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Digital and Intelligent Systems for Maintaining the Working Capacity of People with Chronical Diseases: A Behaviour Modelling and Personalized Support Approach

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Abstract

This study explores how human-centric intelligent systems and digital solutions can contribute to maintaining the working capacity of individuals with Multiple Sclerosis (MS). Focusing on the analysis of behavioural data and modelling individual disease trajectories, the research investigates how personalized work models and support systems can be developed to meet the specific needs of MS patients. By leveraging digital behaviour modelling and AI-driven systems, the interaction between healthcare services, employers and labour market agencies can be optimized to improve the working capacity of individuals with chronic diseases. Mobile and social sensing technologies further enhance the ability to monitor health status and work capacity in real-time, enabling more effective, data-driven interventions.

Keywords: Human-centric intelligent systems; Working capacity; Multiple Sclerosis (MS); Behavioural data analysis; Personalized work models; Support systems; Healthcare services

Introduction

Multiple Sclerosis (MS) results in persistent inflammation of the central nervous system, which may lead to both physical and cognitive impairments [1]. The global prevalence of individuals diagnosed with MS is reported to be around 2.8 million [2], equating to an average of 36 cases per 100,000 people. Additionally, there is a clear divide in MS incidence when comparing northern and southern regions [3]. This disease predominantly affects individuals during their working years (ages 20 to 40), indicating it is not only a personal burden but also carries significant economic implications due to its effects on societal human capital. The most frequently cited physical symptoms leading to early retirement include fatigue, vision difficulties and emotional factors (such as the work environment, demographic traits or financial dependency). Generally, patients identify cognitive and physical challenges as critical in their choice to remain employed [4,5]. In Germany, MS creates substantial financial pressures on long-term care insurance, pension funds and health coverage. This is largely due to the early onset of the condition, as well as the likelihood of ongoing disease progression [6]. In Austria, 11.5% of individuals with a milder manifestation of MS (Expanded Disability Status Scale scores of 0-3) have applied for disability retirement, which notably affects the socio-economic factors surrounding early retirement and healthcare systems [7]. Furthermore, nearly half of the expenses associated with MS can be attributed to declines in work productivity. One study estimates the indirect costs of MS at \$1.5 million per patient, which is four times greater than the indirect costs for a healthy employee [4]. For a long-term absence (due to disability or early retirement), the costs per year are €6,735 for patients

with a mild disease course (EDSS 0-3), €14,924 for those with a moderate course (EDSS 4-6.5) and €18,676 for severe cases (EDSS 7-9) [7]. These figures can be compared to indirect cost estimates in Germany, which are calculated to range from approximately €4,500 to €19,000 per MS patient annually, depending on disease progression [5,8].

In Austria, various governmental support programs are available for individuals suffering from MS and other chronic illnesses; however, there is limited information regarding their effectiveness in helping patients maintain their work capacity. A study involving experts from social and healthcare services working with affected individuals emphasized the importance of tailoring job classifications to meet the unique needs of patients. Additionally, it highlighted the necessity of further promoting workplace measures aimed at combating fatigue [5,9]. The aim of this study is to analyse the governmental support measures to maintain the working capacity of people with MS. The focus was placed on the current governmental offer of support measures and the approaches that can be implemented for improvement in order to provide assistance to as many people affected as possible. The intersection of human-centric intelligent systems and healthcare provides new opportunities to support individuals with MS in the workplace. By utilizing AI-driven systems and behavioural modelling, it is possible to develop interventions that adapt to the changing health conditions of MS patients. These technologies enable the continuous monitoring of health data and provide personalized recommendations that can help extend patients working capacity, addressing both physical and cognitive challenges, which is another approach that affects this paper. In recent years, social and mobile sensing technologies have emerged as powerful tools in health monitoring. These technologies collect data on individuals' behaviours, symptoms and interactions with their environment, enabling the creation of detailed behavioural models. By integrating this data into AI systems, employers and healthcare providers can better understand the needs of MS patients and offer more tailored support measures. This paper explores the potential of these intelligent systems to enhance existing governmental support measures and improve the long-term working capacity of MS patients. For this study, experts from the health and social sectors which are working with people with MS were interviewed, as well as people who suffer from MS.

