

Comparison of sedentary behaviour questionnaires in people with multiple sclerosis

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1 **Abstract**

2 **Background:** People with multiple sclerosis are at risk of developing co-morbidities
3 associated with sedentary behaviour. Despite an increase in studies examining sedentary
4 behaviour in multiple sclerosis, researchers have not yet examined the appropriateness of the
5 content or format of questionnaires assessing sedentary behaviour in multiple sclerosis.

6 **Objective:** Evaluate perceptions of sedentary behaviour questionnaires for people with
7 multiple sclerosis.

8 **Methods:** Fifteen people with multiple sclerosis completed six validated sedentary behaviour
9 questionnaires: Longitudinal Ageing Study Amsterdam, Marshall Sitting Questionnaire,
10 International Physical Activity Questionnaire, Measure of Older Adults Sedentary Time,
11 Sedentary Behaviour Questionnaire and SIT-Q. Participants' perceptions regarding
12 questionnaire content and format were explored by interviews.

13 **Results:** Self-reported sedentary time ranged between a mean of 470 (standard deviation 260)
14 (Measure of Older Adults Sedentary Time) and 782 (322) minutes (Longitudinal Ageing
15 Study Amsterdam) per weekday. Analysis of variance revealed a significant effect of
16 questionnaire on mean sitting time: Longitudinal Ageing Study Amsterdam and SIT-Q
17 yielded higher mean estimates of weekday sitting time than other questionnaires. The
18 questionnaires were viewed as being suitable for use in multiple sclerosis but failed to capture
19 some sedentary activities. Variability of symptoms yielded difficulties in describing a
20 "typical day".

21 **Conclusions:** The questionnaires were considered suitable for multiple sclerosis but
22 produced variation in estimated sedentary time. Future work might validate questionnaire
23 data with device-based assessments of sedentary time.

24 Key words: Multiple sclerosis, sedentary behaviour, sitting, questionnaire, self-report.

25 **Background**

26 Multiple sclerosis (MS) is a chronic neurological disease with symptoms such as muscle
27 spasms and weakness, fatigue, poor balance and visual problems [1]. As there is no cure for
28 MS, treatment is focused on reducing inflammation, relapses, and disease progression, as
29 well as symptom management and restoration of function. There is substantial evidence that
30 physical activity and exercise can improve cardio-respiratory fitness, muscle strength, quality
31 of life, walking mobility and fatigue in MS [2, 3, 4, 5] without increasing the risk for relapse
32 [6]. Yet, the majority of people with MS do not meet public health guidelines for levels of
33 physical activity and are therefore considered physically inactive [7]. The search for other
34 health behaviour change opportunities in this population has prompted interest in the other
35 end of the activity spectrum, namely sedentary behaviour [8].

36 Sedentary behaviour is distinct from physical inactivity and is defined as “any waking
37 behaviour characterised by an energy expenditure ≤ 1.5 Metabolic Equivalent Units (METs)
38 while in a sitting, lying or reclining posture” [9]. Evidence from prospective and
39 epidemiological studies in the general adult population suggests greater levels of sedentary
40 behaviour are associated with an increased risk of all-cause, cardiac and cancer-related
41 mortality, as well as incidence of cardiovascular disease, cancer and type II diabetes [10].
42 Importantly, those associations are independent of physical activity [11]. People with MS
43 have a higher risk for cardiovascular comorbidities, such as stroke, myocardial infarction, and
44 heart failure compared to the general population [12, 13], and sedentary time has been
45 positively associated with blood pressure in MS [14]. Addressing sedentary behaviour could
46 therefore present a suitable approach to improve health outcomes in people with MS

47 Despite the assumption that people with MS lead a sedentary lifestyle, relatively few studies
48 have examined sedentary behaviour in this population [15]. To date, both objective devices
49 (e.g., accelerometers and activPALs) and questionnaires have been used to quantify levels of
50 sedentary behaviour in MS, estimating daily sedentary time to be between 7.5 hours [16] and
51 10.5 hours in this patient population[17]. Most consistently, studies have reported that
52 greater levels of sedentary behaviour are associated with more severe disability [8, 16, 18,
53 19]. In order to explore factors related to sedentary behaviour in people with MS, it is
54 important to evaluate the assessment of sedentary behaviour in this population. Few studies
55 have scrutinized the measurement of self-reported sedentary behaviour using questionnaires
56 in MS.

