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ORIGINAL ARTICLE

Self-reported work productivity in people with multiple sclerosis and its association with mental and physical health

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ABSTRACT

Purpose: This study aimed to identify mental health, physical health, demographic and disease characteristics relating to work productivity in people with multiple sclerosis (MS).

Methods: In this cross-sectional study, 236 employed people with MS (median age = 42 years, 78.8% female) underwent neurological and neuropsychological assessments. Additionally, they completed questionnaires inquiring about work productivity (presenteeism: reduced productivity while working, and absenteeism: loss of productivity due to absence from work), mental and physical health, demographic and disease characteristics. Multiple linear and logistic regression analyses were performed with presenteeism and absenteeism as dependent variables, respectively.

Results: A model with mental and physical health factors significantly predicted presenteeism $F(11,202) = 11.33$, $p < 0.001$, $R^2 = 0.38$; a higher cognitive ($p < 0.001$) and physical impact ($p = 0.042$) of fatigue were associated with more presenteeism. A model with only mental health factors significantly predicted absenteeism; $\chi^2(11)=37.72$, $p < 0.001$, with $R^2 = 0.27$ (Nagelkerke) and $R^2 = 0.16$ (Cox and Snell). Specifically, we observed that more symptoms of depression ($p = 0.041$) and a higher cognitive impact of fatigue ($p = 0.011$) were significantly associated with more absenteeism.

Conclusions: In people with MS, both cognitive and physical impact of fatigue are positively related to presenteeism, while symptoms of depression and cognitive impact of fatigue are positively related to absenteeism.

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Multiple sclerosis; employment; work; fatigue; depression

➤ IMPLICATIONS FOR REHABILITATION

- Multiple sclerosis (MS) affects people of working age, significantly interfering with work productivity.
- Higher cognitive and physical impact of fatigue were associated with more presenteeism in workers with MS.
- A higher cognitive impact of fatigue and more depressive symptoms were associated with absenteeism in workers with MS.
- Occupational and healthcare professionals should be aware of the impact of both physical and mental health on work productivity in workers with MS.

Introduction

Multiple sclerosis (MS) is a chronic, often invalidating disease that may cause occupational difficulties. In a recent Australian study, more than half of the people with MS experienced work productivity loss due to MS [1].

While previous research on MS and work mainly focused on the distinction between employed and unemployed people with MS, recent research highlights the substantial costs of work productivity loss due to physical absence from work (i.e., absenteeism) and reduced productivity while working (i.e., presenteeism) in

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people with MS [1]. Presenteeism is defined as a reduction in work productivity as a consequence of health problems [2]. The focus on work productivity instead of employment status is essential to determine the real socio-economic impact of the disease and enable the development of proper interventions and assistance to prevent unemployment in people with MS.

The cause of work productivity loss due to presenteeism and absenteeism in people with MS is multifaceted. Positive associations have been reported between presenteeism and absenteeism on the one hand and disability, fatigue, pain, cognitive dysfunctioning, and poor mental health on the other hand [1,3–6]. Only one study observed a relationship between demographics and work productivity, in that age was negatively related to presenteeism (only for lower presenteeism) [3]. Still a lot of variance in presenteeism and absenteeism remains unexplained [1,4]. Additionally, research on factors contributing to work productivity yielded contradictory results. For instance, in terms of mental health, some studies found that both anxiety and depression are predictive of presenteeism [1,4], while other studies failed to replicate this effect [3].

Moreover, although most studies on work productivity incorporate mental health, this is mostly restricted to symptoms of fatigue, anxiety and depression or cognitive dysfunctioning [1,3]. Another factor related to both employment and mental health is coping [7–9]. Coping style can be defined as cognitive and behavioural efforts to manage external and internal demands that are considered to be taxing or exceeding one's resources [7]. A broad distinction can be made between task-oriented coping, emotion-oriented coping and avoidance-oriented coping. The existing literature on coping in a work setting suggests that an avoidance-oriented coping style is negatively associated with employment status in people with MS [7,8,10]. Only a few studies have been conducted relating coping style to work productivity or work functioning. In people with MS, an association was found between more emotion-oriented coping and more negative work events [9]. In healthy workers, more avoidant coping was associated with more absenteeism, while the usage of a problem-solving coping style was related to less absenteeism [11].

In view of the above, the aim of the current study was to examine factors associated with presenteeism, absenteeism or both. Identifying factors related to work functioning is beneficial for the development of strategies to support individual people with MS in the working environment [1]. We distinguished three kinds of predictors, namely mental health, physical health, and demographic and disease characteristics. The premise was that there was a positive relationship between both absenteeism and presenteeism and mental health factors, i.e., symptoms of depression and anxiety, the cognitive impact of fatigue, the psychosocial impact of fatigue, avoidance-oriented coping and emotion-oriented coping. We expected a negative relationship between both presenteeism and absenteeism and task-oriented coping and information processing speed. Furthermore, we expected positive relationships between both presenteeism and absenteeism and physical health factors such as disability, the physical impact of fatigue and pain. Finally, we examined the relationship between presenteeism, absenteeism and demographic and disease related factors (age, gender, education, and disease duration).

Methods

Participants

For the current study, we included 236 employed people with remitting–relapsing MS who participated in the MS@Work study [12], a longitudinal study focusing on factors related to work participation in people with MS. Two hundred and eighty people with MS participated in the MS@Work in general (at baseline). Eligible for inclusion in the MS@Work study were people with MS with a diagnosis of relapsing-remitting MS according to the Polman-McDonald criteria [13], being 18 years or older and being in paid (self-)employment or within three years since last employment. We excluded participants not in paid employment ($N = 21$), and participants who did not complete questionnaires concerning mental and physical well-being ($N = 23$). Exclusion criteria for the MS@Work study in general were the presence of co-morbid psychiatric and other neurological disorders, active substance abuse, presence of neurological impairment that might interfere with cognitive testing (i.e., visual impairment), and non-proficiency of the Dutch language.

