

The Ohrid Declaration: Mapping Brain Health Determinants in Southeastern Europe



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ABSTRACT

Objective: Brain health is essential for overall well-being, yet its determinants vary across regions due to geopolitical, cultural, and socioeconomic factors. Southeastern Europe (SEE) faces unique challenges that influence brain health outcomes. Addressing brain health in this region requires tailored approaches that consider the complexity and diversity of these factors. This paper reports on a region-specific framework for addressing brain health challenges in SEE by identifying key determinants through expert collaboration and evidence-based analysis.

Methods: In 2023, a Brain Health Task Force convened in Ohrid, North Macedonia, gathering input from brain health experts across 13 SEE countries and individuals with lived dementia experience. The Task Force focused on the World Health Organization (WHO) brain health

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determinants, integrating expert feedback with a literature review and a SWOT (strengths, weaknesses, opportunities, and threats) analysis. A scoring system was developed, and the results were visualized through thematic maps, highlighting brain health performance variations across the region.

Results: The initial findings reveal significant disparities in SWOT across 25 WHO subdomains of brain health determinants among the 13 SEE countries. Kosovo and Bosnia & Herzegovina scored overall lower (greater weaknesses and threats), while Slovenia and Serbia exhibited stronger outcomes (greater strengths and opportunities). The thematic maps provide a visual representation of these differences, underscoring the diverse challenges and opportunities for brain health across the SEE region.

Conclusions: These findings provide a foundation for further examination of brain health in SEE, guiding policy and strategic interventions, addressing stigma, and fostering cross-sectoral, cross-border, and interregional collaboration.

Keywords: brain health, dementia, health care services, healthy environments, learning, physical health, safety, security, social connection, southeastern Europe, SWOT

INTRODUCTION

Brain health is a dynamic and multidimensional concept, encompassing cognitive, emotional, sensory, behavioral, and motor functions, all shaped by biological, psychological, social, and environmental factors across the lifespan. (Chen et al. 2022) Rather than merely the absence of disease, brain health reflects an individual's capacity for resilience, adaptability, and optimal functioning within their environment (Chen et al. 2022, World Health Organization 2022). Given its lifelong variability, brain health is increasingly recognized as a critical public health priority, with direct implications for individual well-being, economic productivity, and societal resilience. The concept of brain capital, which encompasses the cognitive and emotional resources of populations, is now central to health policy discussions, emphasizing the need for sustained investment in brain health promotion (Smith et al. 2021). Furthermore, brain health diplomacy, an emerging field advocating for cross-sector collaboration and international cooperation, is gaining momentum as a means to address global disparities and drive innovation in brain health strategies (Ternes et al. 2020).

The World Health Organization (WHO) identifies five key sectors of determinants of brain health, which include physical health, healthy environments, safety and security, learning and social connection, and access to quality services. (World Health Organization 2022) Physical health includes factors such as maternal health and the intrauterine environment, genetic and epigenetic factors, nutrition, infections, noncommunicable diseases (NCDs), sensory loss, health behaviors, and traumatic injuries. Healthy environments involve the safe use of chemicals, protection from radiation, healthy and safe workplaces and agricultural practices, air and water quality, a stable climate, access to preserved nature, and health-promoting built environments. Safety and security encompass physical safety, financial security, and protection during humanitarian crises and emergencies. Learning and social connection highlight the importance of education, lifelong learning, nurturing care, social connection/isolation,

and social networks. Finally, access to quality services is understood as receiving integrated care at all health and social care levels by a skilled workforce and interdisciplinary teams, access to essential medicines, diagnostics, and health products, and care partner support. (World Health Organization 2022) This approach aligns well with the syndemic model of health, which explores why certain diseases cluster within specific populations. Considering environmental, physical, social, and political factors to understand global disease burden provides a valuable framework for exploring brain health in the SEE region, a region with significant brain health challenges that have yet to be explored. (Singer et al. 2017)

Southeastern Europe (SEE) is a region of strategic and cultural importance, but with no universally agreed-upon definition. It is most commonly associated with the geographical area known as the Balkans and, for the purposes of this study, includes Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Montenegro, Kosovo, Türkiye, Moldova, North Macedonia, Serbia, Romania, and Slovenia. Southeastern Europe (SEE) has been shaped by successive periods of imperial rule, including the Ottoman and Habsburg Empires, followed by nation-state formation in the late 19th and early 20th centuries. (Jelavich and Jelavich 2000, Grab 2003, Gekas 2016, Verémis 2017). The Cold War further divided the region, with SEE becoming a meeting point of contrasting political ideologies (Judt 2006, Harper 2011). Following the fall of the Berlin Wall in 1989, the region experienced revived ethnic nationalism, religious conflicts, and diminished cultural tolerance (Gallagher 2003).