57 There are a multitude of self-report questionnaires available for measuring sedentary
58 behaviour. These questionnaires vary in the type and number of questions, as well as the
59 recall period of sedentary activities [20]. The questionnaires have been developed for
60 specific populations (e.g. older adults), but the appropriateness of these questionnaires and
61 content for people with MS remains to be studied. The current study therefore used existing
62 questionnaires to explore sedentary behaviour in people with MS. Perceptions of participants
63 regarding these questionnaires were also investigated. This included opinions related to ease
64 of completion, the clarity of the questions, as well as the overall accuracy of the
65 questionnaires and appropriateness of the items for the participant.

66 **Methods**

67 **Participants**

68 Participants were recruited from MS outpatient clinics at the Dudley Group of Hospitals NHS
69 Trust (N = 15). Inclusion criteria were a neurology consultant confirmed diagnosis of MS
70 and proficient in English language. Ethical approval for the study was granted by the East of

71 Scotland Research Ethics Service (Reference number: 15/ES/0194). All participants gave
72 written informed consent for participation in the study.

73 **Procedure**

74 Each of the fifteen participants attended a single visit to Dudley Guest Hospital. At the start
75 of the visit demographic information and clinical characteristics were obtained. Participants
76 then completed six sedentary behaviour questionnaires, which asked them to recall time spent
77 in specific sedentary behaviours and/or total time spent sitting in general or retrospectively
78 according to various time frames (e.g., previous week or previous year). After completion of
79 the questionnaires, a semi-structured interview related to their perceptions of each
80 questionnaire was conducted. Five participants attended with relatives who assisted them in
81 answering the questionnaires. Relatives were also able to contribute to the interview where
82 appropriate.

83 **Questionnaires**

84 *Patient Determined Disease Steps (PDDS)*[21]. This questionnaire assesses perceived
85 disease severity based on the individual's walking ability. Individuals indicate their disease
86 severity on a scale from 0 (mild symptoms which do not limit activity) to 8 (bedridden and
87 unable to sit in a wheelchair for more than one hour). Scores on the PDDS are strongly
88 associated with scores on the physician determined Expanded Disability Status Scale [22].

89 ***Sedentary Behaviour Questionnaires***

90 *The Longitudinal Ageing Study Amsterdam (LASA)* [23]. This questionnaire consists of ten
91 sedentary behaviours (taking a nap on a chair or couch, reading, listening to music, watching
92 television or DVD's, performing a hobby such as knitting or jigsaws, talking with others in
93 person or on the phone, sitting at the computer, performing administrative tasks such as

94 writing a letter or having a meeting, sitting in a car, bus or train, and visiting a church or
95 movie theatre). Participants were asked to state how many hours and minutes on a weekday
96 and weekend day they spent undertaking each behaviour. In adults aged 65-92 years, test-
97 retest reliability calculated using intra-class correlation coefficients (ICC) was good at 0.71,
98 and weak correlations between self-reported and accelerometer-based assessments of
99 sedentary time were reported (Spearman's $\rho = 0.35$, $p < 0.05$) [23].

100 *The Marshall Sitting Questionnaire (MSQ)* [24]. This questionnaire requires participants to
101 report hours and minutes spent sitting on a weekday and weekend day in five categories:
102 travel, work, television viewing, computer use and other leisure pursuits. In adults aged 45-
103 63 years, weekday work-based sitting time and home computer use had the highest intra-class
104 correlation coefficients (ICC = 0.53 – 0.77), with very poor validity demonstrated for all
105 weekend day items. Reliability tests ranged from low to good (ICC = 0.24 – 0.84) across
106 different activities with poorer test-retest reliability for weekend days than weekdays [24].

107 *International Physical Activity Questionnaire - Sedentary question (IPAQ)* [25]. This forms
108 part of a longer questionnaire about a range of physical activities. Participants are asked to
109 report how much time they spent sitting on average on a weekday and a weekend day in the
110 last seven days. In middle-aged adults, test-retest reliability was good with most of the
111 Spearman's correlation coefficients above 0.65. Criterion validity measured against
112 accelerometer data was fair to moderate (Spearman's $\rho = 0.26-0.39$) [25].