The study was approved by the Medical Ethical Committee Brabant (NL43098.008.12 1307). All participants provided written informed consent. The current research is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [14].

Study procedure

Participants had four yearly neurological and neuropsychological assessments, and completed online questionnaires five times: at baseline, and at 6 months, 1, 2, and 3 years. The questionnaires contained questions concerning demographic characteristics, symptoms indicative of depression and anxiety, coping styles, fatigue, pain, and employment measures. The current study is based on data acquired at baseline.

Measures

Work productivity

To assess presenteeism, participants were asked whether they experienced impairment at work due to their MS (presenteeism: Work Productivity and Activity Impairment Questionnaire) [15,16]. The Work Productivity and Activity Impairment Questionnaire has proven to be a valid measurement of work productivity impairment in people with chronic disorders [16,17]. The isolated presenteeism score was strongly associated with health outcomes in studies with people with rheumatoid arthritis [16]. Scores range from 1 to 100% and a higher score reflects more presenteeism.

To examine absenteeism, a single item was used inquiring about absence from the work place due to MS in the last seven days (in hours), based on the Work Productivity and Activity Impairment Questionnaire [15]. Due to the data distribution, we considered absenteeism to be a dichotomous variable (with 0 being no absenteeism, and 1 being absent from work due to MS for minimally one hour in the past seven days).

Mental health

Depression and anxiety symptoms were assessed with the Hospital Anxiety and Depression Scale [18]. The Hospital Anxiety and Depression Scale is a 14-item self-report scale (seven items on anxiety and seven items on depression, with the scores per domain ranging from 0 to 21) with higher scores being indicative of more symptoms of depression and anxiety.

The Coping Inventory for Stressful Situations was administered to examine preferred coping styles [19,20]. The Coping Inventory for Stressful Situations is a 48-item self-report questionnaire that differentiates between three main coping styles: task-oriented coping, emotion-oriented coping, and avoidance-oriented coping. The scores on each subscale range from 16 to 80. A higher score indicates a more frequent usage of a particular coping style.

To measure information processing speed, we asked participants to complete the written version of the Symbol Digit Modalities Test [21]. Possible total scores range from 0 to 110, with higher scores being reflective of a higher information processing speed.

Physical health

MS-related disability was measured using the Expanded Disability Status Scale [22]. The Expanded Disability Status Scale was administered by a neurologist and higher scores are indicative of more disability due to MS, with scores ranging from 0 to 10.

Impact of fatigue was assessed using the Modified Fatigue Impact Scale-21 [23], a 21-item self-report scale that measures the impact of fatigue on daily functioning. The Modified Fatigue Impact Scale-21 has three subscales namely, the impact of fatigue on physical functioning, the impact of fatigue on cognitive functioning, and the impact of fatigue on psychosocial functioning. We included the physical impact of fatigue in the physical health factors, while including the cognitive- and psychosocial impact of fatigue in the psychological factors. Higher scores reflect a greater impact of fatigue. The scores on the subscale physical impact range from 0 to 36, on the subscale cognitive impact from 0 to 40, and on the psychosocial impact from 0 to 8.

Pain was measured using the pain subscale of the Multiple Sclerosis Quality of Life-54 [24]. The scores range from 0 to 100. A higher score is indicative of less pain.

Demographics and disease characteristics

We recorded demographic data on age, gender and educational level. Educational level was divided into three levels: low level education (finished low-level secondary school), middle level education (finished secondary school at a medium level), and high level education (finished secondary school at the highest level and/or obtained a college/university degree). In terms of disease characteristics, we asked participants for their disease duration.

Statistical analysis

First, we performed correlation analyses for both outcome measures, i.e., Spearman's correlations for presenteeism and point-biserial correlations for absenteeism.

Thereafter, presenteeism data were analysed using a block-wise, hierarchical regression analysis, entering the variables in a sequential order. The independent variables were entered into the model in three blocks. The first block contained mental health (symptoms of depression and anxiety, coping styles, the cognitive impact of fatigue, the psychosocial impact of fatigue and information processing speed). The second block added physical health (MS-related disability and the physical impact of fatigue). Finally, in the third block demographic and disease characteristics (gender, age, education, and disease duration) were entered into the model.

In addition, we performed a quantile regression for presenteeism to evaluate the relationships of the aforementioned predictors across the distribution of presenteeism rather than the conditional mean [25,26]. In line with Enns et al., we have used the 50th and 90th percentile as the focus of inference [3].

To examine absenteeism, we performed an block-wise, hierarchical logistic analysis, using the same blocks as the presenteeism analysis.

p-Values of $\leq$0.05 were considered statistically significant. IBM SPSS (Windows, version 23.0, Armonk, NY) was used for data analysis.

Results

Characteristics

Sample characteristics are depicted in Table 1.

Table 1. Demographic, disease, health, and occupational characteristics of workers with MS.

