

Original Article

Perception of Multiple Sclerosis Impact and Treatment Efficacy Beliefs: Mediating Effect of Patient's Illness and Self-Appraisals



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Abstract

Context. Patients with multiple sclerosis (MS) experience many negative, seriously aggravating disease symptoms, and hence, research studies are utmost required to improve their coping with symptoms. Our research is an attempt to show ways to increase participation of patients with MS in the treatment and treatment planning process, as well as in managing the symptoms of the disease.

Objectives. To examine the relationship between perception of MS impact and treatment efficacy beliefs in patients with MS and the extent to which self and illness appraisals can be regarded as mediator variables in this relationship.

Methods. The cross-sectional study included 278 MS patients who completed the Treatment Beliefs Scale, Multiple Sclerosis Impact Scale, Generalized Self-Efficacy Scale, Rosenberg Self-Esteem Scale, and Brief Illness Perception Questionnaire. Demographic and clinical characteristics of the participants were collected with a self-report survey.

Results. Illness perception and general self-efficacy mediated the relationship between perception of MS impact and treatment efficacy beliefs under the control of age and time from diagnosis. The standardized indirect effects for illness perception and general self-efficacy were -0.131 95% CI $[-0.2029, -0.0739]$ and -0.086 95% CI $[-0.1663, -0.0165]$, respectively.

Conclusion. Our results indicate that worse perception of physical condition in patients with MS is associated with more negative treatment efficacy beliefs, and that this association is mediated by self-efficacy and illness perception. To inhibit the increase of negative treatment efficacy beliefs, health care specialists can work on improving self-efficacy and illness appraisals. *J Pain Symptom Manage* 2019;58:437–444. © 2019 American Academy of Hospice and Palliative Medicine. Published by Elsevier Inc. All rights reserved.

Key Words

Multiple sclerosis, treatment efficacy beliefs, illness perception, self-efficacy, self-esteem

Introduction

Patients' beliefs about treatment affect their attitudes toward medications and other treatment behaviors, and have been shown to predict adherence to medication for chronic disorders such as immune-mediated inflammatory diseases,¹ asthma,² renal

disease,³ rheumatoid arthritis,⁴ and stroke.⁵ Treatment beliefs are important factors in theoretical models of health behavior such as the health belief model,⁶ Andersen's behavioral model,⁷ or Leventhal's common sense model,⁸ according to which patients' beliefs about treatment are self-regulatory elements

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underlying treatment preferences, adherence, and outcomes.⁹ Knowing patients' beliefs about treatment effectiveness is an essential step in providing clinicians with all the necessary tools to maximize patients' health, especially if the effectiveness of the drugs prescribed is weak or unclear.^{10,11}

Treatment beliefs are of particular importance in the case of diseases with an unpredictable course and varied symptoms. Such conditions should include multiple sclerosis (MS). MS is a chronic neurological disease characterized by a progressive and unstable course, variable symptoms, and a lack of curative treatments.¹² MS can take several clinical courses with new symptoms either arising in isolated attacks (relapsing forms) or building up over time (progressive forms). Although there is no cure for MS, disease-modifying therapies have been shown to reduce exacerbations, new brain lesions, modify the disease course, and slow overall disease progression.¹³ Unfortunately, evidence from several studies demonstrates that between 30% and 50% of MS patients prematurely discontinue disease-modifying therapies and do not receive benefits because of poor treatment adherence.^{14–16} Uncontrollability of MS, long periods of disease remission, side effects of treatment (such as flu-like symptoms or injection-site reactions), and lack of evident results of therapy or functional improvements contribute to specific treatment beliefs and decisions about discontinuations.¹⁷

Given the importance of medicines in MS treatment and slowing down the disease's progression, surprisingly little attention has focused on how MS patients perceive and make decisions about their treatment. These decisions are based on treatment beliefs. For example, Tremlett and Oger¹⁸ reported that lack of perceived efficacy was the most commonly reported reason for interruptions of therapy longer than one month in duration among MS patients receiving beta-interferon therapy. In Spanish single-centered studies¹⁹ on a group of 632 MS patients, of the 107 patients (17%) who earlier stopped the beta-interferon treatment, 56 did so because of a perceived lack of efficacy. Lack of efficacy, besides side-effects, was also the main cause for stopping beta-interferon therapy in other studies.^{20,21} In a study by Syed et al.²² on patients also treated with interferon β -1a, patients' favorable experiences of treatment was found to have a positive influence on treatment persistence.