113 *Measure of Older Adults Sedentary Time (MOST)* [26]. This questionnaire asks participants
114 for the total time in the last week spent on six specific sedentary behaviours (e.g., watching
115 television or DVD's, using the computer/internet, reading, socialising with friends or family,
116 driving or riding in a car or on public transport, doing hobbies such as craft or crosswords)
117 and "other activities" for those not specified. For retired adults (mean age = 73 years), ICC's

118 for test-retest reliability for total sedentary time ranged from low to good (ICC = 0.23 for
119 other sedentary activities, ICC = 0.90 for computer use). A moderate association was
120 observed between questionnaire-assessed total sedentary time (the sum of all sedentary
121 behaviours) with accelerometer-assessed sedentary time (Spearman's $\rho = 0.02 - 0.54$) [26].

122 *Sedentary Behaviour Questionnaire (SBQ)* [27]. This questionnaire asks about nine different
123 sedentary behaviours: watching television, playing computer/video games, listening to music,
124 talking on the phone, doing paperwork or office work, reading, playing a musical instrument,
125 doing arts and crafts and sitting driving/riding in a car bus or train. Participants indicate the
126 amount of time that they spent undertaking each on a grid with nine options ranging from
127 "none" to "6 hours or more". Test-retest reliability, in adults (mean age = 20 years), for all
128 items in the questionnaire was better for weekdays (ICC = 0.64 - 0.9) than weekends (ICC =
129 0.51 - 0.93). Partial correlations (adjusted for potential confounders) between questionnaire-
130 assessed sedentary time with accelerometer-assessed sedentary time were low overall
131 (highest $r = 0.26$) in women with no significant correlations in men) [27].

132 *SIT-Q* [28]. This questionnaire consists of 18 multi-part questions. Participants are asked to
133 indicate the usual amount of time that they spent sitting or lying down during work and
134 leisure time over the past twelve months. The sedentary behaviours included work-based
135 sitting, to sitting during mealtimes or while caring for a child or elderly relative. For average
136 past-year total sedentary time in adults, test-retest reliability was fair (ICC = 0.53).
137 Spearman's ρ associations between SIT-Q and objectively assessed sedentary behaviour
138 ranged between 0.22 and 0.37. The questionnaire generally overestimated sedentary time
139 when compared with objective measures [29].

140 ***Perceived ease and accuracy of questionnaires***

141 Table 1 shows the questions the participants were asked regarding their perceptions of the
142 ease of completion of the questionnaires and their accuracy.

143 *Open-ended interview questions*

144 Table 2 displays the questions that participants were asked about each questionnaire as part of
145 the semi structured interviews. Each participant was also asked to choose their most and least
146 favourite questionnaire. The responses to the open-ended questions were voice recorded.

147 **Data analysis**

148 Questionnaire data were analysed using IBM SPSS version 22. The main analysis involved a
149 2 Day (weekday, weekend day) by 6 Questionnaire (LASA, Marshall Sitting, IPAQ, MOST,
150 SBQ and SIT-Q) within-subject analysis of variance (ANOVA), with Greenhouse-Geisser
151 correction. Sedentary behaviour assessed by MOST provides an overall score of sitting time
152 for a week. In order to compare values between questionnaires, we have calculated a daily
153 average by dividing the overall score by 7. Given that the MOST does not make a distinction
154 between week and weekend days, the same value for sedentary behaviour was used for both
155 days for this questionnaire. All other questionnaires specify sedentary behaviour during
156 week and weekend days separately. To check for the influence of the MOST on the effect of
157 day, we conducted an additional 2 Day by 5 Questionnaire (LASA, Marshall Sitting, IPAQ,
158 SBQ and SIT-Q) within-subjects ANOVA. These analyses revealed similar findings as those
159 with the MOST included. Therefore, it was decided to report the analyses which included the
160 MOST. Differences in evaluation scores regarding perceived ease and accuracy between the
161 questionnaires were explored using separate 6 Questionnaire (LASA, Marshall Sitting, IPAQ,
162 MOST, SBQ and SIT-Q) within-subject ANOVAs. Where appropriate, post hoc analyses
163 (Least Significant Differences) were conducted. Statistical significance was set at $p < .05$,

164 and η^2 is reported as a measure of effect size with $\eta^2= 0.01$, $\eta^2= 0.06$ and $\eta^2= 0.14$ used for
165 small, medium and large effect size, respectively [30].

166 The interview recordings were transcribed verbatim by the first author. Interviews were
167 analysed using the six-stage thematic analysis process shown in Table 3 [31], in order to
168 summarise and identify patterns within the data. The process involved reading the transcripts
169 thoroughly, highlighting statements viewed as significant and those which recurred between
170 different interviews. This allowed the generation of codes to identify interesting features of
171 the data. Initial themes were reviewed by a second researcher, who was not involved in
172 conducting the interviews. The second researcher read through the interview transcripts, and
173 the initial coding. They offered feedback on possible overlap of themes and codes to assist
174 with refining the data into broad themes.