	N	(%)	Descriptives
Gender (% female)	236	78.8	
Age	236		42.0 (34.5–49)
Education level			
High	102	43.2	
Middle	93	39.4	
Low	41	17.4	
Time since diagnosis (in years)	222		5.3 (2.3–10.5)
Expanded Disability Status Scale	219		2.0 (1.5–2.5)
Hospital Anxiety and Depression Scale depression	236		3.0 (1.0–5.0)
Hospital Anxiety and Depression Scale anxiety	236		5.0 (3.0–8.0)
Coping Inventory for Stressful Situations: task-oriented coping	236		60.5 (54.0–64.0)
Coping Inventory for Stressful Situations: emotion-oriented coping	236		37.1 (10.6)
Coping Inventory for Stressful Situations: avoidance-oriented coping	236		46.0 (40.0–53.0)
Multiple Sclerosis Quality of Life-54 pain subscale	236		93.3 (70–100)
Modified Fatigue Impact Scale total	236		35.6 (15.4)
Modified Fatigue Impact Scale cognitive subscale	236		16.0 (11.0–21.0)
Modified Fatigue Impact Scale psychosocial subscale	236		3.0 (2.0–4.0)
Modified Fatigue Impact Scale physical subscale	236		16.6 (7.7)
Symbol Digit Modalities Test	226		54.1 (9.1)
Working hours[a]	236		15.5 (9.5–23.5)
Presenteeism	236		20 (10–45)
Absenteeism	236	17.8[b]	
Job type			
Mentally challenging job[c]	111	56.1%	
Physically challenging job[c]	20	10.1%	
Both mentally and physically challenging job[c]	67	33.8%	

The values indicate median and Q1 and Q3 (given the lack of a normal distribution) or, in case of the normally distributed variables Coping Inventory for Stressful Situations emotion-oriented coping, Modified Fatigue Impact Scale total, Modified Fatigue Impact Scale psychosocial impact of fatigue and SDMT, mean (standard deviation).

[a]Contract hours per week.

[b]Percentage of participants who experienced absenteeism, based on a dichotomous distribution.

[c]Note that $N = 198$.

Table 2. Correlation coefficients for presenteeism and absenteeism.

	Presenteeism	Absenteeism
Gender	−0.10	−0.11
Age	−0.04	**−0.13***
Education level	−0.07	−0.04
Time since diagnosis (years)	**−0.14***	−0.09
Expanded Disability Status Scale	**0.23****	**0.16***
Hospital Anxiety and Depression Scale depression	**0.43****	**0.34***
Hospital Anxiety and Depression Scale anxiety	**0.38****	**0.25***
Coping Inventory for Stressful Situations: task-oriented coping	−0.05	0.02
Coping Inventory for Stressful Situations: emotion-oriented coping	**0.27****	**0.15***
Coping Inventory for Stressful Situations: avoidance-oriented coping	0.02	0.01
Multiple Sclerosis Quality of Life-54 pain subscale	**−0.36****	**−0.23****
Modified Fatigue Impact Scale cognitive subscale	**0.53****	**0.31****
Modified Fatigue Impact Scale psychosocial subscale	**0.50****	**0.23****
Modified Fatigue Impact Scale physical subscale	**0.55****	**0.24****
Symbol Digit Modalities Test	−0.11	**−0.16***

Values in bold indicate significant *p*- values.
*$p < 0.05$.
**$p < 0.01$.

Univariate relationships with presenteeism and absenteeism

Correlations between either presenteeism and absenteeism and the predictors are presented in Table 2. Presenteeism was significantly negatively correlated to diagnosis duration and pain. Positive significant relationships were observed between presenteeism and MS-related disability, depression, anxiety, emotion-oriented coping, and all three fatigue subscales. Absenteeism was significantly negatively related to age, pain and information processing speed. Positive correlations were observed between absenteeism and MS-related disability, depression, anxiety, emotion-oriented coping, and all three fatigue subscales.

Correlation coefficients for predictors are depicted in Table 3.

Five strong correlations have been observed between predictors (above >0.5): The correlation between cognitive impact of fatigue and depression ($r^2 = 0.53$), between depression and anxiety ($r^2 = 0.59$), anxiety and emotion-oriented coping ($r^2 = 0.51$), the physical impact of fatigue and the cognitive impact of fatigue ($r^2 = 0.54$), and between the cognitive impact of fatigue and the psychosocial impact of fatigue ($r^2 = 0.51$).

Multivariate relationships with presenteeism

We performed a multiple regression analysis, using bootstrapping, with presenteeism as the outcome variable. First, anxiety, depression, coping styles, information processing speed, cognitive impact of fatigue, and psychosocial impact of fatigue were added into the equation with $F(8,205) = 13.18$, $p < 0.001$, with $R^2 = 0.34$. Both cognitive impact of fatigue ($\beta = 0.29$, $p = 0.001$) and psychosocial impact of fatigue ($\beta = 0.32$, $p = 0.001$) were unique significant predictors of presenteeism, as shown in Table 4. Higher cognitive and psychosocial impacts of fatigue predicted more presenteeism.

Entering the physical health characteristics (MS-related disability, fatigue, pain, physical impact of fatigue) into the regression model of presenteeism yielded a significant equation, $F(11,202)=11.33$, $p < 0.001$ with $R^2=0.38$, significantly improving the model ($p < 0.004$). Both cognitive impact of fatigue ($\beta = 0.24$, $p = 0.001$) and physical impact of fatigue ($\beta = 0.20$, $p = 0.042$) were unique significant predictors in the second model. A higher impact of physical and cognitive fatigue was related to more presenteeism.

Finally, adding the demographic and disease characteristics (age, gender, and education), yielded a significant equation, with $F(15,198)=9.00$, $p < 0.001$, $R^2 = 0.45$. However, adding demographic and disease characteristics did not significantly improve the model ($p = 0.10$). In this final model, only cognitive impact of fatigue was a significant unique predictor of presenteeism ($\beta = 0.22$, $p = 0.001$). A higher cognitive impact of fatigue was related to more presenteeism.