Methods

The methods were first described in the article of Eberharter et al. [5] and further developed for additional scientific papers [5]. For this, a study in two stages was carried out by using qualitative interviews. In the first stage, problem-centred interviews were conducted with specialists from the health care and social sector who work with individuals affected by MS. The second stage of the study involved conducting qualitative interviews in biographical formats [10] with people diagnosed with MS. Sampling was used for the process to map the difference of the results between both the experts and the people with MS. This was ensured for the

group of experts based on the following factors: Cooperation with people suffering from MS, demographical factors, urban or rural area, diversity of profession (medical orientation, rehabilitation, protection of employee, labour law, insurance, financial support, self-help groups). The participants who suffer from MS differed according to the following criteria: Demographical factors, profession, level of education, work activity, age at diagnosis, status of employment, medical care (medication), symptoms and progression of disease, etc. The main criterion in this study was that the participants are working or were working to be able to state a realistic assessment of the situation at work for people with MS.

Data analysis

A total of 43 experts from diverse institutions were initially identified and contacted multiple times via phone and email. Of these, eight declined participations due to insufficient knowledge of support programs for individuals with MS and despite multiple follow-up attempts, 21 experts did not respond. Ultimately, 14 experts agreed to participate in the study; however, four were either unable or unwilling to provide input on certain topics. This left 10 fully engaged experts, achieving the study's objective of gathering diverse perspectives. MS participants were recruited through a social media platform, leading to 42 volunteers. Based on demographic screening, 20 participants were selected, with telephone interviews conducted with each [5]. The studies followed a qualitative content analysis methodology, specifically the summary content analysis approach described by Mayring P [11]. Using the MAXQDA data analysis platform, findings from both studies were systematically compared, enabling the extraction of core insights from the interviews [11]. To ensure process consistency, all interviews were conducted by the same researcher and data coding and analysis were completed by the lead author, maintaining rigor in the approach [12]. All participant information was anonymized to protect confidentiality.

Result

Following an analysis of the gathered data, the outcomes from the two-phase study were thoroughly compared. The primary focus was on the Austrian government's supportive measures aimed at helping individuals with MS sustain their work abilities. Throughout the research, the most effective interventions for participants were carefully assessed. On one side, existing support strategies were evaluated for optimization, while participants also voiced a need for additional programs to enhance the assistance available to MS patients. Three main findings stood out, each bolstered by suggestions for improvement from study participants, which included 10 experts from health and social services and 20 individuals affected by MS [5]. Key insights from this study underscored specific areas for strengthening government support for those living with MS. Presently, Austria offers various supports such as personal assistance, subsidies for vehicle purchases, heating allowances, and medical rehabilitation programs. Yet, participants advocated for expanded information dissemination to employers, employees and service providers to increase awareness of these

supports. The study highlighted a need for centralizing disability-related facilities at the municipal level, making it simpler to access information and support. Additionally, participants called for less restrictive criteria for state assistance to improve accessibility. Shifting disability services from regional to federal jurisdiction was recommended to promote equitable access across Austria [5].

The introduction of partial pensions, modelled after the German approach, was proposed to allow people with MS to work part-time while receiving pension benefits. There was also strong advocacy for expanding outpatient rehabilitation, improving access to MS-specific therapies and enhancing neuropsychological services, particularly in underserved areas. Further, the research emphasized the role of occupational therapy, suggesting greater investment in therapist training, increased financial backing for rehabilitation and the development of more adaptable outpatient therapy options. Such changes would enable individuals to manage work alongside treatment. Participants also emphasized the importance of comprehensive interdisciplinary support, including establishing a central hub for MS-related inquiries and enhancing specialized nursing roles for MS care. Lastly, the study urged stronger collaboration among healthcare providers, labor market services and businesses to create employment opportunities and retraining pathways for MS patients. This would involve better training for vocational rehabilitation personnel and the establishment of a centralized office specifically aimed at supporting employees with disabilities in their workplaces [5].