175 **Results**

176 **Participants**

177 Twelve women and three men participated in this study. The mean age \pm standard deviation
178 (SD) of the participants was 49.7 ± 10.2 years (range: 29 - 49 years), PDDS score of 2.8 ± 1.6
179 (range 0-7), and disease duration was 10.4 ± 6.9 years (range: 0.5 – 24 years). The
180 demographic information is provided per participant in Table 4.

181 [Table 4 & Table 5 to be inserted near here]

182 **Self-reported sedentary time**

183 Mean self-reported sedentary time is reported in Table 5. Sedentary time during weekdays
184 ranged between 470 ± 260 minutes per day measured by the MOST and 782 ± 322 minutes
185 assessed per day by the LASA. For weekend days, mean self-reported sedentary time was
186 lower, ranging between 443 ± 287 minutes (IPAQ) and 664 ± 297 (LASA) minutes per day.

187 Values for the MSQ for both weekdays and weekend days most closely mapped to overall
188 mean self-reported sedentary time across the six questionnaires.

189 The 2 Day by 6 Questionnaire ANOVA yielded an overall effect for questionnaire ($F(3,34)$
190 $=7.37, p=.001, \eta^2=.362$). Post hoc analyses revealed that weekly reported sedentary time was
191 higher on the LASA and SIT-Q compared with the other questionnaires. No differences were
192 observed between LASA and SIT-Q, nor were the responses on the MSQ, IPAQ, MOST and
193 SBQ different from one another. There was no main effect for day (weekday vs. weekend
194 day ($F(1,13)=1.30, p=.275, \eta^2=.091$). There was also no significant day by questionnaire
195 interaction ($F(3,37)=0.55, p=.639, \eta^2=.041$).

196 **Participants' perceptions of the sedentary behaviour questionnaires**

197 Table 6 reports the results of the evaluation of the questionnaires as well as the results from
198 the ANOVAs exploring any differences in scores between questionnaires. Results revealed
199 significant differences in the participants' perceived clarity of the questionnaire ($F(3,30)=$
200 $3.03, p=.04, \eta^2=.252$), accuracy of the questionnaires ($F(2,18)=3.87, p=.037, \eta^2=.326$), and
201 perceived suitability for their age ($F(3,22)=4.48, p=.015, \eta^2=.359$). Post hoc analyses
202 indicated that overall, the SBQ was perceived to have the clearest instructions and the MOST
203 was perceived as most suitable for people of participants' age. The SBQ and the MOST were
204 perceived to be the most accurate questionnaires. The SBQ was chosen as the favourite
205 questionnaire by 10/15 participants. Not all participants identified a questionnaire as least
206 favourite.

207 [Table 6 to be inserted near here]

208 **Responses to open-ended questions about the questionnaires**

209 Following the six-stage thematic analysis process, three broad themes emerged from the
210 semi-structured interviews: 1) Issues around questionnaire completion and suitability for
211 MS, 2) Feelings about reporting sedentary behaviour, and 3) Recording of additional
212 sedentary behaviours.

213 [Table 3 to be inserted near here]

214 *1) Issues around questionnaire completion and suitability for MS*

215 Participants preferred questionnaires which were laid out clearly without too many
216 instructions or the requirement for lengthy writing. The SBQ and MOST were viewed
217 favourably because of the grid format, allowing for easy reading and completion for
218 individuals who may experience problems with hand function. *“The tick box answer is really
219 the best for people with (MS). ...If you haven’t got the mobility skills in your hands it’s more
220 difficult to fill in the numbers.”* Related to SBQ, husband of Participant 13.

221 Day to day variability of MS symptoms is significant and the range of activities on any one
222 day was also variable. Participants felt that questionnaire accuracy may be limited by the
223 requirement for data on time spent sitting on an “average day”. Some participants also
224 highlighted the questions about employment as not being appropriate for people with their
225 condition. Comments about the limitations of the questionnaires included the difficulty of
226 being precise about numbers of minutes spent sitting or in specific sedentary behaviours (all
227 questionnaires apart from the SBQ). Participants also highlighted unpredictable daily or
228 weekly schedules due to family commitments, work or study patterns, or social activities,
229 may also affect the accuracy of their self-reported sedentary time. *“...Each week is so
230 different,so you just spend it on what you do most of the time”* Participant 6.

