

1 **Short report: Multiple Sclerosis and Related Disorders**

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3 **Obesity, dieting, and multiple sclerosis**  
4 R.D. Russell, A. Langer-Gould, E.G. Gonzales, J.B. Smith, V. Brennan, G. Pereira, R.M. Lucas, A.  
5 Begley, L.J. Black

5 **Highlights**

- 6 • Thirty-seven percent of participants were obese  
7 • People with multiple sclerosis were no more likely to adopt a diet than controls  
8 • Being obese, younger, female, or non-Hispanic were associated with dieting  
9

10 **Abstract**

11

12 **Background**

13 Obesity is common in the United States and is associated with a higher risk of relapse and  
14 comorbidities, and increased disease progression, in people with MS.

15 **Methods**

16 We examined the prevalence of overweight and obesity in the MS Sunshine Study, a  
17 matched case-control study of multiple sclerosis in Southern California (470 cases, 519  
18 controls). We reported the proportion of participants who adopted a specific diet for nutrition  
19 or weight loss purposes, and identified independent predictors of dieting.

20 **Results**

21 In the total population, 32% and 37% were overweight and obese, respectively. Case  
22 participants were no more likely to adopt a specific diet for nutrition or weight loss purposes  
23 than control participants (10% and 11%, respectively). Being obese, younger, female or non-  
24 Hispanic were independently associated with dieting.

25 **Conclusion**

26 Despite the evidence that obesity can worsen MS prognosis, and the high prevalence of  
27 overweight/obesity, case participants were no more likely to adopt a specific diet than control

28 participants. Improved nutrition education may help people with MS make healthy dietary  
29 changes for nutrition or weight loss purposes.

30

31 **Keywords**

32 Dietary behavior; dietary changes; MS Sunshine Study; multiple sclerosis; nutrition

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## 2 **1.0 Introduction**

3

4 In the United States (US), 40% of adults are obese, a trend that is increasing (Hales, Carroll,  
5 Fryar, & Ogden, 2017). Overweight/obesity in people with MS (pwMS) has been associated with  
6 greater neuroinflammation (Stampanoni Bassi et al., 2019), relapse risk and disability  
7 progression (Tettey et al., 2017). There is little research exploring the diets adopted by pwMS  
8 for nutrition or weight loss purposes. Using data from the MS Sunshine Study, a multi-ethnic  
9 matched case-control study in Southern California examining risk factors for MS (Langer-Gould  
10 et al., 2018), we aimed to describe the number and proportion of pwMS adopting specific diets  
11 after MS symptom onset, and to identify predictors of adopting a specific diet. We hypothesized  
12 that the onset of MS symptoms would increase motivation among overweight or obese  
13 individuals to change their diet.

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## 15 **2.0 Material and Methods**

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17 Participants of the 2011-2015 MS Sunshine Study were recruited from the Kaiser Permanente  
18 Southern California (KPSC) database of >4 million members; detailed methods are described  
19 elsewhere (Langer-Gould et al., 2018). In brief, adult members ( $\geq 18$  years) diagnosed with MS  
20 or clinically isolated syndrome within the past 18 months, or those with symptom onset within  
21 the past three years, were eligible. Control participants from the KPSC population were matched  
22 on age, sex, race/ethnicity, and home KPSC facility (a surrogate measure for socioeconomic  
23 status). After written informed consent was obtained, data were collected from structured in-  
24 person interviews (race/ethnicity, education), self-administered questionnaire (diets), and the  
25 complete electronic health record (BMI at date of symptom onset). The study was conducted in

26 accordance with the Declaration of Helsinki. The protocol was approved by the KPSC  
27 Institutional Review Board (IRB 5962).  
28  
29 Body mass index (BMI) was categorised as: normal/underweight (<25 kg/m<sup>2</sup>); overweight (25-  
30 <30 kg/m<sup>2</sup>); obese class I (30-<35 kg/m<sup>2</sup>), or obese class II (≥35 kg/m<sup>2</sup>). Participants reported  
31 start and end dates of specific diets they followed for “nutrition or weight loss purposes”,  
32 selecting from nine predefined diets (Paleo, South Beach, Perricone, Jenny Craig, Weight  
33 Watchers, 17 Day Diet, Jillian Michael’s, The Mommy Diet, Nutrisystem), and an open text field  
34 for “Other”. Participants could select multiple options.