Quantile relationships with presenteeism

We performed a quantile regression analysis for presenteeism using the 50th and the 90th quantile. The 50th percentile in our dataset corresponded to a 20% score on presenteeism, while the 90th percentile corresponded to a 70% score on presenteeism. Results are summarised in Table 5. Regarding the 50th quantile, we observed significant positive relationships between presenteeism and cognitive and psychosocial impact of fatigue (Pseudo $R^2 = 0.21$). Regarding the 90th quartile, presenteeism was significantly positively related to cognitive impact of fatigue, physical impact of fatigue, and educational level. Significant negative relationships were observed between presenteeism and the MSQOL-54 pain sub scale, indicating that more pain was related to more presenteeism. Finally, a significant negative relationship was observed between gender and presenteeism, suggesting that more presenteeism is associated with being female (Pseudo $R^2 = 0.35$).

Multivariate relationships with absenteeism

The data violated the assumption of linearity. Linearity can be considered the most essential assumption, and violation of linearity causes an invalid model [27]. Therefore, we conducted a multiple logistic regression analysis, considering absenteeism as a dichotomous variable (with 0 being no absenteeism, and 1 being absent from work due to MS for minimally one hour in the past seven days).

First, mental health characteristics (anxiety, depression, coping styles, information processing speed, cognitive impact of fatigue, and psychosocial impact of fatigue) were added into the equation with $\chi^2(8)=34.04$, $p < 0.001$, with $R^2 = 0.25$ (Nagelkerke) and $R^2 = 0.15$ (Cox and Snell). Both depression and the cognitive impact of fatigue were unique significant positive predictors of absenteeism.

Second, physical health characteristics (MS-related disability, the physical impact of fatigue and pain) were added into the equation with $\chi^2(11)=37.72$, $p < 0.001$, with $R^2 = 0.27$ (Nagelkerke) and $R^2 = 0.16$ (Cox and Snell). However, adding physical health in

Table 3. Correlation coefficients of the predictors.

	Gender	Age	Educational level	Time since diagnosis	Expanded Disability Status Scale	Depression	Anxiety	Task-oriented coping	Emotion-oriented coping	Avoidance-oriented coping	Pain	Cognitive impact of fatigue	Physical impact of fatigue	Psychosocial impact of fatigue	Information processing speed
Gender	–	0.07	−0.03	0.07	0.01	0.04	−0.02	−0.05	−0.08	−0.17*	0.12	−0.09	−0.16*	−0.12	−0.11
Age	0.07	–	−0.24**	0.44**	0.41**	−0.05	−0.12	−0.05	0.03	−0.06	−0.07	−0.09	0.08	0.05	−0.29**
Education level	−0.03	−0.24**	–	−0.09	−0.11	−0.11	−0.07	0.25**	−0.08	−0.04	0.07	−0.10	−0.07	−0.08	0.24**
Time since diagnosis (years)	0.07	0.44**	−0.09	–	0.25**	−0.09	−0.12	0.02	−0.02	−0.12	0.12	−0.12	−0.04	−0.03	−0.19**
Expanded Disability Status Scale	0.01	0.41**	−0.11	0.25**	–	0.11	−0.03	−0.11	−0.05	−0.15*	−0.28**	0.08	0.40**	0.22**	−0.27**
Depression	0.04	−0.05	−0.11	−0.09	0.11	–	0.59**	−0.14*	0.30**	−0.04	−0.27**	0.53**	0.44**	0.47**	−0.12
Anxiety	−0.02	−0.12	−0.07	−0.12	−0.03	0.59**	–	−0.14*	0.51**	0.01	−0.22**	0.48**	0.29**	0.33**	0.06
Task-oriented coping	−0.05	−0.05	0.25**	0.02	−0.11	−0.14*	−0.14*	–	−0.04	0.12	−0.06	−0.04	0.01	0.01	0.06
Emotion-oriented coping	−0.08	0.03	−0.08	−0.02	−0.05	0.30**	0.51**	−0.04	–	0.07	−0.18**	0.38**	0.22**	0.25**	−0.04
Avoidance-oriented coping	−0.17*	−0.06	−0.04	−0.12	−0.15*	−0.04	0.01	0.12	0.07	–	−0.22**	0.06	0.16*	0.08	0.03
Pain	0.12	−0.07	0.07	0.12	−0.28**	−0.27**	−0.22**	−0.06	−0.18**	−0.22**	–	−0.30**	−0.31**	−0.31**	0.06
Cognitive impact of fatigue	−0.09	−0.09	−0.10	−0.12	0.08	0.53**	0.48**	−0.04	0.38**	0.06	−0.30**	–	0.54**	0.51**	−0.04
Physical impact of fatigue	−0.16*	0.08	−0.07	−0.04	0.40**	0.44**	0.29**	0.01	0.22**	0.16*	−0.31**	0.54**	–	0.69**	−0.15*
Psychosocial impact of fatigue	−0.12	0.05	−0.08	−0.03	0.22**	0.47**	0.33**	0.01	0.25**	0.08	−0.31**	0.51**	0.69**	–	−0.14*
Information processing speed	−0.11	−0.29**	0.24**	−0.19**	−0.27**	−0.12	0.06	0.06	−0.04	0.03	0.06	−0.04	−0.15*	−0.14*	–

*$p < 0.05$.
**$p < 0.01$.
Values in bold indicate significant *p*-values.

Table 4. Summary of hierarchical regression analyses for variables predicting presenteeism (95% bias corrected and accelerated; confidence intervals and standard errors based on 1000 bootstrap samples).