Although much evidence indicates the important role of treatment beliefs in the MS treatment process, there is little research showing the basis on which these beliefs are formed. Most of the researchers simply assume that treatment efficacy beliefs are the consequence of the perceived impact of the disease.^{23,24} When patients see improvements in health, they assume that treatment is effective. In the absence of improvement or the deterioration of health, the

appraisal of treatment effectiveness is decreasing. This simple relationship works well for predictable diseases. The situation is different in cases of diseases such as MS, where the disease course varies between patients and effects of treatment may not become immediately apparent. In addition, the true benefit of treatment in individual patients is unclear because it is impossible to predict how MS will affect patients if they were not in treatment.²⁵ Side-effects and cumbersome ways of taking medicines also play a role. While reviewing literature, we have not been able to find any research addressing the relationship of the impact of MS on treatment efficacy beliefs; it is of interest to explore this relationship.

Based on the current knowledge, it is well known that perceptions of treatment do not develop in isolation. Two other perceptions seem to be particularly important. First, patients differ in the ways they interpret their disease. People evaluate their health threats by constructing their own perceptions of illness that in turn influence their patterns of coping and adjustment.²⁶ Researchers indicate that psychological appraisals of illness are salient predictors of adjustment to MS, even when the effects of disease severity are taken into account.^{26–28} According to Nicklas et al.,²⁹ illness perception is strongly associated with treatment beliefs, and together these variables are related to adherence. Just as patients develop perceptions about their illness, they also develop ideas about treatment and its perspective to control their illness.⁹ Mutual relationships between treatment beliefs and illness perception are in a central position of an extended version of Leventhal's self-regulatory model confirmed by empirical studies on several groups of patients.^{2,30,31}

Second, perception refers to self. MS generally reduces self-esteem,³² which in turn influences one's beliefs on the self-capabilities required to manage prospective situations expressed on a self-efficacy level. Higher self-efficacy has been shown to predict improved health status during inpatient rehabilitation and steroid treatment for relapses.³³ In other studies, self-efficacy has been reported to be a predictor of adherence to Copaxone therapy in individuals with relapsing-remitting MS³⁴ and glatiramer acetate therapy in individuals with progressive forms of MS.³⁵ According to other studies, self-efficacy and self-esteem were significantly associated with self-management in MS patients.³⁶ Surprisingly, we were not able to find any studies analyzing the relationship between self-appraisals and treatment beliefs in MS patients.

According to Horne,³⁷ a better understanding of how people perceive treatments will improve their ability to operationalize theories of self-regulation and enhance their power to explain variations in adherence and to guide the development of interventions to improve the use of health care resources. Our

research is an attempt to expand knowledge in this area. The aim of the study was to examine the relationship between perception of impact of MS and treatment efficacy beliefs in patients with MS and the extent to which self and illness appraisals can be regarded as mediator variables in this relationship.

Methods

Participants and Procedure

Participants of this study were recruited through the cooperation of the Multiple Sclerosis Rehabilitation Center in Borne Sulinowo and the Polish Society of Multiple Sclerosis between November 2012 and July 2015. The data used in the study were from a larger study and was not collected with the goal of testing this particular conceptual model. The study included a convenience sample of 278 individuals diagnosed with MS, confirmed by a neurologist. The inclusion criteria were as follows: 1) lack of MS exacerbation at the time of the study and during four preceding weeks, 2) no current alcohol/drug abuse, 3) no previously diagnosed mental disorders, 4) lack of other comorbidities, and 5) absence of MS-related cognitive problems, as confirmed by a neurologist. All individuals meeting the inclusion criteria were approached. The patients were assured that their data will be treated as confidential. All the tools were administered face-to-face by research team members in collaboration with a neurologist. The group consisted of inpatients' sample ($n = 209$) and outpatients' sample ($n = 69$). Patients from inpatients' sample were recruited during their three-week stay at a rehabilitation center. Every second person from the list of current patients was invited into the study. Following consent, the respondents were interviewed individually after rehabilitation in their own rooms. Patients from outpatients' sample were selected by a social worker from the list of patients affiliated with the Polish Society of Multiple Sclerosis (list of patients from the Greater Poland province) and examined individually in their homes by a social worker. Of 364 patients invited into the study, 39 refused to participate, 13 withdrew during the survey, and 34 were excluded because of missing data.

Measures

In this study analysis, the dependent variable was treatment beliefs assessed with the Treatment Beliefs Scale developed for this study to examine one's perceptions of anti-MS treatment effectiveness. The Treatment Beliefs Scale was modeled on the Outcome Expectancy Scale used by Ferrier et al.³⁸ in a group of MS patients. Several changes have been made to adapt the tool to measure the

treatment efficacy beliefs. The scale consists of eight statements preceded by: *How confident are you that if you adhere to all your medical requirements and follow your treatment plan ...* Sample statements are: *Your overall health will improve* or *You will have (or restore) the correct muscle tension*. The individual statements referred to the most common problems arising from MS (such as fatigue, balance, vision, feeling, speech, and coordination).¹² Each item consists of five response choices, ranging from 1 (*not at all*) to 5 (*completely*). The global score is represented by the sum of scores for the eight items (range 8–40), with higher scores corresponding to positive treatment efficacy beliefs. Statistical analysis showed the one-dimensionality of the scale. Factor analysis, where factors were separated on the basis of the Kaiser criterion and the Cattell's scatter plot, allowed to isolate one factor explaining 74.19% of the variability. The instrument used in our study had a high internal consistency rate (Cronbach $\alpha = 0.95$).