These historical disruptions have had long-lasting effects on socioeconomic development, health infrastructure, and population well-being. Today, despite shared historical trajectories, SEE countries exhibit substantial demographic and socioeconomic heterogeneity—including differences in population size, ageing structure, and economic capacity—which shape health system performance and brain health determinants (see Supplementary Table S1). While the region is diverse, many SEE countries now face shared

health challenges including high rates of non-communicable diseases, limited mental health services, and persistent health system fragmentation. (Habova 2016) State-run healthcare systems in many SEE countries struggle to meet needs due to limited financing, health workforce shortages, and aging populations (Iuga et al. 2024). These systemic barriers exacerbate disparities in brain health outcomes and point to the urgent need for context-specific, multisectoral responses.

In this study, we aimed to apply the WHO brain health framework to the SEE region to identify disparities, strengths, and opportunities in brain health determinants. By integrating expert consensus, literature review, and structured SWOT analysis, we offer a regionally grounded assessment of the status of brain health in SEE.

METHODS

This study was conducted by the SEE Brain Health Task Force, convened during the 2nd Thematic Conference on Dementia and Neurodegeneration in Ohrid, North Macedonia, in October 2023. The Task Force, coordinated by the Global Brain Health Institute (GBHI) at Trinity College Dublin, comprised clinicians, researchers, and humanities scholars with expertise in older adult mental health and cognition across the 13 SEE countries. Each country was represented by at least two professionals with relevant expertise. Contributors were recruited through the GBHI and affiliated research networks based on experience in cognitive health, health systems, or relevant policy work.

The analytical approach combined a structured consensus process with SWOT (strengths, weaknesses, opportunities and threats) analyses (Helms and Nixon 2010, Alim and Wenig 2021), conducted independently by interdisciplinary national teams within each participating country. The process was guided directly by the five WHO-defined domains of brain health determinants—Physical Health; Healthy Environments; Safety & Security; Learning & Social Connection; and Access to Quality Services—and their corresponding subdomains as outlined in the WHO position framework (Table 1) (World Health Organization 2022). Within each WHO-defined subdomain, national teams identified strengths, weaknesses, opportunities, and threats using nationally available evidence, including peer-reviewed literature, government reports, public health statistics, policy documents, and expert contextual knowledge.

To enhance consistency and reduce subjectivity, a structured consensus process was employed. Each national team presented its findings using a standardized template aligned with the WHO domains and subdomains, with equal allocated presentation time during scheduled virtual meetings. Materials were circulated in advance to facilitate

Table 1. Determinants of brain health across the life course as determined by WHO

Domain	Subdomains
Physical Health	Maternal health, Intrauterine environment Genetic and epigenetic factors Nutrition Infections NCDs Health behaviours Traumatic injuries
Healthy Environments	Safe use of chemicals Protection from radiation Healthy and safe workplaces and agricultural practices Air and water quality Stable climate Access to preserved nature and health-promoting built environments
Safety & Security	Physical safety Financial security Humanitarian crises and emergencies
Learning & Social Connection	Education Lifelong learning Nurturing care Social connection/ social isolation Social networks
Access to Quality Services	Integrated care at all health/social care levels Skilled workforce and Interdisciplinary teams Access to essential medicines, diagnostics and health products Carer support

WHO: World Health Organization

informed discussion. Meetings were moderated by the central coordination team to ensure balanced participation. Where discrepancies or divergent interpretations emerged, these were revisited collectively until a shared understanding was reached. This cross-review mechanism aimed to mitigate potential national optimism or pessimism in SWOT categorization. Although expert-based assessment inherently involves interpretive elements, the use of predefined WHO subdomains and a shared scoring matrix provided a structured and comparable framework across countries.

To complement Task Force input, a rapid literature review was conducted. Searches were performed in Google Scholar, PubMed, and Medline, alongside grey literature sources including governmental reports, national strategy documents, and international agency publications. Search terms were derived from the five WHO determinant domains (World Health Organization 2022). Searches were conducted locally for each country to ensure contextual relevance. Priority was given to nationally representative data where available. However, reporting years varied across countries due to differences in documentation cycles and data availability. Both peer-reviewed and grey literature sources were included; the relative proportion varied by country depending on availability

of published evidence. No formal quantitative imputation was performed for missing data, as the study design relied on structured expert-informed synthesis rather than pooled statistical modelling. Where data gaps were identified, these were addressed through expert contextual interpretation and discussed during consensus meeting. Findings were reviewed within national teams prior to presentation at five virtual Task Force meetings.

To further organize and streamline the review process, we utilized AI tools, specifically an OpenAI tool based on a transformer-based large language model developed using the Generative Pre-trained Transformer (GPT) architecture. Additionally, findings were processed through Perplexity AI, an evaluation metric used to assess the predictive quality and performance of language models. The OpenAI tool was used to generate structured summaries and organize key aspects of the SWOT inputs. Perplexity was applied as a supplementary analytical tool to assist in evaluating textual coherence and thematic consistency, rather than for generating substantive content. Importantly, AI tools were used solely to assist in organizing and summarizing textual material. They were not used to generate primary data, assign scores, or interpret findings. All AI-assisted outputs were reviewed and validated by Task Force members, led by EG, prior to inclusion. Where non-English materials were involved, summaries were cross-checked against original sources to ensure accuracy. This approach allowed for the efficient management of large volumes of information while maintaining high standards of quality and expert oversight. Final analytical decisions, scoring assignments, and interpretations were made exclusively by human experts.