Presenteeism							
Variable	*B*	LB	UB	*β*	*p* Value	R^2	ΔR^2
Step 1						**0.34**	**0.34**
Constant	1.61	−1.04	4.21		0.207		
Anxiety	0.10	−0.03	0.22	0.16	0.096		
Depression	−0.29	−0.16	0.11	−0.04	0.705		
Task-oriented coping	0.01	−0.26	0.03	0.01	0.952		
Emotion-oriented coping	−0.01	−0.04	0.02	−0.05	0.513		
Avoidance-oriented coping	−0.02	−0.04	0.01	−0.07	0.221		
Information processing speed	−0.01	−0.04	0.03	−0.03	0.678		
Cognitive impact of fatigue	0.08	0.05	0.12	0.29	**0.001**		
Psychosocial impact of fatigue	0.39	0.20	0.57	0.32	**0.001**		
Step 2						**0.38**	**0.04**
Constant	1.75	−1.34	4.85		0.278		
Anxiety	0.10	−0.04	0.22	0.16	0.103		
Depression	−0.04	−0.16	0.10	−0.05	0.577		
Task-oriented coping	−0.01	−0.03	0.02	−0.06	0.927		
Emotion-oriented coping	−0.01	−0.04	0.02	−0.04	0.587		
Avoidance-oriented coping	−0.02	−0.05	0.01	−0.10	0.090		
Information processing speed	0.01	−0.03	0.04	0.01	0.908		
Cognitive impact of fatigue	0.07	0.03	0.11	0.24	**0.001**		
Psychosocial impact of fatigue	0.21	0.01	0.43	0.18	0.060		
Physical impact of fatigue	0.06	0.01	0.12	0.20	**0.042**		
MS-related disability	0.13	−0.02	0.38	0.07	0.285		
Pain	−0.01	−0.10	0.01	−0.08	0.231		
Step 3						**0.41**	0.024
Constant	3.63	0.30	6.81		**0.032**		
Anxiety	0.10	−0.04	0.21	0.14	0.119		
Depression	−0.05	−0.17	0.10	−0.06	0.532		
Task-oriented coping	0.01	−0.03	0.03	0.01	0.909		
Emotion-oriented coping	−0.01	−0.04	0.02	−0.02	0.783		
Avoidance-oriented coping	−0.03	−0.06	0.01	−0.11	0.075		
Information processing speed	−0.01	−0.04	0.03	−0.03	0.656		
Cognitive impact of fatigue	0.06	0.02	0.10	0.22	**0.001**		
Psychosocial impact of fatigue	0.23	0.01	0.46	0.18	0.058		
Physical impact of fatigue	0.05	−0.01	0.11	0.17	0.071		
MS-related disability	0.23	−0.03	0.49	0.13	0.070		
Pain	−0.01	−0.02	0.01	−0.07	0.349		
Disease duration	−0.03	−0.08	0.01	−0.10	0.121		
Age	−0.02	−0.05	0.01	−0.08	0.173		
Gender	−0.40	−0.90	0.01	−0.07	0.136		
Educational level	−0.05	−0.41	0.43	−0.02	0.822		

N= 214, 95% CI for *B*. Values in bold indicate significant *p* values.

model two did not significantly improve the fit of the model, $p = 0.299$. In the second model, both depression and the cognitive impact of fatigue remained significant positive predictors of absenteeism.

Finally, we added demographic characteristics (age, gender, and educational level) to the equation with $\chi^2(15)=43.77$, $p < 0.001$, with $R^2 = 0.31$ (Nagelkerke) and $R^2 = 0.18$ (Cox and Snell). The third block did not significantly improve the model, $p = 0.195$. Disease duration violated the assumption of linearity and was therefore not added in the current model. In the final model cognitive impact of fatigue and age were significant predictors of absenteeism. While the cognitive impact of fatigue is positively related to absenteeism ($p = 0.037$), age is negatively related to absenteeism ($p = 0.037$). This suggests that younger people report more absenteeism. Although depression was a significant predictor of absenteeism in the first two models, it failed to reach significance in the third model ($p = 0.053$). Coping style did not reach significance in the three models. Results are presented in Table 6.

Discussion

The aim of the current study was to examine the relationship between work productivity in people with MS and physical health,

Table 5. Summary of quantile regression analyses for variables predicting presenteeism.

	Coefficient	SE	LB	UB	*p* Value
50th percentile					
Intercept	0.74	1.69	−2.60	4.08	0.66
Anxiety	0.08	0.05	−0.02	0.17	0.10
Depression	0.01	0.05	−0.10	0.11	0.94
Task-oriented coping	0.01	0.01	−0.02	0.04	0.45
Emotion-oriented coping	0.01	0.01	−0.02	0.03	0.58
Avoidance-oriented coping	−0.01	0.01	−0.04	0.02	0.42
Information processing speed	0.01	0.01	−0.01	0.04	0.31
Cognitive impact of fatigue	0.05	0.02	0.02	0.09	**0.005**
Psychosocial impact of fatigue	0.23	0.09	0.05	0.41	**0.01**
Physical impact of fatigue	0.02	0.02	−0.02	0.07	0.32
Expanded Disability Status Scale	0.21	0.11	−0.01	0.42	0.06
Pain	−0.01	0.01	−0.02	0.01	0.34
Disease duration	−0.03	0.02	−0.06	0.01	0.18
Age	−0.01	0.01	−0.04	0.02	0.39
Gender	−0.16	0.28	−0.70	0.38	0.56
Educational level	−0.26	0.16	−0.58	0.06	0.11
90th percentile					
Intercept	9.78	2.88	4.10	15.46	**0.001**
Anxiety	0.14	0.08	−0.01	0.30	0.07
Depression	−0.06	0.09	−0.23	0.12	0.52
Task-oriented coping	−0.02	0.02	−0.07	0.02	0.34
Emotion-oriented coping	−0.04	0.02	−0.08	0.01	0.054
Avoidance-oriented coping	−0.03	0.02	−0.08	0.012	0.15
Information processing speed	0.01	0.02	−0.04	0.05	0.83
Cognitive impact of fatigue	0.11	0.03	0.05	0.17	**0.001**
Psychosocial impact of fatigue	−0.12	0.15	−0.43	0.18	0.42
Physical impact of fatigue	0.10	0.04	0.02	0.18	**0.02**
Expanded Disability Status Scale	0.21	0.19	−0.16	0.57	0.27
Pain	−0.05	0.01	−0.07	−0.03	**0.001**
Disease duration	−0.06	0.03	−0.12	0.01	0.08
Age	0.00	0.02	−0.05	0.05	0.99
Gender	−1.26	0.47	−2.18	−0.35	**0.01**
Educational level	0.77	0.28	0.22	1.31	**0.01**

SE: standard error; LB: lower bound; UB: upper bound.
Values in bold indicate significant *p* values.