231 Participants preferred to break down the time by day, rather than add up sedentary hours over
232 a week as required by the MOST.

233 *2) Feelings about reporting sedentary behaviour*

234 Many participants felt negatively about reporting time spent doing sedentary behaviours. *“It*
235 *makes me look really lazy because it’s all to do with sitting down. Is this because you think*
236 *that people with MS sit down more?”* Participant 15.

237 The reporting of sedentary time also emphasised lost activities that participants were no
238 longer able to undertake as a result of their MS. *“It just reinforces the fact that that is a big*
239 *part of her life, the resting, the napping, the watching the tv..... It’s a fact with the MS she*
240 *can’t get up and about and do a lot of things”* Husband of Participant 13.

241 People felt particularly negatively about spending long periods watching the television. *“You*
242 *look at it and think ‘70 hours watching the television.’ Did I really do that?”* Participant 12.

243 Some people commented positively however about their enjoyment of sitting to socialise or
244 enjoy a meal. *“Sitting can be quite important..... getting the chance to interact and be a*
245 *family”*. Participant 11.

246 *3) Recording of additional sedentary behaviours*

247 There were also some participants who felt that not all questionnaires included an appropriate
248 range of sedentary behaviours. Additional sedentary behaviours not covered included styling
249 hair, bathing, and other personal grooming tasks. Sitting could also be accrued during caring
250 activities, which were not always covered in the questions. *“When I sit down it’s not always*
251 *for leisure time, I might be feeding my children or changing nappies or playing games which*
252 *is generally when I sit. To me that’s not leisure time but that’s the only real way of putting it*
253 *down”* Participant 3.

254 Browsing the internet on their mobile phone rather than a desktop computer was also
255 mentioned. The MOST and SIT-Q both allow participants to record additional sedentary
256 behaviours not specifically detailed in the questions, which was seen as positive to aid
257 accuracy of the questionnaires as a whole.

258 **Discussion**

259 Self-reported sedentary time in this group of people with MS ranged between 7.8 and 13.0
260 hours on weekdays and 7.4 and 11.0 hours on weekends. This amount of sedentary time is
261 consistent with other studies of people with MS which used device-based measures
262 [32],[33]). The recorded time spent sitting was significantly different between
263 questionnaires, with a large effect size [30]. Opinions of the questionnaires were generally
264 positive with participants rating questionnaires as having clear instructions, giving an
265 accurate account of their sedentary behaviour and being suitable for their age. Due to its
266 clear layout and perceived ease of completion the SBQ was most frequently reported as the
267 favourite questionnaire. The SIT-Q was most frequently reported as least favourite due to its
268 length and the complexity of questions.

269

270 For the LASA and SIT-Q sedentary time was reported to be significantly higher compared to
271 the other questionnaires. Differences in the structure and phrasing of the questionnaires may
272 account for some of this variation. The SIT-Q includes the largest number of questions
273 (eighteen questions), and thus more prompts to assist in recalling various sedentary
274 behaviours. The LASA and SBQ are similar in the number and types of sedentary behaviours
275 included, but the LASA has more detailed instructions and requires participants to report the
276 actual time spent undertaking specific behaviours. In the SBQ, participants indicate on a grid
277 the range of time spent in each sedentary behaviour. The ranges vary from 15 min or less to 6

278 hrs or more. Thus, when a sedentary behaviour is undertaken for more than 6 hours, this is
279 recorded as 6 hours, which can underestimate actual sedentary time. Indeed, one participant
280 stated that she often sits for 7 or 8 hours at work and others indicated watching television for
281 6 hours or more, leading to a ceiling effect with the SBQ. Variations in reported amounts of
282 physical activity may result from the balance of open and closed ended questions[34], which
283 may impact the data obtained from sedentary behaviour questionnaires in the same manner.
284 Interestingly, the SBQ was the only closed ended questionnaire, reported as the favourite
285 questionnaire by 66% of participants and was highly rated for accuracy. The MOST, which
286 asks participants to add up overall weekly time spent in different sedentary behaviours was
287 also highly rated for accuracy. The SIT-Q, which was the longest and most detailed
288 questionnaire, was viewed less favourably by participants, being scored as the overall least
289 favourite of 60% of our sample. In contrast, the IPAQ which includes a single question about
290 weekday/weekend sitting was not perceived favourably. Thus, a relatively short
291 questionnaire which covers a range of relevant sedentary behaviours with an easy format
292 appears to be viewed most positively. Assessing self-reported sedentary behaviour by the
293 sum of a number of relevant behaviours has also been shown to have the closest agreement
294 with objective measures [20].