Ethical approval was not required, as the study involved expert opinion, desk-review literature synthesis, and analysis of non-identifiable secondary data.

Scoring System

A standardized scoring matrix was developed to convert qualitative SWOT inputs into numerical values: Strength=+1; Weakness=-1; Opportunity=+2; Threat=-2. Opportunities and threats were assigned greater absolute weight to reflect their forward-looking and potentially system-shaping implications. When strengths or opportunities balanced weaknesses or threats within a subdomain, a score of 0 was assigned. Scores were first aggregated at the subdomain level and then at the domain level for each country. To enable cross-country comparison, aggregated scores were converted into percentage values based on each domain's maximum possible score, with 100% representing optimal alignment with brain health-supportive conditions. This standardization allowed relative comparison across domains and countries despite differences in the number of identified SWOT items.

Development of Visual Representation of Brain Health Diversity Across the Region

To visualise cross-country variation in SWOT-derived domain scores, thematic maps were generated using Python (GeoPandas and Matplotlib libraries). Country-level percentage scores for each of the five WHO brain health domains were merged with publicly available geographical shapefiles using ISO-3 country codes as unique identifiers.

Domain-specific choropleth maps were produced using colour gradients to represent relative performance within each determinant. The Jenks natural breaks classification method was applied to optimise visual differentiation between countries and enhance interpretability of score distributions. Scores are expressed as percentages (0–100%), reflecting normalised domain scores calculated relative to the maximum theoretical score. Countries were labelled using standardised ISO 3166-1 alpha-2 codes (AL=Albania; BA=Bosnia and Herzegovina; BG=Bulgaria; HR=Croatia; GR=Greece; ME=Montenegro; XK=Kosovo; TR=Türkiye; MD=Moldova; MK=North Macedonia; RS=Serbia; RO=Romania; SI=Slovenia) to improve clarity and comparability across maps. Font colour was adjusted where necessary to ensure adequate contrast and legibility against darker gradient ranges. Standardised legends, borders, and scale formatting were implemented to ensure clarity and consistency across maps.

RESULTS

The overall scores (Fig. 1) across the five WHO brain health domains varied significantly across SEE, reflecting disparities in healthcare infrastructure, policy implementation, and socioeconomic conditions. Slovenia achieved the highest overall score (78%), driven by strong performance in learning & social connection, safety & security, and access to services. In contrast, Montenegro scored lowest (33%), reflecting broader structural gaps across multiple domains.

Several mid-range countries –including Serbia (63%) and Croatia (61%)– demonstrated strengths in maternal and child health while continuing to face challenges related to non-communicable diseases and mental health burden. In Bulgaria (41%) and Romania (45%), access to services and environmental health emerged as recurrent weaknesses. Greece (47%) and Türkiye (38%) exhibited domain-specific variability, with modernization efforts offset by safety and access gaps. Bosnia and Herzegovina (38%) and Kosovo (40%) showed relatively stronger maternal health indicators despite broader socioeconomic constraints. Albania (43%), Moldova (42%), and North Macedonia (46%) reflected moderate performance with persistent gaps in healthcare quality and service delivery.

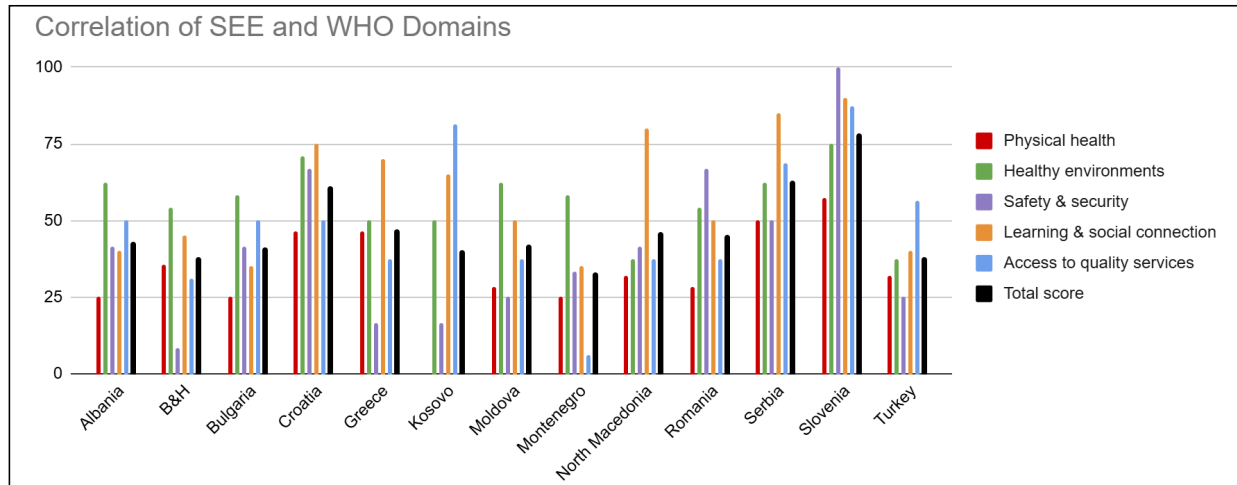


Figure 1. Country-Level Scores Across WHO Brain Health Domains in SEE based on nationally available evidence reviewed between 2023 and 2025. WHO: World Health Organization; SEE: Southeastern Europe

Overall, the findings suggest that regional disparities are driven less by isolated weaknesses and more by uneven performance across structural determinants, particularly service integration, environmental protection, and socioeconomic stability.

