional variations in MS prevalence might be partly attributed to differences in healthcare infrastructure and patient access to specialist care, factors which are not accounted for in our cost analysis (9).

Limitations

While our study provides valuable insights into the economic burden of MS in Slovakia, several limitations must be acknowledged. First, our analysis focuses primarily on direct medical costs and excludes important non-medical costs, such as informal caregiving, productivity losses, and out-of-pocket expenses for patients. Previous research has shown that these indirect costs can be substantial, particularly in chronic conditions like

MS, where long-term care needs are significant (15). As a result, the true economic burden of MS is likely to be higher than our estimates suggest.

Another limitation is the exclusion of premature mortality costs from our analysis. Although we deemed the impact of MS on mortality to be relatively small and difficult to assess, studies have demonstrated that MS patients do have a shortened life expectancy, which could contribute to lost productivity and increased societal costs (16). Including mortality costs in future studies could provide a more comprehensive picture of the economic burden of MS.

Additionally, the data used in this analysis are limited to information reported by healthcare providers and health insurance companies. Consequently, any inaccuracies or omissions in the reporting could have influenced our findings. For example, out-of-pocket expenses for MS patients were not captured, and there is limited information available on the non-medical costs associated with the disease in Slovakia. This data gap restricts our ability to fully assess the financial impact on patients and their families.

Finally, while our study spans a ten-year period, it does not account for potential long-term changes in healthcare policies, treatment availability, or demographic shifts that may have influenced MS incidence and prevalence during this time. Future research should aim to incorporate a broader range of economic and social factors to provide a more holistic understanding of the evolving burden of MS.

Conclusion

In conclusion, our research highlights the significant and growing economic burden of MS in Slovakia, driven primarily by the rising incidence of the disease and the substantial costs associated with drug therapies. While improvements in patient outcomes, as indicated by the declining death-to-incidence ratio, offer a positive outlook, the financial burden of MS remains high, particularly due to the increasing cost of disease-modifying therapies. Further research is needed to fully capture the indirect costs of the disease and to explore more cost-effective strategies for managing MS in the long term.*

***Compliance with Ethics Requirements:** Authors declare no conflict of interest regarding this article. The authors declare, that all the procedures and experiments of this research respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008 (5), as well as the national law.

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References

1. BEVAN S. Economic impact of musculoskeletal disorders (MSDs) on work in Europe. Elsevier BV 2015, 29 (3): 356-373. <https://doi.org/10.1016/j.berh.2015.08.002>

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2. WOOLF AD, ERWIN J, MARCH L. The need to address the burden of musculoskeletal conditions. Elsevier BV 2012, 26 (2): 183-224. <https://doi.org/10.1016/j.berh.2012.03.005>
 3. LUBECK DP. The costs of musculoskeletal disease: health needs assessment and health economics. Elsevier BV 2003, 17 (3): 529-539. [https://doi.org/10.1016/s1521-6942\(03\)00023-8](https://doi.org/10.1016/s1521-6942(03)00023-8)
 4. HARALSON RH, ZUCKERMAN JD. Prevalence, Health Care Expenditures, and Orthopedic Surgery Workforce for Musculoskeletal Conditions. American Medical Association 2009, 302 (14): 1586-1586. <https://doi.org/10.1001/jama.2009.1489>
 5. NCZI. Tematické štatistické výstupy. 2023, Národné centrum zdravotníckych informácií, Available at: https://www.nczisk.sk/Statisticke_vystupy/Tematicke_statisticke_vystupy/Neurologia/Pages/default.aspx
 6. ŠÚ SR. Databases. 2023, Štatistický úrad SR, Available at: <https://slovak.statistics.sk/wps/portal/ext/Databases/>
 7. BERGER T, ADAMCZYK-SOWA M, CSÉPÁNY T, FAZEKAS F, et al. Management of multiple sclerosis patients in central European countries: current needs and potential solutions. SAGE Publishing 2018, 11: 175628641875918-175628641875918. <https://doi.org/10.1177/1756286418759189>
 8. Multiple Sclerosis International Federation (MSIF). 2014. https://doi.org/10.1163/1570-6664_iyb_sim_org_38982
 9. KINGWELLE, MARRIOTT J, JETTÉN, PRINGSHEIM T, et al. Incidence and prevalence of multiple sclerosis in Europe: a systematic review. BioMed Central 2013, 13 (1). <https://doi.org/10.1186/1471-2377-13-128>
 10. BROWNE P, CHANDRARATNA D, ANGOOD C, TREMLETT H, et al. Atlas of Multiple Sclerosis 2013: A growing global problem with widespread inequity. Lippincott Williams & Wilkins 2014, 83 (11): 1022-1024. <https://doi.org/10.1212/wnl.0000000000000768>
 11. BABELA R, DUGAS J. Economic burden of multiple sclerosis in Slovakia -- from 2015 to 2020. BioMed Central 2022, 22 (1). <https://doi.org/10.1186/s12913-022-08883-6>
 12. COMPSTON A, COLES A. Multiple sclerosis. Elsevier BV 2008, 372 (9648): 1502-1517. [https://doi.org/10.1016/s0140-6736\(08\)61620-7](https://doi.org/10.1016/s0140-6736(08)61620-7)
 13. KOBELT G, THOMPSON AJ, BERG J, GANNEDAHL M, ERIKSSON J. New insights into the burden and costs of multiple sclerosis in Europe. SAGE Publishing 2017, 23 (8): 1123-1136. <https://doi.org/10.1177/1352458517694432>
 14. ICER's Final Report on Disease-Modifying Therapies for Multiple Sclerosis. 2017. <https://icer.org/news-insights/press-releases/final-ms-report/>
 15. KOBELT G, BERG J, ATHERLY D, HADJIMICHAEL O. Costs and quality of life in multiple sclerosis. Lippincott Williams & Wilkins 2006, 66 (11): 1696-1702. <https://doi.org/10.1212/01.wnl.0000218309.01322.5c>
 16. COLEMAN CI, SIDOVAR M, ROBERTS M, KOHN CG. Impact of Mobility Impairment on Indirect Costs and Health-Related Quality of Life in Multiple Sclerosis. Public Library of Science 2013, 8 (1): e54756-e54756. <https://doi.org/10.1371/journal.pone.0054756>

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