The independent variable was the impact of MS measured with the physical subscale of Multiple Sclerosis Impact Scale 29 (MSIS-29),³⁹ a popular self-reported measure designed to assess the patients' views about the impact of MS on their lives during the past two weeks. The MSIS-29 physical subscale consists of 20 questions related to one's functional ability. Each item is scored on a five-point Likert scale, with higher scores corresponding to worse physical conditions (range 20–100). Previous studies showed that MSIS-29 constitutes an accurate, valid, and sensitive measure suitable for the examination of both community- and hospital-based samples.^{40,41} In our study, MSIS-29 demonstrated a high internal consistency rate (Cronbach $\alpha = 0.93$).

For mediating variables, we used three well-established measurement tools. Illness perception was assessed with the Brief Illness Perception Questionnaire (B-IPQ)⁴² based on the Leventhal Commonsense Model of Illness.⁴³ The B-IPQ consists of eight items graded on a linear 0–10 response scale used to measure cognitive and emotional illness representation. Higher and lower B-IPQ scores correspond to a more threatening and more positive view of MS, respectively. The internal consistency rate of the B-IPQ used in this study was 0.89. General self-efficacy was measured with the General Self-Efficacy Scale (GSES),⁴⁴ a widely-used 10-item psychometric scale designed to assess optimistic self-beliefs to cope with a variety of difficult demands in life. The GSES consists of 10 items scored on a four-point scale, from 1 (*not at all true*) to 4 (*exactly true*), with higher scores corresponding to higher self-efficacy. The internal consistency rate of GSES in our sample amounted to 0.91. To measure global self-esteem, we used the Rosenberg Self-

Esteem Scale.⁴⁵ The instrument includes 10 items, each rated on a four-point scale. The higher the cumulative Rosenberg Self-Esteem Scale score, the greater one's self-esteem. The internal consistency rate of the instrument used in this study was 0.84.

In addition, a standardized questionnaire was used to obtain patient demographics and clinical data. Personal characteristics of the patients, such as gender, age, and educational level, were documented. The list of clinical data included duration of the illness, MS subtype, medication, route of anti-MS drug administration, and general medical condition determined with the Expanded Disability Status Scale (EDSS) conducted by a neurologist. EDSS is the most widely used scale to assess disease progression and neurological impairment, which ranges from EDSS 0 (normal neurologic examination) to EDSS 10 (death due to MS) in half-point increments from EDSS 1.

Statistical Analysis

The analysis was performed using SPSS, version 25 (IBM SPSS Statistics 25; IBM Corp., Armonk, NY). To verify the purpose of the study, the mediation analysis was performed using PROCESS Macro for SPSS and materials presented by Hayes.⁴⁶ The analysis was performed with three mediators (illness perception, self-efficacy, and self-esteem) and two covariates (age and time from diagnosis). The impact of MS was assumed as an independent variable and treatment beliefs were assumed as a dependent variable. For indirect effects, 95% CIs were determined using percentile bootstrapping (5000 bootstrap samples were used). In addition, the completely standardized indirect effects were presented as a measure of effect size.

Some of the obtained effects may disappear after introducing additional variables to the model. Therefore, it was decided to conduct a preliminary analysis to search for potential covariates. Several variables have been considered that are potentially significant to variables in our model, especially for dependent variable (treatment beliefs). Therefore, before testing the hypotheses regarding the associations between the impact of MS and perceptions of treatment, self, and illness, we investigated the relationships between age, time from diagnosis, type of MS, medication, route of anti-MS drug administration, and treatment efficacy beliefs to examine whether we should control for these variables in future analyses. To assess the relationship between age, time from diagnosis, and treatment beliefs, Pearson correlation coefficient r was used. To compare people with different type of MS and route of anti-MS drug administration in terms of level treatment beliefs, one-way analysis of variance was used. Because of large discrepancies in the size of the groups, we could not analyze the relationship

between medication type and treatment efficacy beliefs. After all, dependent variable (treatment efficacy beliefs) was found to be significantly correlated only with age and time from diagnosis (respectively: $r = -0.18$, $P < 0.01$; $r = -0.12$, $P < 0.05$). As these two factors turned out to be related to treatment efficacy beliefs, they were used as covariates during further analyses.