35  
36 Control participants were considered to have adopted a diet if it occurred between date of  
37 symptom onset and interview date of their matched case. Analyses were conducted for the  
38 three major racial/ethnic groups (whites, blacks and Hispanics). Predictors of adopting a specific  
39 diet (case/control status, sex, age at symptom onset, education, race, BMI category, smoking  
40 history) were investigated using logistic regression models (unadjusted and adjusted). We  
41 tested for an interaction between case/control status and BMI using an interaction term in the  
42 adjusted model. Data were analysed using Stata Software version 14 (StataCorp, College  
43 Station, TX, USA). Statistical significance was defined as  $P<0.05$ .

### 44 45 **3.0 Results**

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47 Of the 1193 white, black, and Hispanic participants, 989 (83%) had complete data on diets and  
48 potential predictors. BMI distribution was similar for cases and controls, with a median of 28  
49 kg/m<sup>2</sup> (interquartile range (IQR) 9 kg/m<sup>2</sup>). Most participants were overweight or obese (Table 1),  
50 and the prevalence was similar for cases and controls (overweight 31% and 33%; obese 36%  
51 and 38%, respectively). Cases and controls had a similar education level (58% and 53%,

52 respectively, had not completed college). The median time from symptom onset to  
 53 questionnaire completion was 278 months (IQR, 30 months).

54

55 Table 1 Participant characteristics at index date<sup>1</sup>

	Cases (n=470)	Controls (n=519)
Sex, % (n)		
Male	26.8% (126)	27.6% (143)
Female	73.2% (344)	72.5% (376)
Age, y, mean (SD)	37.5 (12.6)	37.0 (12.7)
Race/ethnicity, % (n)		
White	48.1% (226)	45.3% (235)
Black	21.5% (101)	21.0% (109)
Hispanic	30.4% (143)	33.7% (175)
BMI (kg/m <sup>2</sup> ), median (IQR)	28.1 (24.0-33.0)	27.9 (24.1-33.5)
BMI category (kg/m <sup>2</sup> ), % (n)		
Normal/underweight (<25)	32.6% (153)	29.1% (151)
Overweight (25-<30)	31.1% (146)	33.0% (171)
Obese class I (30-<35)	17.9% (84)	17.2% (89)
Obese class II (≥35)	18.5% (87)	20.8% (108)
Education, % (n)		
Some college or less	57.7% (271)	53.4% (277)
College or graduate school	42.3% (199)	46.6% (242)
Smoking history (ever smoked), % (n)		
No	66.8% (314)	74.0% (384)
Yes	33.2% (156)	26.0% (135)

56 <sup>1</sup>Date of MS symptom onset (or matched time frame for controls)  
 57 IQR, interquartile range; SD, standard deviation

58

59 A total of 10% (n=46) of case participants reported adopting a specific diet for nutrition or weight  
 60 loss purposes after symptom onset, while 11% (n=56) of controls did so within the same time  
 61 frame. There was no independent association between MS status and adopting a specific diet  
 62 (Table 2). Being overweight/obese, female or younger were independently associated with  
 63 significantly increased odds of adopting a specific diet. Hispanics were 46% and blacks 44%

64 less likely to adopt a specific diet compared to whites, even after controlling for BMI, sex, age,  
 65 education and smoking, although this finding did not reach statistical significance in blacks.  
 66 There was no statistically significant interaction between MS status and BMI category ( $P>0.05$ ).

67

68 **Table 2** Unadjusted and adjusted logistic regression models showing participant characteristics  
 69 and odds of adopting a specific diet after MS symptom onset ( $n=989$ ; cases,  $n=470$ ; controls,  
 70  $n=519$ )