295

296 Examining individual sedentary behaviours, watching television was the most prevalent
297 behaviour (an average of 3.9 hours per day across questionnaires), which is consistent with
298 other studies [23, 26]. Assessing engagement in other activities such as use of a mobile
299 phone or tablet whilst sedentary, were highlighted by some participants as an omission. This
300 may reflect a shift in behaviours that people do more commonly now than when the
301 questionnaires were first developed. It has been suggested that the range of environments in
302 which sedentary behaviours take place should be considered and should include the

303 workplace, transportation and leisure [35]. Apart from the IPAQ, all questionnaires do reflect
304 this range of environments. The range of sedentary behaviours proposed in each
305 questionnaire were generally perceived by participants as being appropriate. It is worth
306 noting that three participants specifically mentioned that they liked the opportunity provided
307 by the MOST to record additional sedentary behaviours.

308

309 Two questionnaires (the LASA and the SIT-Q) include napping as an example of a sedentary
310 behaviour. Napping is a non-waking behaviour, which is not in alignment with the globally
311 recognised definition of sedentary behaviour (i.e., waking behaviours)[9]. Interestingly
312 napping was highlighted by some participants as being part of living with MS, with 60% of
313 participants reporting taking a daytime nap at some point during the week. However, others
314 felt it was not something they or others their age would do. Analysis showed the MOST,
315 which does not include napping, to be perceived as significantly more suitable for
316 participants' age than the other questionnaires. The LASA and the SIT-Q, the two
317 questionnaires which mention napping, also have the highest reported amount of sedentary
318 time of all questionnaires. However, the average time for a nap was quite short, only 21-25
319 minutes for the LASA, and 28-30 minutes for the SIT-Q, therefore the higher self-reported
320 sedentary behaviour is unlikely to be due to the inclusion of napping. Misclassification of
321 napping as a sedentary behaviour has been previously reported [36], and this highlights the
322 need for the consistency of criteria and to increase awareness of the definition of sedentary
323 behaviour when examining factors related to sedentary behaviour.

324 Questionnaires which make a distinction between sedentary time during the week and during
325 the weekend are observed to have greater accuracy compared to those that do not make this
326 distinction [20]. In this sample of people with MS, although the difference between weekdays

327 and weekend days was not statistically significant, participants reported sitting for 72 (\pm 32)
328 minutes per day more on weekdays than weekends. There was substantial variation between
329 participants in the difference between sedentary behaviour reported on weekdays and
330 weekend days, which could perhaps be due to the employment status of our participants.
331 Indeed, eight participants (53%) reported being in employment or education, and secondary
332 analyses revealed that those who were employed/in education spent less time sedentary for
333 transport at weekends than on weekdays, whereas those not employed spent more time
334 sedentary for transport at weekends. In addition, non-significant differences were found for
335 reading and computer work between employed and non-employed participants. In line with
336 this, Aminian and colleagues [37] reported that participants who were employed felt that the
337 nature of their jobs, particularly office work, led to higher amounts of sitting during a work
338 day. Differences between sedentary behaviour during weekdays and weekend days have
339 been reported in some studies [38] but not all [23]. Differences in waking hours between
340 week and weekend days could perhaps contribute to this [33]. None of the surveyed
341 questionnaires asked about length of waking day, and it is not possible to determine if waking
342 day influenced our findings. Variations could also result from different types of social,
343 leisure and transport activities [28] [23]. For example, in our sample 10/15 participants
344 indicated spending more time for meals on weekends compared to weekdays. Further
345 research in a larger sample of people with MS is necessary to explore factors which may
346 influence variability in sedentary time in more detail.