Results

Group Characteristics

The study group included 182 women and 96 men with a mean age of 48 years. Most participants were married (57.2%), 8.5% were widowed, 11% divorced, 1.1% separated, and 22.3% had never married. With respect to education, 14.2% of the participants reported having primary or vocational education, 36.7% reported having secondary education, and 49.1% had higher education. Less than half of the participants were currently employed (33.2%), with the remaining 66.8% self-identifying as retired (14.5%), receiving disability pension (47.7%), or otherwise unemployed (4.6%). Clinical parameters of the study participants are summarized in [Table 1](#).

Mediation Analysis

In line with the main aim of this study, the meditation model was tested ([Fig. 1](#)). Effect of impact of MS on treatment beliefs statistically controlling for age and time from diagnosis was reported to be significant (total effect in analyzed mediation model: $B = -0.06$, $P < 0.05$). Illness perception mediated the relationship between impact of MS and treatment beliefs under the control of age and time from diagnosis. There was a positive relationship between impact of MS and illness perception of the disease ($B = 0.25$, $P < 0.001$) and the negative relationship between illness perception and treatment beliefs ($B = -0.21$, $P < 0.001$) ([Fig. 1](#)). The indirect effect was also statistically significant: -0.054 95% CI $[-0.0803, -0.0293]$ (standardized effect: -0.137 95% CI $[-0.2029, -0.0739]$; [Table 2](#)).

General self-efficacy was also a significant mediator under the control of age and time from diagnosis: a negative relationship between impact of MS and general self-efficacy was observed ($B = -0.15$, $P < 0.001$) and a positive relationship between general self-efficacy and treatment beliefs was observed ($B = 0.23$, $P < 0.05$) ([Fig. 1](#)). The indirect effect was statistically significant: -0.034 95% CI $[-0.0657, -0.0064]$ (standardized effect: -0.086 95% CI $[-0.1663, -0.0165]$).

Self-esteem did not appear to be a significant mediator. The relationship between self-esteem and beliefs

Table 1
Clinical Characteristics of the Study Participants

Clinical Characteristic	MS Patients (n = 278)
Time from diagnosis (years ± SD)	13.4 ± 9.2
Type of MS, n (%)	
RRMS	89 (32)
PPMS	71 (25.5)
SPMS	64 (23)
PRMS	24 (8.6)
DKMS	29 (10.4)
Medication	
Interferon beta 1b (Betaseron)	12 (4.3)
Interferon beta 1a (Avonex)	7 (2.5)
Interferon beta 1a (Rebif)	4 (1.4)
Glatiramer (Copaxone)	11 (3.9)
Mitoxantrone	7 (2.5)
Natalizumab	6 (2.1)
Others	108 (38.8)
Unknown	123 (44.2)
Route of anti-MS drug administration (%)	
Subcutaneous injection	34 (12.2)
Intramuscular injection	18 (6.5)
Oral	99 (35.6)
Other	127 (45.7)
Disability level according to EDSS, n (%)	
Mild (EDSS ≤ 3.5)	35 (12.6)
Moderate (3.5 < EDSS ≤ 6.5)	192 (69)
High (EDSS > 6.5)	51 (18.4)

MS = multiple sclerosis; RRMS = Relapsing-remitting MS; PPMS = Primary progressive MS; SPMS = Secondary progressive MS; PRMS = Progressive-relapsing MS; DKMS = did not know their type of MS; EDSS = Expanded Disability Status Scale.

about treatment was not statistically significant (Fig. 1). The indirect effect was also not statistically significant: 0.003 95% CI [−0.0227, 0.0313] (standardized effect: 0.008 95% CI [−0.0574, 0.0782]; Table 2).

Effect of impact of MS on treatment efficacy beliefs controlling for age and time from diagnosis was not statistically significant after including mediators (direct effect: $B = 0.02$, $P > 0.05$).

Summarizing, the obtained results indicate relationship between perception of MS impact and treatment efficacy beliefs mediated by general self-efficacy and illness perception under the control of age and time from diagnosis.

Discussion

The preliminary aim of this study was to analyze the relationship between perception of MS impact and treatment efficacy beliefs. The results of our study indicate that worse perception of physical condition in patients with MS is associated with more negative treatment efficacy beliefs. This is in line with our hypothesis, supported by studies in other patient groups where researchers have shown that symptoms can function as evidence for or against treatment efficacy.^{24,47} Our research clearly indicates that MS does not differ in this area from other diseases.