Discussion

The two-phase study proposed several strategies to enhance and expand government support measures designed to help individuals with MS remain employable:

- A. Relaxation of approval criteria for state-funded assistance programs.
- B. Centralizing facilities for disabled individuals at the municipal level.
- C. Transferring disability support oversight from regional to federal authorities.
- D. Allocating more resources specifically to rehabilitation services, with a heightened focus on occupational therapies.
- E. Increasing financial backing from policymakers for rehabilitation and tailored therapies.
- F. Expanding outpatient rehabilitation options that accommodate work and family commitments.
- G. Evaluating the German partial pension model for potential adoption in Austria.
- H. Establishing a centralized counselling service for people with MS to address a range of inquiries.
- I. Introducing specialist MS nursing roles as key contact points, offering guidance post-diagnosis and support with

work-related and care questions, in addition to or in place of MS physicians.

J. Promoting collaboration among healthcare providers, labour market services and employers** to develop appropriate job opportunities.

K. Enhancing training for vocational rehabilitation staff to better support individuals in sustaining their work capacity [5].

Several findings from this study align with international research results [5], underlining the need to expand government-funded MS-specific therapies and neuropsychological services throughout the regions. This need is similarly emphasized by O'Connor et al. [13], who highlighted the importance of accessible MS therapies [13]. Creating a centralized counselling service for individuals with MS could significantly improve access to information on available support, echoing findings by Roessler et al. [14] on the benefits of rehabilitation counsellors as information hubs [14]. The proposal to train MS-specialized nurses as primary points of contact for patients-either supplementing or even replacing the role of MS physicians-gained support from Townsend [15], who demonstrated how such nurses could provide critical guidance following diagnosis and address work-related concerns [15]. Moreover, the study emphasized the importance of stronger collaboration between employment services and businesses to facilitate additional training and job opportunities for MS patients [16], supporting vocational rehabilitation goals. This need for integration aligns with O'Connor et al. [13], who stressed the necessity of vocational and healthcare rehabilitation services to help people with MS retain employment. O'Connor et al. [13] also analysed how policy shifts increasingly advocate for rehabilitation programs that combine employment services with healthcare providers [5,13].

Conclusion

Integrating existing government measures with optimizations proposed by MS patients and experts can significantly reduce work absences and limitations. Participants called for more flexible approval criteria for state aid, centralized services for disabled individuals, and federal oversight of disability support. A central counselling service was recommended to provide accessible information, alongside MS-specialized nurses as primary contacts for guidance after diagnosis, especially regarding work and care-related issues [5,17]. Ensuring long-term work ability also depends on targeted investment in rehabilitation and individualized therapies. Expanding outpatient and occupational therapies can improve access to exercise-based health interventions. Stronger collaboration between healthcare providers, labor market services and employers were emphasized to create job opportunities tailored to MS needs [18]. Training for vocational rehabilitation staff and exploration of Germany's "partial pension" model were also recommended [5]. The study highlights the potential of human-centric intelligent systems in supporting MS patients through personalized, real-time support. AI-driven behavioral

models can predict fatigue or cognitive decline, enabling timely work adjustments and treatment optimization. Social sensing technologies facilitate better coordination between healthcare providers and employers by offering insights into patients' health and performance.

Participants expressed strong interest in flexible work arrangements and AI-supported occupational health services. Improved communication among stakeholders was seen as essential, with AI-driven case management systems suggested to bridge existing gaps. AI technologies can enhance work capacity by offering tailored interventions based on health data, adapting work environments to evolving patient needs. Continuous monitoring via behavioral modelling and sensing technologies can identify trends and guide proactive strategies to prevent early retirement. Ethical issues, especially around data privacy, must be addressed through transparent and fair systems to build trust. Integrating these digital tools into existing support structures presents a powerful opportunity to enhance the quality of life and workplace inclusion for MS patients. Further research, including pilot programs, is needed to test these technologies in real-world settings. Collaboration between healthcare providers, employers, and tech developers will be key to realizing their full potential in maintaining employment for individuals with chronic illnesses like MS.

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