Table 6. Summary of hierarchical logistic regression analyses for variables predicting absenteeism.

Absenteeism					
Variable	*B*	SE	O.R.	[95% CI O.R.]	*p* Value
Step 1					
Constant	−3.19	2.32	0.04		0.169
Anxiety	−0.04	0.08	0.96	[0.83–1.12]	0.600
Depression	0.17	0.08	1.19	[1.00–1.40]	**0.041**
Task-oriented coping	0.02	0.03	1.02	[0.96–1.07]	0.574
Emotion-oriented coping	−0.01	0.02	1.00	[0.94–1.04]	0.918
Avoidance-oriented coping	0.01	0.02	1.01	[0.96–1.05]	0.820
Information processing speed	−0.04	0.02	0.96	[0.92–1.01]	0.117
Cognitive impact of fatigue	0.09	0.03	1.12	[1.02–1.17]	**0.011**
Psychosocial impact of fatigue	0.12	0.13	0.04	[0.87–1.46]	0.377
Step 2					
Constant	−1.93	3.10	0.15		0.533
Anxiety	−0.05	0.08	0.95	[0.82–1.10]	0.494
Depression	0.17	0.09	1.19	[1.00–1.41]	**0.047**
Task-oriented coping	0.01	0.03	1.01	[0.96–1.07]	0.656
Emotion-oriented coping	−0.01	0.02	1.00	[0.95–1.04]	0.931
Avoidance-oriented coping	−0.01	0.03	1.00	[0.95–1.05]	0.913
Information processing speed	−0.03	0.03	0.98	[0.93–1.02]	0.279
Cognitive impact of fatigue	0.08	0.04	1.09	[1.02–1.17]	**0.018**
Psychosocial impact of fatigue	0.04	0.17	1.04	[0.75–1.44]	0.816
Physical impact of fatigue	0.02	0.05	1.02	[0.93–1.11]	0.754
MS-related disability	0.08	0.18	1.08	[0.76–1.56]	0.657
Pain	−0.02	0.01	0.98	[0.96–1.01]	0.533
Step 3					
Constant	1.76	3.65	5.78		0.631
Anxiety	−0.07	0.08	0.93	[0.80–1.09]	0.384
Depression	0.17	0.09	1.19	[1.00–1.42]	0.053
Task-oriented coping	0.01	0.03	1.00	[0.95–1.06]	0.902
Emotion-oriented coping	0.01	0.02	1.01	[0.96–1.05]	0.806
Avoidance-oriented coping	−0.01	0.03	1.00	[0.94–1.05]	0.788
Information processing speed	−0.05	0.03	0.95	[0.90–1.01]	0.090
Cognitive impact of fatigue	0.08	0.04	1.08	[1.01–1.17]	**0.037**
Psychosocial impact of fatigue	0.07	0.17	1.07	[0.77–1.51]	0.678
Physical impact of fatigue	0.01	0.05	1.00	[0.91–1.10]	0.970
MS-related disability	0.20	0.01	1.22	[0.84–1.77]	0.301
Pain	−0.02	0.01	0.98	[0.96–1.00]	0.105
Age	−0.06	0.03	0.94	[0.90–1.00]	**0.035**
Gender	0.50	0.58	1.64	[0.53–5.07]	0.390
Educational level low					0.932
Educational level middle	−0.22	0.68	0.80	[0.21–3.03]	0.746
Educational level high	−0.15	0.49	0.86	[0.33–2.25]	0.631

$N = 214$, 95% CI for *B*. Values in bold indicate significant *p* values.
ΔModel 1–0 $\chi^2(8)=34.04$, $p < .001$.
ΔModel 2–1 $\chi^2(3)=3.68$, $p = 0.299$.
ΔModel 3–2 $\chi^2(4)=6.05$, $p = 0.195$.

mental health characteristics, demographic and disease characteristics. Work productivity was defined in terms of presenteeism and absenteeism.

With respect to presenteeism, univariate positive relationships have been observed with MS-related disability, depression, anxiety, emotion-oriented coping, and fatigue. More presenteeism was related to a shorter disease duration and more pain.

Thereafter, we examined a model containing mental health factors. Higher cognitive and psychosocial impact of fatigue were both significant predictors of more presenteeism. Adding physical health factors significantly explained more variance in presenteeism, with the cognitive and physical impacts of fatigue significantly predicting presenteeism. Adding demographic and disease characteristics did not explain more variance in presenteeism.

Subsequently, we evaluated the relationships between the independent variables and presenteeism for two different percentiles. The results suggest that in the people scoring lower on presenteeism (50th percentile), more presenteeism was associated with a higher cognitive and psychosocial impact of fatigue. In the people scoring higher on presenteeism (90th percentile), more presenteeism was significantly related to more pain, a higher cognitive and physical impact of fatigue, being female and a higher educational level.

Concerning absenteeism, we observed univariate relationships with MS-related disability, depression, anxiety, emotion-oriented coping, and fatigue. More absenteeism was related to a slower processing speed, more pain, and a younger age.