A key finding of our study refers to the mediating effect of self and illness appraisals in the analyzed relationship. Specifically, our study indicates that part of

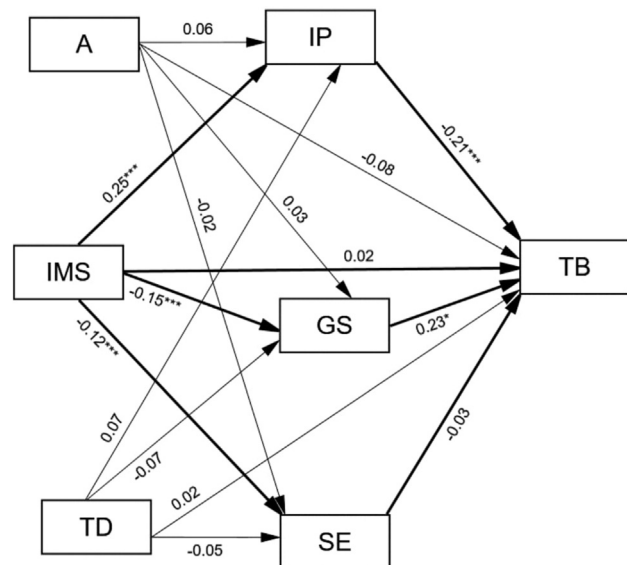


Fig. 1. IP, GS, and SE as mediators between IMS and TB, with A and TD as covariates. IP = illness perception; GS = general self-efficacy; SE = self-esteem; IMS = impact of multiple sclerosis; TB = treatment beliefs; A = age; TD = time from diagnosis.

the association between the impact of MS on physical condition treatment efficacy beliefs is mediated by illness perception. This is the expected result as many previous studies have shown a relationship between illness perception and treatment necessity beliefs,¹ beliefs about medicines,²⁹ and adherence to medication and treatment recommendations.⁴⁸

Illness perception has also been associated with physical functioning within a range of chronic conditions;^{49–51} however, few studies have provided opposite results,^{52,53} indicating that illness beliefs cannot be explained by disease status. Our results support this group of evidence that assumes that patients' perceptions of their illness may be a function of disease severity, considering that we are not talking about objective evaluation but subjective assessment of the impact of MS on physical condition. These findings seem to support the hypothesis that patients' models of their illness are strongly influenced by the interpretation of symptoms⁵⁴ and related to treatment efficacy beliefs.

According to oneself, self-efficacy was found to partially mediate the analyzed relationship. Patients with a worse MS impact might have lower levels of self-efficacy, which in turn might lead to lower levels of treatment efficacy beliefs. These findings suggest that interventions focusing on both treatment efficacy beliefs and self-efficacy might be more useful than interventions that only target one of these. Previous research indicated that the beliefs of treatment effectiveness and self-efficacy were both important predictors of self-management in patients with diabetes mellitus.⁵⁵ In other studies, self-efficacy and

Table 2
Indirect Effects With 95% CI for Particular Mediators

Mediators	Indirect Effects/Standardized Indirect Effects
Illness perception	-0.054 [-0.0803, -0.0293]/-0.137 [-0.2029, -0.0739]
General self-efficacy	-0.034 [-0.0657, -0.0064]/-0.086 [-0.1663, -0.0165]
Self-esteem	0.003 [-0.0227, 0.0313]/0.008 [-0.0574, 0.0782]
Total	-0.085 [-0.1216, -0.0520]/-0.216 [-0.3049, -0.1301]

perception that treatment can control disease were among the most important correlates of self-management in MS.³⁶ Self-efficacy also has been shown to predict adherence to therapies similar to perceived treatment effectiveness.^{56,57} Our results support the hypothesis stated by Schuz et al.,⁵⁸ according to which, self-efficacy positively affects the degree to which treatment is perceived to help with a specific illness; this in turn might improve self-management. In other words, self-efficacy-promoting interventions should be developed among patients with MS to strengthen treatment efficacy beliefs that will consequently—based on well-established knowledge—lead to better treatment adherence.

In our model, self-esteem did not reach statistical significance as a mediating factor although it was significantly correlated with the impact of MS on physical condition and treatment efficacy beliefs. This may indicate a lesser importance of this factor in shaping beliefs about treatment; however, the final solution to this problem requires more in-depth research.

There are also practical implications to our studies. Choosing the most appropriate treatment for individual patients with MS can be challenging, and clinical guidelines recommend taking into account patients' preferences. However, research indicates that MS physicians frequently do not involve their patients in treatment decisions despite the fact that most MS patients prefer a collaborative approach to the treatment process.^{59,60} This may be due to a lack of knowledge about the importance of cognitive factors in shaping the patient's approach to treatment. Our research provides needed knowledge for this area.