To illustrate these regional disparities, colour-gradient maps (Figures 2–6) were created. Darker shades denote higher scores across each domain, offering a visual tool to compare country performance. These visualizations emphasize regional strengths and gaps in brain health determinants and provide an accessible foundation for cross-country learning and policy planning.

Summary of Physical Health Challenges in SEE

Darker shades represent better outcomes. Scores are percentages derived from a weighted SWOT analysis using WHO's brain health subdomains.

The SWOT analysis revealed substantial disparities in physical health across SEE countries. Several countries have some of the highest smoking rates in Europe, with Bosnia and Herzegovina (39.4%) and Serbia (37.1%) exceeding the European Union (EU) average (18.4%). (Mechili et al. 2021, 2023). Maternal healthcare varies widely. Slovenia leads with 95% prenatal care coverage and maternal mortality of 4.6 per 100,000 births, matching Scandinavian benchmarks (Mathers 2024). In contrast, in parts of Southeastern Europe -including Türkiye, Albania, Kosovo, and North Macedonia- caesarean section rates exceed 50% within the private healthcare sector, substantially surpassing the WHO-recommended 10–15% threshold (World Health Organization 2018, World health statistics by WHO 2024). These figures refer specifically to private-sector deliveries rather than national averages. (Ebadi et al. 2026) Obesity and diet-related diseases are significant concerns in Greece and Croatia, where adult obesity rates have reached 25.5% and 30.5%, respectively (World Health Organization 2024). Nutritional issues, including malnutrition and obesity,

are widespread, with unbalanced diet being a significant issue particularly in Bosnia and Herzegovina, Croatia, and Slovenia (Gicevic et al. 2019, Mathers 2024). Albania, Kosovo, and Serbia had the lowest scores for trauma care infrastructure, with rural areas facing severe limitations in emergency medical response. Kosovo reported one of the highest road traffic mortality rates in the region, at 25.6 deaths per 100,000 people, exceeding the European average (James et al. 2019). Antimicrobial resistance is a critical issue, with efforts focused on it in Bulgaria, Croatia, and Serbia (Murray et al. 2022). Historical and conflict-related health impacts uniquely affect Bosnia and Herzegovina and Kosovo and have led to disrupted services and high prevalence of traumatic injuries (Ringdal and Ringdal 2016). Croatia and Slovenia excel in genetic and epigenetic health research (Zergollern-Ćupak et al. 2014, Maisano Delser et al. 2018).

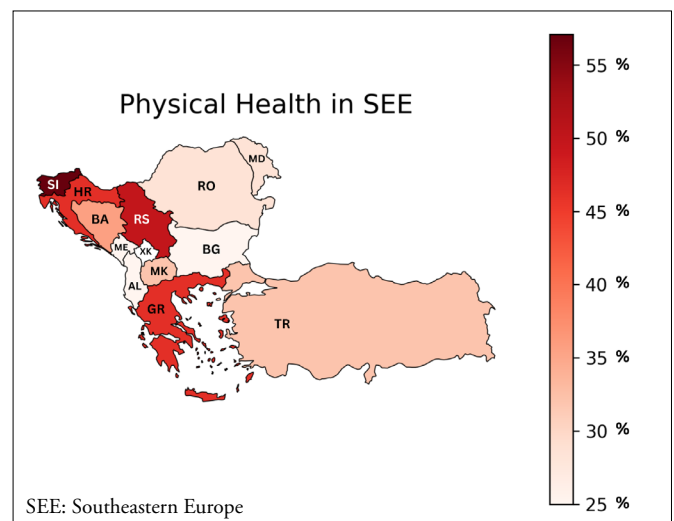


Figure 2. Thematic map representing the performance in Physical Health across SEE based on nationally available evidence reviewed between 2023 and 2025.

Summary of Healthy Environments in SEE

Darker shades represent better outcomes. Scores are percentages derived from a weighted SWOT analysis using WHO's brain health subdomains.