	Model 1: unadjusted		Model 1: adjusted	
	OR (95% CI)	P	aOR (95% CI) <sup>1</sup>	P
Age at symptom onset (years) <sup>2</sup>	0.97 (0.95, 0.99)	<0.001	0.96 (0.94, 0.98)	<0.001
MS status				
Control	Reference		Reference	
Case	0.90 (0.59, 1.35)	0.605	0.94 (0.61, 1.44)	0.759
Sex				
Male	Reference		Reference	
Female	4.29 (2.13, 8.62)	<0.001	4.48 (2.20, 9.12)	<0.001
Race/ethnicity				
White	Reference		Reference	
Black	0.98 (0.58, 1.68)	0.952	0.66 (0.38, 1.16)	0.150
Hispanic	0.91 (0.57, 1.46)	0.691	0.54 (0.31, 0.92)	0.023
BMI category (kg/m <sup>2</sup> )				
Normal/underweight (<25)	Reference		Reference	
Overweight (25-<30)	1.23 (0.66, 2.29)	0.518	1.71 (0.90, 3.25)	0.103
Obese class I (30-<35)	2.65 (1.42, 4.95)	0.002	3.76 (1.95, 7.23)	<0.001
Obese class II ( $\geq 35$ )	3.06 (1.68, 5.55)	<0.001	3.93 (2.11, 7.35)	<0.001
Education				
Some college or less	Reference		Reference	
College or graduate school	1.07 (0.71, 1.61)	0.750	1.12 (0.72, 1.75)	0.604
Smoking history (ever smoked)				
No	Reference		Reference	
Yes	0.72 (0.44, 1.15)	0.170	0.80 (0.48, 1.35)	0.400

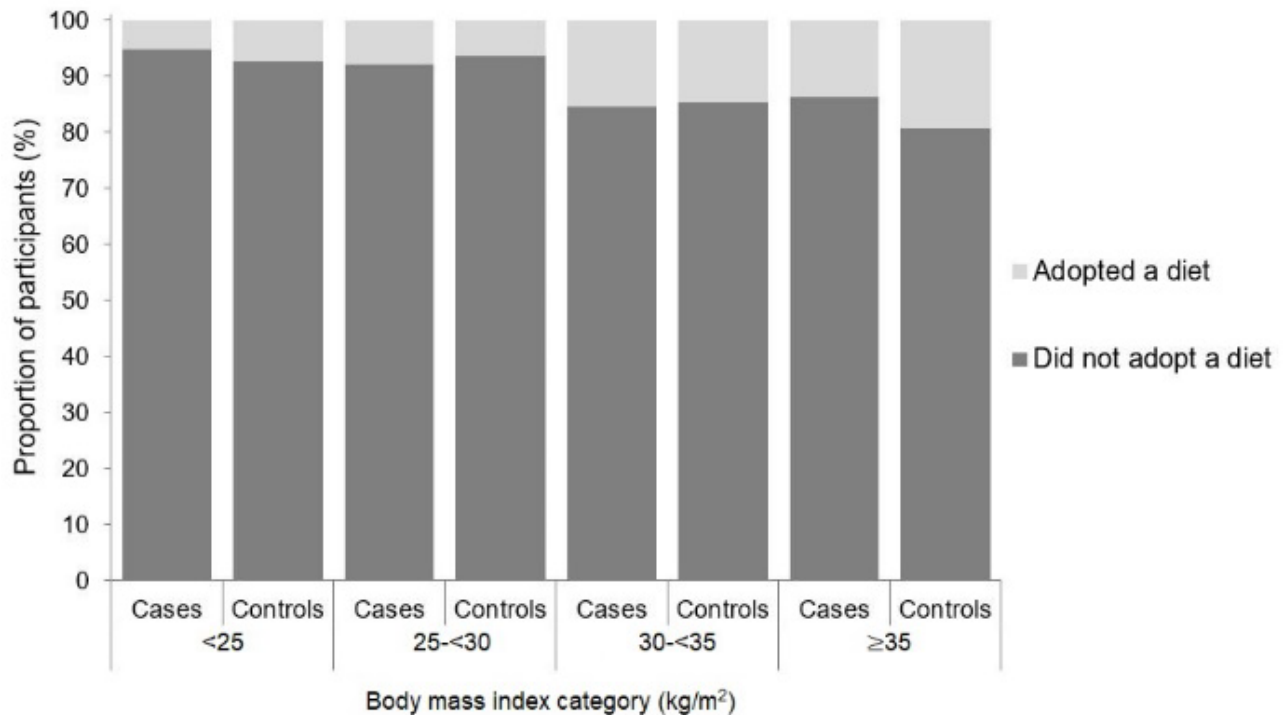
71 OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval

72 <sup>1</sup>All variables included in a single model

73 <sup>2</sup>Odds ratio is per one-year increase in age

74

75 The proportion of participants within each BMI category who adopted a specific diet was similar  
76 for cases and controls (Figure 1). The most frequently reported diet was Weight Watchers  
77 (cases,  $n=16$ ; controls  $n=18$ ).