Specifically, patients who are experiencing serious consequences from their condition usually create negative beliefs about treatment efficacy; however, to inhibit the growth of these beliefs, specialists can work on improving the appraisal of self-efficacy. This intervention should focus on modeling, observational learning, planning alternative strategies, and training for internal self-regulation. Our findings also support the hypothetical idea that it is possible to improve treatment efficacy beliefs through the enhancement of positive illness perception for those with a worse

impact of MS. This could be done with the aid of appropriate cognitive-behavioral techniques. An awareness of patients' perceptions of treatment efficacy and all the associated illness perceptions and self-appraisals offers the potential for a better understanding of patients' responses to illness and treatment with major implications for research and practice, especially in the field of improving adherence, compliance, and persistence with treatment.

This study has several potentially important limitations. As it has used cross-sectional data, causal relationships between the impact of MS on physical condition, self-efficacy, illness perception, and treatment efficacy beliefs could not be established. Consequently, future research should focus on causality. Moreover, we excluded patients in aggressive phases of the disease (in cases of relapsing-remitting type of MS), with cognitive problems, and with other comorbidities. The group consisted mostly of a moderate-degree disability (69% of them had EDSS 3.5–6.5). We are aware that all these factors may affect the result; therefore, extrapolation of current results to more diverse populations should be conducted with caution. What is also important is that the analyzed data in this study were obtained via self-report, which may be a source of considerable bias. We also used a one-shot questionnaire survey that always poses a risk for falsification of results because people have a tendency to respond with an inflated degree of consistency. Finally, we cannot exclude the impact of other sociodemographic, situational, and personal factors on the results. It is well known that such factors, such as attitudes toward drugs in general, the opinions of other patients and family members, and information obtained from the Internet, play important roles in creating patients' perceptions of treatment efficacy.⁶¹ We also did not control for such a significant variable as the side effects of treatment. Side effects are one of the main causes of treatment nonadherence.²⁰ Patients often have difficulty distinguishing MS symptoms from side effects of treatment, which may significantly influence the assessment of treatment efficacy. We also failed to analyze the relationship between treatment efficacy beliefs and the type of medication, which is of great importance in the context of the various side effects. This problem should be addressed during future studies.

Conclusion

Our results indicate that worse perception of physical condition in patients with MS is associated with more negative treatment efficacy beliefs, and that this association is mediated by self-efficacy and illness perception. These findings are encouraging because they suggest that negative treatment efficacy beliefs

(often considered as a major barrier to MS treatment adherence) may be improved by interventions aimed to correct negative beliefs about illness and self.