Environmental health challenges across SEE reveal significant disparities in air and water quality, occupational safety, and climate resilience. Air pollution remains a critical issue, with North Macedonia's capital, Skopje, ranking among the most polluted cities globally, where concentrations of particulate matter (PM_{2.5} and PM₁₀) regularly exceed WHO recommended levels by over twelve times (Meisner et al. 2023). Similarly, Sarajevo frequently reports hazardous air quality levels, particularly in winter, with air quality indices reaching "very unhealthy" levels (Health Effects Institute 2022). Serbia experiences higher rates of premature deaths due to air pollution compared to many EU countries, largely attributed to fossil fuel use, industrial emissions, and household heating practices (World Health Organization 2019). Albania and Bosnia and Herzegovina also contend with severe air and water pollution, particularly in urban areas (World Health Organization 2024). Workplace safety and environmental regulations vary widely. Albania, Moldova, and North Macedonia have initiated programs to improve workplace safety and sustainable practices (United Nations 2017), whereas Kosovo faces ongoing contamination from industrial legacy pollution and war-related environmental damage. (United Nations Environment Programme and United Nations Centre for Human Settlements 1999). In contrast, Slovenia and Croatia have stronger regulatory frameworks focusing on greenhouse gas emissions and occupational safety (Ravbar and Šebela 2015, Švarc et al. 2022), while Bulgaria and Slovenia excel in hazardous substance handling and waste management, adhering to the European Union's Directive 89/391/EEC (United Nations Environment Programme 2016). However, Moldova and Romania continue to struggle with inspections and factory safety enforcement. (Yoshifumi 2021). Greece has made notable progress in waste management (United Nations Environment Programme 2016) but faces challenges in agricultural occupational safety and air pollution (World Health Organization 2024). Climate resilience efforts also show regional variability. North Macedonia, despite its ecological diversity, faces severe air pollution in Skopje, exacerbating urban health risks. (Meisner et al. 2023). Türkiye contends with high CO₂ emissions (World Health Organization 2024), while Montenegro and Albania, despite prioritizing biodiversity, continue to grapple with outdated safety regulations and persistent air pollution. (Yoshifumi 2021, World Health Statistics by WHO 2024).

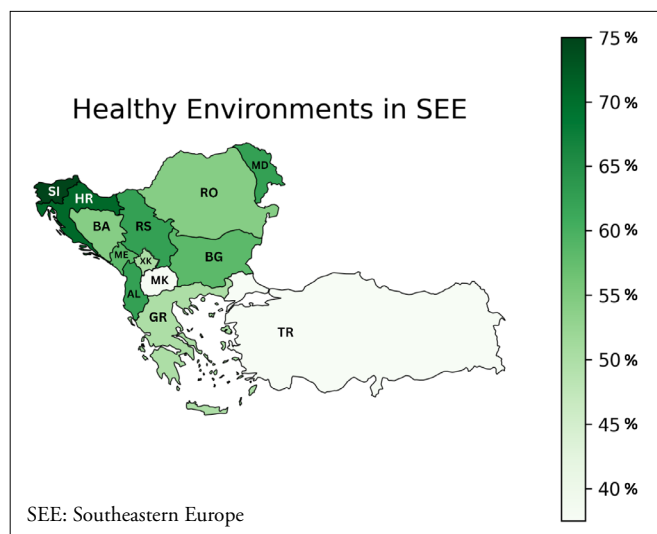


Figure 3. Thematic map representing the performance in Healthy Environments across SEE based on nationally available evidence reviewed between 2023 and 2025.

Safety and Security in SEE

Darker shades represent better outcomes. Scores are percentages derived from a weighted SWOT analysis using WHO's brain health subdomains.

Southeastern Europe is scourged by widespread safety and security challenges, including economic instability, crime, natural disasters, and humanitarian crises. Physical safety varies across the region, with Slovenia ranking among the safest countries, where 91% of people feel safe walking alone at night, compared to Türkiye, where public confidence in security is among the lowest in the OECD (Duffy 2021). Bosnia and Herzegovina deals with high crime rates, landmine hazards, and economic instability (European Commission - Questions and answers 2023), while Moldova reported a murder rate of 2.27 per 100,000 in 2023, alongside ongoing corruption and human trafficking issues (United Nations Office on Drugs and Crime / Vienna 2023). Traffic safety is also a concern, with Montenegro recording a road traffic death rate of 7–12 per 100,000, predominantly affecting working-age men (Global Status Report on Road Safety 2023). Economic security remains fragile in parts of SEE, with Türkiye, Bosnia and Herzegovina and Moldova experiencing high inflation, while Greece has the second-highest unemployment rate in Europe at 8.7%, following Spain (Coelho 2023). In Albania, despite moderate economic growth, nearly 60% of employment remains informal, limiting access to social security and stable wages (ILO 2024). Kosovo continues to mitigate the long-term effects of industrial pollution and radiation exposure (United Nations Environment Programme and United Nations Centre for Human Settlements (Habitat) 1999). Humanitarian crises continue to strain the region, with Türkiye hosting over 2.3 million Syrian refugees, the second largest refugee population

in the world (United Nations Environment Programme and United Nations Centre for Human Settlements (Habitat) 1999, Republic of Türkiye Ministry of Interior Presidency of Migration Management –temporary protection, n. d.).