Subsequent multivariate analyses showed that the mental health model was significantly related to absenteeism. Specifically depression and cognitive impact of fatigue were significant unique predictors of absenteeism. Adding physical and demographical characteristics did not explain more variance in absenteeism.

Although neither of the predictor variables violated the assumption of multicollinearity, correlations as high as $r^2 = 0.59$ were observed between predictors (for anxiety and depression). It should be recognised that including parameters with considerable shared variance enhances difficulties for the estimation of the relationship between each predictor and the dependent variable independently. For instance, five strong relationships have been found between the predictors (between the cognitive impact of fatigue and depression, depression and anxiety, anxiety and emotion-oriented coping, physical impact and the cognitive impact of fatigue and the cognitive impact of fatigue and the psychosocial impact of fatigue). Hence, the construction of the model might explain why some of the univariate relationships are not being observed in the multivariate models. This consideration needs to be taken into account when interpreting the results.

Several studies have been conducted examining work productivity in MS, all varying in methodology, participant characteristics, and chosen predictors. Despite these methodological differences, there is one crucial similarity: fatigue (or the impact of fatigue) appears to be the most important predictor of work productivity [1,3,4]. Fatigue is often linked to employment measures in research on employment in MS [28]. Simmons et al. reported fatigue as the most common reason for job loss in a longitudinal study [29]. The current study underlines the association between fatigue and both presenteeism and absenteeism in a sample with otherwise limited disability. Effective management of fatigue in the workplace should therefore be encouraged. Research suggests that facilitators, such as flexible work scheduling, enable people with MS to sustain employment regardless of the presence of MS-symptoms [30]. Additionally, fatigue should be targeted in clinical care [31]. For instance, research suggests that cognitive behavioural therapy is an effective method of decreasing MS-related fatigue [32]. Moreover, positive treatment outcomes have been demonstrated for pharmacological interventions such as amantadine [33], as well as non-pharmacological interventions including physical exercise [34].

In the current study, the cognitive impact of fatigue specifically was predictive of both absenteeism and presenteeism. The impact of physical fatigue was only significantly related to presenteeism. These results suggest that the cognitive impact of fatigue withholds people with MS from going to work, but the physical impact does not. This finding might be a result of our sample with relatively more white collar workers than blue collar workers.

More research is needed to unravel the relationship between fatigue and work. Particular aspects of fatigue might have different consequences for daily life and work productivity. Moreover, we have used the Modified Fatigue Impact Scale-21 to assess fatigue in the current study. It has to be noted that the Modified Fatigue Impact Scale-21 is aimed to measure the impact of fatigue on daily life [35], rather than the severity or frequency of fatigue. Additional research should incorporate these intrinsic aspects of fatigue in research on work productivity in MS.

In addition to the impact of fatigue, symptoms of depression were significantly associated with absenteeism in employed people with MS. This is in line with research by Enns et al. [3], who also found significant associations between depression and absenteeism, but not between depression and presenteeism in multivariate analyses. In contrast, research by Glanz et al. suggests that depression was related to presenteeism but not absenteeism [4]. The adverse effects of depressive symptoms on work productivity have been previously reported in people with other chronic illnesses such as diabetes and rheumatoid arthritis [36,37]. These results highlight the importance of mental health aspects of chronic illness and the concern for adequate treatment. In MS specifically, depression has successfully been treated with either medication or cognitive behavioural therapy [38]. The implementation of a work-focused cognitive behavioural therapy may reduce lost time and costs associated with work disability for mental health conditions [39].

The current study incorporated symptoms indicative of depression (as measured by the HADS), rather than a clinical diagnosis as stated by the DSM V. The current sample is characterised by relatively mild mood complaints (median = 3.0), and participants with psychiatric disorders have not been approached to participate in the MS@Work study in general. Hence these results emphasise the relevance of subtle affective symptoms when considering work productivity. However, future research on work productivity and employment should additionally include people with clinically significant affective symptoms.

In accordance with the results of Enns et al. [3] fatigue and depression conjoined were significant predictors of absenteeism (next to physical functioning in their study). Fatigue and depression have often been linked in prior research [38,40,41]. Although fatigue exists independently in MS it is important to note that fatigue can also be a symptom of depression [38]. Research by Greim et al. suggests that depressed people with MS report more fatigue than people without depressive symptoms, irrespective of objective measures [42]. These findings indicate that depressed mood affects the subjective experience of fatigue. The moderate correlations between depression and fatigue found in the current study are in line with this findings. More research into the nature of the interaction between depression and fatigue is needed. Both depression and fatigue are susceptible to cognitive behavioural therapy [32,38], and optimal intervention may consist of a programme combining treatment goals. This might ultimately improve work productivity and employment in people with MS.

Besides the similarities between the current study and prior research, some discrepancies have to be noted. In contrast to Chen et al., we did not find associations between work productivity and cognitive functioning. They found significant relationships between work productivity and “fatigue and cognitive symptoms”, “pain and sensory symptoms”, “difficulties with walking, balance and spasticity”, and “feelings of anxiety and depression” [1]. The different outcomes may be due to methodological differences. First, Chen et al. used the total work productivity scale as an outcome measure instead of examining absenteeism and presenteeism separately. Second, Chen et al. extended the recall period to four weeks instead of the one week as stated in the original questionnaire. This extension may reduce the disproportionate influence of atypical work weeks, while increasing the risk of recall bias on the other hand. These differences may have substantial effects on the outcomes of both studies.

In the current study, we demonstrated that the relationships between presenteeism and the predictors differed between people scoring higher on presenteeism and people scoring lower on presenteeism, although in both analyses fatigue was an important predictor. In accordance with Enns et al. [3], we observed significant relations between pain and presenteeism; however, we only observed this relationship for the group reporting higher presenteeism. In contrast to other studies on work productivity in MS, we did observe significant relationships between more presenteeism and demographics, i.e., being female and having a higher education in the people scoring higher on presenteeism. Research on employment status in MS demonstrated contradictive results concerning the influence of gender with several studies relating male gender to unemployment [28], while other studies demonstrated a relationship between female gender and unemployment [43].