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References

1. Michetti P, Weinman J, Mrowietz U, et al. Impact of treatment-related beliefs on medication adherence in immune-mediated inflammatory diseases: results of the global ALIGN study. *Adv Ther* 2017;34:91–108.
2. Horne R, Weinman J. Self-regulation and self-management in asthma: exploring the role of illness perceptions and treatment beliefs in explaining non-adherence to preventer medication. *Psychol. Health* 2002;17:17–32.
3. Butler JA, Peveler RC, Roderick P, Smith PW, Horne R, Mason JC. Modifiable risk factors for non-adherence to immunosuppressants in renal transplant recipients: a cross-sectional study. *Nephrol Dial Transpl* 2004;19:3144–3149.
4. Neame R, Hammond A. Beliefs about medications: a questionnaire survey of people with rheumatoid arthritis. *Rheumatology* 2005;44:762–767.
5. Sjölander M, Eriksson M, Glader EL. The association between patients' beliefs about medicines and adherence to drug treatment after stroke: a cross-sectional questionnaire survey. *BMJ Open* 2013;3:e003551.
6. Becker MH. The health belief model and personal health behavior. *Health Educ Monogr* 1974;2:376–423.
7. Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? *J Health Soc Behav* 1995;36:1–10.
8. Leventhal H, Meyer D, Nerenz D. The common sense representation of illness danger. In: Rachman S, ed. *Medical psychology*. New York: Pergamon Press, 1980:7–30.
9. Horne R. Patients' beliefs about treatment: the hidden determinant of treatment outcome? *J Psychosom Res* 1999;47:491–495.
10. Montori VM, Brito JP, Murad MH. The optimal practice of evidence-based medicine: incorporating patient preferences in practice guidelines. *JAMA* 2013;310:2503–2504.
11. Barry MJ, Edgman-Levitan S. Shared decision making – pinnacle of patient-centered care. *N Engl J Med* 2012;366:780–781.
12. McDonald WI, Compston A, Edan G, et al. Recommended diagnostic criteria for multiple sclerosis: guidelines from the international panel on the diagnosis of multiple sclerosis. *Ann Neurol* 2001;50:121–127.
13. Finkelsztejn A. Multiple sclerosis: overview of disease-modifying agents. *Perspect Medicin Chem* 2014;6:65–72.
14. Reynolds MW, Stephen R, Seaman C, Rajagopalan K. Persistence and adherence to disease modifying drugs among patients with multiple sclerosis. *Curr Med Res Opin* 2010;26:663–674.
15. Bruce JM, Hancock LM, Lynch SG. Objective adherence monitoring in multiple sclerosis: initial validation and association with self-report. *Mult Scler* 2010;16:112–120.
16. Wong J, Gomes T, Mamdani M, Manno M, O'Conner P. Adherence to multiple sclerosis disease-modifying therapies in Ontario is low. *Can J Neurol Sci* 2011;38:429–433.
17. Treadaway K, Cutter G, Salter A, et al. Factors that influence adherence with disease-modifying therapy in MS. *J Neurol* 2009;256:568–576.
18. Tremlett HL, Oger J. Interrupted therapy: stopping and switching of the beta-interferons prescribed for MS. *Neurology* 2003;61:551–554.
19. Río J, Porcel J, Téllez N, et al. Factors related with treatment adherence to interferon- β and glatiramer acetate therapy in multiple sclerosis. *Mult Scler* 2005;11:306–309.
20. O'Rourke KE, Hutchinson M. Stopping beta-interferon therapy in multiple sclerosis: an analysis of stopping patterns. *Mult Scler* 2005;11:46–50.
21. Ruggieri RM, Settipani N, Viviano L, et al. Long-term interferon- β treatment for multiple sclerosis. *Neurol Sci* 2003;24:361–364.
22. Syed M, Rog D, Parkes L, Shepherd GL. Patient expectations and experiences of multiple sclerosis interferon β -1a treatment: a longitudinal, observational study in routine UK clinical practice. *Patient Prefer Adher* 2014;8:247–255.
23. Leventhal EA, Prohaska TR. Age, symptom interpretation, and health behavior. *J Am Geriatr Soc* 1986;34:185–191.
24. Siegel K, Schrimshaw EW, Dean L. Symptom interpretation and medication adherence among late middle-age and older HIV-infected adults. *J Health Psychol* 1999;4:247–256.
25. Patti F. Optimizing the benefit of multiple sclerosis therapy: the importance of treatment adherence. *Patient Prefer Adher* 2010;4:1–9.
26. Jopson NM, Moss-Morris R. The role of illness severity and illness representations in adjusting to multiple sclerosis. *J Psychosom Res* 2003;54:503–511.
27. Mullins LL, Cote MP, Fuemmeler BF, Jean VM, Beatty WW, Paul RH. Illness intrusiveness, uncertainty, and distress in individuals with multiple sclerosis. *Rehabil Psychol* 2001;46:139–153.
28. Dennison L, Moss-Morris R, Chalder T. A review of psychological correlates of adjustment in patients with multiple sclerosis. *Clin Psychol Rev* 2009;29:141–153.
29. Nicklas LB, Dunbar M, Wild M. Adherence to pharmacological treatment of non-malignant chronic pain: the role of illness perceptions and medication beliefs. *Psychol Health* 2010;25:601–615.