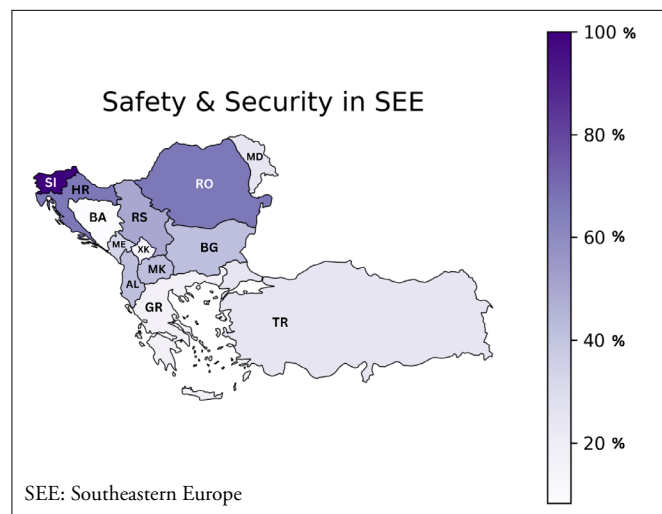


Figure 4. Thematic map representing the performance in Safety and Security across SEE based on nationally available evidence reviewed between 2023 and 2025.

Learning and Social Connection in SEE

Darker shades represent better outcomes. Scores are percentages derived from a weighted SWOT analysis using WHO's brain health subdomains.

Southeastern Europe countries face diverse educational and social challenges, with significant variations in attainment, lifelong learning participation, and social care systems. Average years of schooling range from 11.5 years in Greece to 8.6 years in Albania (United Nations Development Programme 2024). According to Programme for International Student Assessment (PISA) 2018, students in SEE countries generally score below the Organisation for Economic Co-operation and Development (OECD) reading average of 487, with Albania (405), North Macedonia (393), and Bosnia and Herzegovina (402) among the lowest in Europe (Organisation for Economic Co-operation and Development 2021). Albania, Bulgaria, and Slovenia have strong foundational literacy and compulsory education systems, yet lifelong learning participation remains below 5%, significantly lower than the EU average of 11% (Coelho 2023). Bosnia and Herzegovina, Montenegro, and North Macedonia struggle with underfunded educational infrastructure, affecting the quality of both primary and vocational education (Coelho 2023, UNESCO Institute for Statistics (UIS) 2023). Türkiye and Greece report high enrolment rates (above 95%) for compulsory schooling, yet challenges remain in resource allocation, vocational training, and early childhood education accessibility, impacting long-term workforce development

(Coelho 2023, Hellenic Statistical Authority (ELSTAT) 2023). Croatia, despite strong educational infrastructure, has one of the lowest higher education participation rates in the EU (35%), while Romania's early school leaving rate (15.6%) remains nearly double the EU average (Žiljak et al. 2023).

In social care, Albania, Bulgaria, Greece, and Slovenia emphasize strong family and community ties, but struggle with poverty, loneliness, and aging populations. Bosnia and Herzegovina, Kosovo, North Macedonia, and Montenegro experience social isolation linked to economic hardship, rural depopulation, and health inequities (Coelho 2023, European Commission 2023, United Nations Population Fund Kosovo and University College London 2022). Türkiye faces significant gaps in social welfare programs, while Serbia and Moldova implement community-based initiatives to counteract increasing social disconnection (Eurofound 2023).

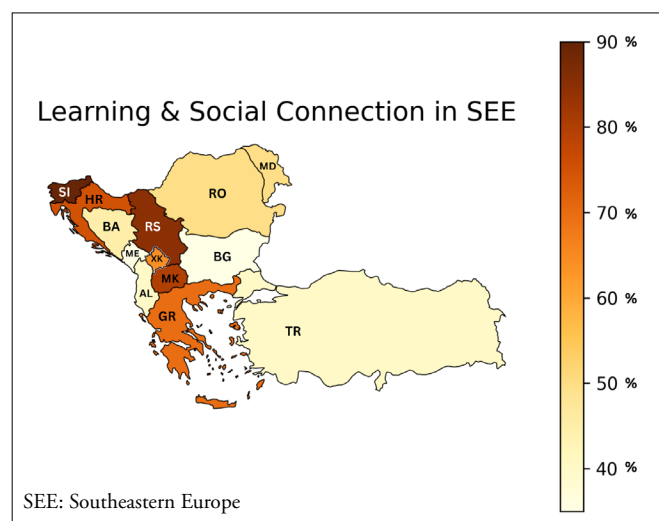


Figure 5. Thematic map representing the performance in Learning and Social Connection across SEE based on nationally available evidence reviewed between 2023 and 2025.

Access to Quality Services Across SEE

Darker shades represent better outcomes. Scores are percentages derived from a weighted SWOT analysis using WHO's brain health subdomains.