In contrast with our hypothesis, we did not find significant associations between work productivity and coping styles. Research in people with MS found a negative association between avoidant coping and employment status [7,8,10], but we failed to replicate this effect for work productivity specifically. Future research should look into the possible moderating effects of coping on work productivity in MS. Prior research emphasised the importance of the indirect effects of coping style in MS [44]. For instance, the positive relationship between fatigue and future cognitive problems was moderated by the reliance on avoidant coping strategies [45]. Additionally, in healthy (aging) workers, a moderation effect was found for the relationship between mental health and work ability, in that the negative impact of avoidant coping was the strongest for workers with poor mental health

[46]. These findings substantiate the need to examine the indirect effects of coping style in workers with MS.

Strengths and limitations

First, previous research on work productivity in MS limited mental health factors to symptoms of depression and anxiety. In the current study, we also incorporated coping styles as well as the cognitive and psychosocial impact of fatigue. There is increasing evidence supporting the relevance of psychological functioning contributing to employment [47]. Incorporating a broader definition of mental health in employment research may lead the way to holistic care and seeing the person behind the patient.

Additionally, by dividing the fatigue assessment into three components (cognitive, psychosocial, and physical impact), we acknowledged the multidimensional nature of fatigue as a symptom. Given the high prevalence of fatigue, and its association with work productivity, work functioning, and employment [28], elaborating further on the underlying mechanisms in the relationship between work productivity and fatigue is warranted. Finally, another strength is the large sample size.

In terms of limitations, it should be noted that our sample of workers with MS had mild disability (median expanded disability scale status = 2.0). Furthermore, by the inclusion of working people with MS, the risk of healthy worker effect increases (the observation that people in paid employment have a lower morbidity and mortality compared to the general population) [48]. The current sample reported relatively low levels of presenteeism (median = 20 [10–45]), and only 18% reported absenteeism. Although previous research examining work productivity in MS found similar low levels of absenteeism [1,3,4], this might limit generalisation of our findings to the entire MS population. Moreover, the current sample is relatively highly educated. This notion needs to be taken into account, given the presumed positive association between educational level and work productivity [1].

Furthermore, we used a self-reported measure of work productivity rather than an objective measure. However, assessing subjective productivity loss is valuable. Prior research has highlighted the costs associated with both absenteeism and presenteeism [1]. Future research should assess whether the factors that underlie subjective work functioning are related to objective work functioning as well. Additionally, both presenteeism and absenteeism cover a time range of only seven days. Although these outcome measures are often used in prior research, the time range is narrow and the measurement can be subject to irregular working weeks.

In addition, we did not incorporate workplace characteristics in our model, while these factors may contribute to work productivity in MS [1]. Messmer Uccelli et al. [30] identified three categories that differentiated employed from unemployed people with MS, namely MS symptoms, financial considerations, and the workplace environment. Although symptom management is crucial, aspects like flexible work hours or the possibility to set your own pace can predominate in the decision to keep working. Research by Vornholt et al. [49] further highlights the importance of workplace characteristics in workers with disabilities. They described barriers for workplace integration such as job requirements, attitudes towards workers with disabilities and absence of an inclusive organisational culture.

Vornholt et al. [49] observed that many European countries strive towards creating an inclusive work environment that embraces differences in backgrounds and perspectives. In line with this observation, it is important to note that a change in inclusivity may also affect work outcome measures. In the literature, presenteeism is often considered to be negative. However, when considering an increase in inclusivity, more people with disability will be enabled to work, automatically leading to an increase in presenteeism. Thus while presenteeism may be seen as something negative, it also may be an effect of an increasing inclusive society.

In addition, characteristics of the used instruments need to be taken into account when considering the outcomes. First, it should be noted that, although the Modified Fatigue Impact Scale is one of the most commonly used instruments to measure fatigue and is used in both clinical and research settings [50], there is an ongoing debate on the underlying structure and the psychometrics of the instrument. A psychometric analysis of the Modified Fatigue Impact Scale substantiated good reliability for the cognitive- and physical subscale, but less so for the psychosocial subscale [50]. This is in line with research by Kos et al. [51] who recommend to use the psychosocial subscale with caution. More research into the psychometric characteristics of the Modified Fatigue Impact Scale is needed.

Second, in order to assess information processing speed, we have used the Symbol Digit Modalities Test [21]. This instrument is commonly used in both research and clinical practice. While previous research has supported the reliability and validity of the instrument [52], it is important to take into account that performance on the written version can be influenced by eye and hand functioning [53].

Finally, due to the distribution of the data, we considered absenteeism as a dichotomous variable, with either absenteeism or no absenteeism. This may eliminate nuance in terms of absenteeism, e.g., the difference between being absent for one hour in comparison to a higher frequency of missed work hours.

Conclusions

To conclude, we found that a higher cognitive and physical impact of fatigue were associated with more presenteeism in working people with MS. In the people scoring higher on presenteeism (90th percentile), more presenteeism was additionally related to more pain, being female and a higher educational level. A higher cognitive impact of fatigue and more symptoms of depression were significantly related to more absenteeism. As most variables did not contribute independently to the models, the ORs of those variables that did contribute were rather low. Furthermore, strong relationships have been observed between (mental) health predictors, affecting the estimations in the multivariate models. Since the majority of the variance in work productivity remains unexplained, future research building on the present study, and adding the influence of work characteristics is warranted.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, E. E. A. van Egmond, upon a reasonable request.

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