30. Ross S, Walker A, MacLeod MJ. Patient compliance in hypertension: role of illness perceptions and treatment beliefs. *J Hum Hypertens* 2004;18:607–613.
31. Byrne M, Walsh J, Murphy AW. Secondary prevention of coronary heart disease: patient beliefs and health-related behavior. *J Psychosom Res* 2005;58:403–415.
32. Vaughan R, Morrison L, Miller E. The illness representation of multiple sclerosis and their relation to outcome. *Br J Health Psychol* 2003;8:287–301.
33. Riazi A, Thompson AJ, Hobart JC. Self-efficacy predicts self-reported health status in multiple sclerosis. *Mult Scler* 2004;10:61–66.
34. Fraser C, Hadjimichael O, Vollmer T. Predictors of adherence to Copaxone therapy in individuals with relapsing-remitting multiple sclerosis. *J Neurosci Nurs* 2001;33:231–239.
35. Fraser C, Hadjimichael O, Vollmer T. Predictors of adherence to Glatiramer Acetate therapy in individuals with self-reported progressive forms of multiple sclerosis. *J Neurosci Nurs* 2003;35:163–170.
36. Wilski M, Tasiemski T. Illness perception, treatment beliefs, self-esteem, and self-efficacy as correlates of self-management in multiple sclerosis. *Acta Neurol Scand* 2016;133:338–345.
37. Horne R. Treatment perceptions and self-regulation. In: Cameron LD, Leventhal H, eds. *The self-regulation of health and illness behavior*. New York: Routledge, 2003: 138–153.
38. Ferrier S, Dunlop N, Blanchard C. The role of outcome expectations and self-efficacy in explaining physical activity behaviors of individuals with multiple sclerosis. *Behav Med* 2010;36:7–11.
39. Hobart J, Lamping D, Fitzpatrick R, Riazi A, Thompson A. The Multiple Sclerosis Impact Scale (MSIS-29): a new patient-based outcome measure. *Brain* 2001; 124:962–973.
40. Hoogervorst EL, Zwemmer J, Jelles B, Polman CH, Uitdehaag BM. Multiple Sclerosis Impact Scale (MSIS-29): relation to established measures of impairment and disability. *Mult Scler* 2004;10:569–574.
41. Riazi A, Hobart JC, Lamping DL, Fitzpatrick R, Thompson AJ. Evidence-based measurement in multiple sclerosis: the psychometric properties of the physical and psychological dimensions of three quality of life rating scales. *Mult Scler* 2003;9:411–419.
42. Broadbent E, Petrie KJ, Main J, Weinman J. The brief illness perception questionnaire. *J Psychosom Res* 2006;60: 631–637.
43. Leventhal H, Meyer D, Nerenz D. The commonsense representation of illness danger. In: Rachman S, ed. *Contributions to medical psychology*, 2. New York: Pergamon Press, 1980:17–30.
44. Schwarzer R, Jerusalem M. Generalized self-efficacy scale. In: Weinman J, Wright S, Johnston M, eds. *Measures in health psychology: a user's portfolio. Causal and control beliefs*. Windsor, UK: Nfer-Nelson, 1995:35–37.
45. Rosenberg M. *Society and the adolescent self-image*. Wesleyan University Middletown, CT Press, 1989.
46. Hayes AF. *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: The Guilford Press, 2013.
47. Phillips LA, Leventhal H, Leventhal EA. Assessing theoretical predictors of long-term medication adherence: patients' treatment-related beliefs, experiential feedback, and habit development. *Psychol Health* 2013;28:1135–1151.
48. Petrie KJ, Jago LA, Devcich DA. The role of illness perceptions in patients with medical conditions. *Curr Opin Psychiatr* 2007;20:163–167.
49. Scharloo M, Kaptein AA, Schlösser M, et al. Illness perceptions and quality of life in patients with chronic obstructive pulmonary disease. *J Asthma* 2007;44:575–581.
50. Scharloo M, Baatenburg de Jong RJ, Langeveld TP, van Velzen-Verkaik E, Doorn-op den Akker MM, Kaptein AA. Quality of life and illness perceptions in patients with recently diagnosed head and neck cancer. *Head Neck* 2005;27:857–863.
51. Rutter CL, Rutter DR. Illness representation, coping, and outcome in irritable bowel syndrome (IBS). *Br J Health Psychol* 2002;7:377–391.
52. Carlisle ACS, John AMH, Fife-Schaw C, Lloyd M. The self-regulatory model in women with rheumatoid arthritis: relationships between illness representations, coping strategies, and illness outcome. *Br J Health Psychol* 2005;10: 571–587.
53. Graves H, Scott DL, Lempp H, Weinman J. Illness beliefs predict disability in rheumatoid arthritis. *J Psychosom Res* 2009;67:417–423.
54. Pennebaker JW. *The psychology of physical symptoms*. New York: Springer, 1982.
55. Rahimian Boogar E, Besharat MA, Mohajeri Tehrani M, Talepasand S. Predictive role of self-efficacy, belief of treatment effectiveness and social support in diabetes mellitus self-management, Iran. *J Psychiat Clin Psychol* 2011;17: 232–240.
56. Zwibel H, Pardo G, Smith S, Denney D, Oleen-Burkey M. A multicenter study of the predictors of adherence to self-injected glatiramer acetate for treatment of relapsing-remitting multiple sclerosis. *J Neurol* 2011;258:402–411.
57. Fraser C, Morgante L, Hadjimichael O, Vollmer T. A prospective study of adherence to glatiramer acetate in individuals with multiple sclerosis. *J Neurosci Nurs* 2004;36: 120–129.
58. Schuz B, Wurm S, Warner L, Ziegelmann JP. Self-efficacy and multiple illness representations in older adults: a multi-level approach. *Psychol Health* 2012;27:13–29.
59. Bruce J, Bruce A, Lynch S, et al. A pilot study to improve adherence among MS patients who discontinue treatment against medical advice. *J Behav Med* 2016;39:276–287.
60. Pietrolongo E, Giordano A, Kleinfeld M, Confalonieri P, Lugaresi A, Tortorella C. Decision-making in multiple sclerosis consultations in Italy: third observer and patient assessments. *PLoS One* 2013;8:e60721.
61. Iudici M, Russo B, Mitidieri M, Cuomo G, Valentini G. Glucocorticoids in systemic sclerosis: patients' beliefs and treatment adherence. *Scand J Rheumatol* 2015;44:229–237.