Access to quality healthcare services across SEE varies significantly due to differences in infrastructure, workforce availability, and funding mechanisms. While Albania leads in legislative reforms and integrated care initiatives (Duffy 2021), Bosnia and Herzegovina struggles with fragmented entitlements and overloaded personnel (Duffy 2021). Bulgaria offers broad service access but faces coordination challenges between health and social care, particularly in mental health. (Dimova et al. 2022). Croatia, benefiting from EU funding, experiences persistent workforce shortages (Džakula et al 2021), while Greece explores telemedicine

solutions (Politis et al. 2023) to counteract inefficiencies caused associated with workforce shortages and brain drain (Ifanti et al. 2014). Kosovo's healthcare infrastructure is relatively strong, but bureaucratic inefficiencies hinder accessibility (United Nations Environment Programme and United Nations Centre for Human Settlements (Habitat 1999), and Moldova remains heavily dependent on out-of-pocket payments due to limited government investment. Romania offers universal coverage but grapples with brain drain and regional disparities, while Serbia focuses on community-integrated services but struggles with healthcare system limitations (Bjegovic-Mikanovic et al. 2019). Slovenia leads in healthcare education but faces shortages in medical staff, and Türkiye has made major advancements but still contends with significant regional disparities and workforce retention issues (Tatar et al. 2011). Common challenges across the region include healthcare workforce shortages, particularly in mental health and primary care, rural-urban disparities impacting access, and financial constraints affecting sustainability. Countries are increasingly adopting integrated care models to improve coordination and outcomes, leveraging legislative reforms and cross-sector collaborations. However, while telemedicine (Politis et al. 2023) services show promise, they remain in early stages of implementation across much of the region. (Duffy 2021, Coelho 2023)

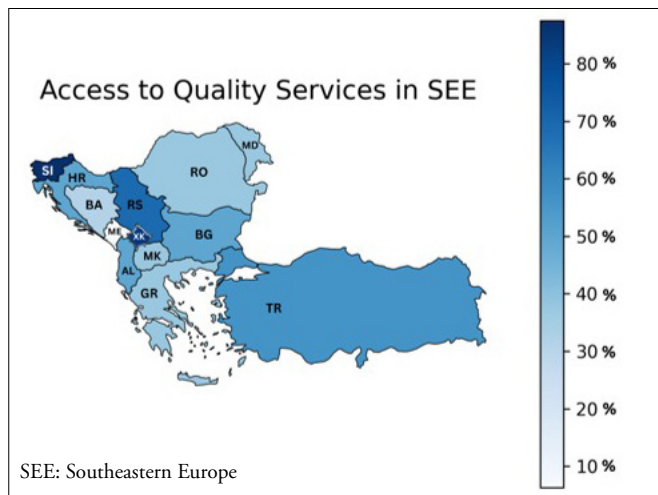


Figure 6. Thematic map representing the performance in Access to Quality Services across SEE based on nationally available evidence reviewed between 2023 and 2025.

DISCUSSION

Initial Recommendations to Address Regional Brain Health Challenges.

This study marks the first comprehensive assessment of brain health determinants across the SEE region, which, despite its historical fragmentation and geopolitical divisions, shares

deep-rooted cultural and historical commonalities, that offer a unique platform for cross-border collaboration (Bracewell and Drace-Francis 1999, United Nations Educational, Scientific and Cultural Organization 2001, Verémis 2017). Through a detailed examination of five key domains defined by the WHO, this research provides a starting point for further exploration for guiding regional strategies aimed at tackling the growing brain health burden in SEE countries.

The implications of this study extend beyond national borders. By integrating SWOT analyses localized to each country with the WHO's brain health determinants, the research presents a new model for addressing brain health inequities and fostering collaboration. This approach is particularly timely, as existing literature has focused primarily on brain health in Western and Central Europe (Dukelow et al. 2023, Zülke et al. 2023), leaving SEE underrepresented. Previous studies, such as those from the European Brain Council (Olesen and Freund 2006), have demonstrated the effectiveness of regional collaboration in advancing brain health initiatives (Di Luca et al. 2019). Our findings build on this body of work by showing that such collaboration is not only viable but also critical for SEE –a region with unique socioeconomic and geopolitical characteristics that demand a tailored approach to health interventions.

Given the heterogeneity in demographic structure, economic capacity, and health system development across SEE countries, the recommendations presented here are intentionally framed at the domain level rather than hierarchically prioritized. The aim of this mapping exercise is to identify shared structural areas requiring attention while allowing national stakeholders to determine context-specific prioritization according to local feasibility, urgency, and available resources.

To advance brain health in the socioeconomically fragmented SEE region (Dabrowski and Myachenkova 2018) it is necessary to consider targeted interventions across various domains, emphasising cross-sectoral and cross-border collaboration (Footman, et al. 2014, Schmidt et al. 2022, Wismar et al. 2022), stigma reduction, and the enhancement of neurocognitive and mental disorder prevention efforts. Suggested recommendations for each key domain are discussed below.

Physical Health

To mitigate physical health challenges, SEE countries would benefit from stricter regulations on tobacco and alcohol consumption while launching robust public education campaigns. Standardizing prenatal care protocols and enhancing healthcare provider training can address high caesarean rates and improve maternal and child health, particularly in Albania, Kosovo, Bosnia and Herzegovina, and

North Macedonia. Challenges in the domain of nutrition, especially in Bosnia and Herzegovina, Croatia, and Slovenia, could be tackled through educational programs and subsidies for healthy foods.