78  
79 **Figure 1** Proportion of participants who did and did not adopt a specific diet for nutrition or  
80 weight loss purposes since MS symptom onset (or matched time frame for controls)  
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## 82 4.0 Discussion

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84 In the MS Sunshine Study, case participants with recent onset of MS symptoms or diagnosis of  
85 MS were no more likely to adopt a specific diet for weight loss or nutrition purposes than control  
86 participants, despite a high proportion being overweight or obese. Achieving and maintaining a  
87 healthy weight is particularly important for pwMS, since obesity is associated with a higher risk  
88 of relapse (Tettey et al., 2017), comorbidities (e.g. diabetes, hypertension, depression), and  
89 greater disease progression of MS (Marrie, 2017).

90

91 The proportion of pwMS making dietary modifications in other studies is higher than in our  
92 study, ranging from 17% (Brenton & Goldman, 2016) to approximately 40% (Fitzgerald et al.,  
93 2018; Riemann-Lorenz et al., 2016; Russell et al., 2018). This is likely due to differences in  
94 study population, design and dietary assessment. Previous studies included greater  
95 representation of white participants (>90%) (Fitzgerald et al., 2018; Russell et al., 2018) and  
96 prevalent cases (mean disease duration >7 years) (Brenton & Goldman, 2016; Riemann-Lorenz  
97 et al., 2016), and inquired about any dietary change (Russell et al., 2018), whereas we focused  
98 on specific diets for weight loss or nutrition purposes.

99

100 Our finding that females were more likely to adopt a weight loss diet than males is consistent  
101 with the general population (Martin, Herrick, Sarafrazi, & Ogden, 2018) and a large survey of  
102 prevalent MS cases ( $n=6989$ ) (Fitzgerald et al., 2018). Likewise, our findings that low-calorie  
103 and low-carbohydrate diets were the most popular weight loss diets are consistent with a large  
104 survey of pwMS (Fitzgerald et al., 2018).

105

106 A limitation of our study is that we did not capture other dietary weight loss efforts participants  
107 may have been making after symptom onset or diagnosis, such as reducing the consumption of  
108 unhealthy foods. We also cannot exclude the possibility that, with longer duration of follow-up,  
109 case participants may have been more likely to engage in specific diets than control  
110 participants. Furthermore, we did not examine the relationship between the likelihood of  
111 adopting a diet and other variables that may influence dieting, such as MS phenotype, disability  
112 status, physical activity, alcohol consumption, comorbidities, and family history of obesity.

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## 114 **5.0 Conclusions**

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116 Our findings support the need for MS-focussed nutrition education, with an emphasis on healthy  
117 approaches to weight loss for those who are overweight or obese. Only one study has reported  
118 the development and feasibility of a dietary education program for pwMS (Riemann-Lorenz et  
119 al., 2016), but it had overall low participant satisfaction and was a largely white study population.  
120 Furthermore, there is no evidence regarding the effective elements of dietary education to elicit  
121 behavior change or weight loss in pwMS. Such programs, particularly ones targeted to ethnic  
122 diversity and males, should be developed and evaluated in randomized controlled trials.

### 123 **Author contributions**

124  
125 **R. D Russell:** Writing - Original Draft, Visualization. **A. Langer-Gould:** Conceptualization,  
126 Funding acquisition, Writing - Review & Editing. **E. G. Gonzales:** Writing - Review & Editing. **J.**  
127 **B. Smith:** Formal analysis, Writing - Review & Editing. **V. Brennan:** Writing - Original Draft. **G.**  
128 **Pereira:** Formal analysis. **R. M. Lucas:** Writing - Review & Editing. **A. Begley:** Writing - Review  
129 & Editing. **L. J. Black:** Supervision, Formal analysis, Writing - Review & Editing  
130

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