Healthy Environments

Southeastern Europe countries could consider harmonize regulatory standards for chemical safety, radiation protection, and environmental conservation. Strengthening monitoring and enforcement mechanisms, especially in urban pollution hotspots, is crucial. Investing in sustainable technologies, improving waste management, and building institutional capacity through targeted training programs are vital to enhance public health outcomes related to environmental risks.

Safety and Security

Enhancing safety measures in the SEE region necessitates improving emergency response systems and developing strategies to combat rising cybercrime and organized crime. In countries with high unemployment, like Albania, Greece, Türkiye, and Kosovo, targeted economic policies are critical to improving financial security and reducing stress-related mental health issues. Strengthening social support systems, particularly in Moldova and Montenegro, can help reduce social isolation and promote brain health.

Learning and Social Connection

Promoting lifelong learning and social connection is essential for cognitive health in the SEE region. Educational reforms that focus on enhancing curricula and vocational training can equip individuals to navigate changing economic conditions. Implementing community-based programs that reduce isolation and foster social interaction is key to mitigating the effects of social isolation and promoting cognitive engagement.

Access to Quality Services

Access to quality healthcare across SEE countries is essential for improving brain health outcomes. Prioritizing integrated care models with skilled, interdisciplinary teams can help bridge existing gaps. Future electronic cross-border healthcare services may improve coverage for remote border communities. Expanding access to essential medicines, diagnostics, and health products in underserved areas is crucial for reducing disparities. Further research into national regulations and improved regional coordination could guide comprehensive recommendations to support brain health across SEE.

Brain Health as an Opportunity of Regional Cooperation

Addressing the detected gaps and inequities may be facilitated through efforts to increase, deepen and consolidate regional cooperation. The SEE area is increasingly moving towards economic and social integration within the framework of the EU. The SEE space includes five European Union member states, eight countries have been granted EU candidate status, while Kosovo is recognised as a potential candidate for EU accession. Territorial cohesion belongs to the top priorities of the EU since the 2009 “Lisbon Treaty” (Medeiros et al. 2023). European Territorial Cooperation, being an element of paramount importance for European Cohesion Policy, is implemented on three different levels, i. e. on the local and regional level, on the transnational level and/or on the interregional one (Reitel et al. 2018). It paves the way towards multiple transborder synergies and thematic network cooperations between public, civil society and economic actors (Servillo 2010). Such synergies facilitate diffusion of knowledge, territorially flexible collaborative endeavours, adaptive planning processes, and strengthening of functional relationships between communities (Medeiros et al. 2023). They result in the improvement of educational and healthcare public service delivery, local economic growth, socioeconomic integration, promotion of environmental sustainability and equity (Medeiros 2016, Mehrabian et al. 2019, Medeiros et al. 2023). Within this context, the SEE Brain Health Task Force aims to serve as a platform for continued regional dialogue and mutual learning. The present mapping exercise represents an initial step toward informing future collaborative initiatives, knowledge exchange, and coordinated efforts to address shared brain health challenges across SEE countries. European Union funding opportunities dedicated to fostering European spatial development and integration such as the INTERREG Community Initiative (Pallagst et al. 2022) may embody valuable tools for combating SEE brain health inequities, which do not exclusively burden healthcare service delivery, but are linked to socioeconomic and cultural characteristics of the region which are crucial for brain health maintenance and protection, as here depicted in detail.

Limitations

This study has several limitations. Although subnational (NUTS1) analysis was initially intended, inconsistent regional data necessitated a country-level approach, which may not fully capture within-country variation. Cross-country comparability was constrained by variability in data availability, reporting cycles, and source types. In some cases, reports informing SWOT categorization were produced in different years, and harmonized quantitative indicators (e.g., prevalence rates, workforce density, or service coverage

metrics) were not uniformly available across countries. As such, findings should be interpreted as structured comparative assessments rather than contemporaneous epidemiological equivalence. Additionally, although AI tools were used solely for information structuring, language model biases and variability in performance across linguistic contexts remain potential limitations. The study relied on expert-informed synthesis conducted through affiliated professional networks. While a structured consensus process was applied, expert selection may not fully represent national diversity, and interpretive judgment is inherent in this approach. Finally, translating qualitative SWOT inputs into percentage scores facilitated comparison but may oversimplify complex system-level dynamics. The framework is intended as a strategic regional mapping tool rather than a precise quantitative model. Future work could strengthen this approach through harmonized datasets and longitudinal monitoring.

CONCLUSION

Addressing the healthcare and environmental challenges in SEE requires a comprehensive approach that includes legislative changes, risk reduction policies, public education, strategic investments, community participation and cross-border, transnational and interregional collaborations. By focusing on the five key domains of brain health determinants, SEE countries can make significant strides in advancing brain health. These recommendations provide a roadmap for policymakers, healthcare professionals, and community leaders to implement effective interventions and may lay the groundwork for cross-border, transnational and interregional collaborative initiatives that will improve brain health outcomes and enhance overall public health across the region.

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