347 Participants perceived a negative bias about completing all six sedentary behaviour
348 questionnaires together, stating the lack of opportunity to provide a full picture of their daily
349 activities. Some participants wished to report non-sedentary behaviours such as dog walking
350 and housework, as they felt that these were important ways that they spent their time. This is
351 possibly due to the artificial nature of being asked to complete the six questionnaires in one

352 visit, and may not have been the case if asked to complete a single questionnaire, or in
353 conjunction with questionnaires regarding physical activity. However, there is evidence that
354 people with MS share a belief that sedentary behaviour has a harmful impact on their health
355 [35]. Some were surprised by the length of time that they spent undertaking some sedentary
356 behaviours, particularly watching television and mentioned feeling ‘lazy’ as they were adding
357 up the hours. Other studies [39], [37] similarly found that participants reported having little
358 awareness of the amount of time that they spent sedentary before taking part in the study.
359 Our study did not include any attempts to change sedentary behaviour but several participants
360 stated that they intended to increase their activity levels after taking part. *“Looking at it on*
361 *paper I’ve realised how long I sit down and that I should make myself move more.”*

362 *Participant 6*

363 **Limitations of the study**

364 By design this is a detailed but otherwise relatively small-scale study of voluntary
365 participants with MS. It was important to capture the full spectrum of MS reflected in a wide
366 range of time since diagnosis (6 months – 24 years) but as a result there is a degree of
367 population heterogeneity including a broad range of PDDS scores (0-7). Overall the majority
368 of participants had relatively low disease severity. Completing six sedentary behaviour
369 questionnaires at one session may also potentially influence answers as a consequence of
370 easier recall and training effects when undertaking subsequent questionnaires, balanced
371 against fatigue. The questionnaires were also completed in the same order by all participants,
372 perhaps leading to a more negative emotional state and greater fatigue during the latter
373 questionnaires that were completed.

374 The self-reported nature of the targeted questionnaires should be acknowledged. As
375 indicated above, underestimation of self-reported sedentary behaviour compared to device-

376 based assessments of sedentary behaviour has been reported in older adults [26] and people
377 with MS,[36],even though a moderate correlation,[was found between objective and self-
378 reported sitting time [40]. This aspect was highlighted by a number of participants, possibly
379 suggesting an impact from direct or indirect (for example medication related) cognitive
380 difficulties. There may also be overestimation of some sedentary behaviours, when a
381 questionnaire asks for a sum of behaviours during a particular time period or lists activities
382 which could occur concurrently [20]. However, the advantage of using self-report
383 questionnaires is that information about the types of sedentary behaviour is captured, which
384 could provide important information for the development of interventions to reduce sedentary
385 behaviour.

386 **Implications for future research**

387 Future work should combine self-report questionnaires with device-based assessments of
388 sedentary behaviour, to determine which questionnaire represents the most valid assessment
389 of sedentary time for people with MS. The questionnaires focus on overall sitting time,
390 however, there is evidence that the way sitting is accumulated throughout a day has health
391 impacts [42]. The SIT-Q is the only questionnaire to explicitly ask participants about the
392 frequency of breaks in their sedentary time (e.g. less than hourly, hourly, half hourly, every
393 ten minutes, every five minutes). Given that there is some evidence that sedentary time was
394 accumulated in longer bouts in people with MS compared to healthy controls [32, 33], it
395 would be interesting to explore if it is possible to assess breaks in sedentary behaviour using
396 self-report in people with MS. Indeed, lack of detail in questionnaires about the length of
397 sedentary bouts and frequency of sedentary breaks was mentioned in one of our interviews as
398 a limitation.

399 **Conclusion**

400 Consistent with other work, this study demonstrates that people with MS report high total
401 daily sedentary time. However, variation in total sedentary time is observed depending on
402 the specific questionnaire employed, the range of questions asked, and the manner in which
403 they are framed. Participants reported the SBQ as the overall favourite questionnaire, due to
404 having a clear layout and providing tick boxes for answer options. Future studies should
405 consider employing both subjective and device-based measures of sedentary behaviour
406 concurrently to determine their level of agreement in measuring sedentary behaviour.

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411 **Declaration of interest**

412 The authors report no conflicts of interest.

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Table 1: Perceived ease and accuracy of questionnaires

1. How clear are the instructions on the questionnaire?^
 2. How easy was the questionnaire to complete?^
 3. How accurate an account of your sedentary activities does this questionnaire give?^
 4. How suitable is this questionnaire for people of your age?^
-

Note: ^Scored on a scale from 1 (very clear, easy, accurate, and suitable) to 10 (very unclear, difficult, inaccurate, and unsuitable).

Table 2: Questions asked in semi-structured interviews

5. Was there anything you found confusing or anything you would change about this questionnaire?
 6. What were you thinking about when rating this questionnaire?
 7. Are there any sedentary activities that you do that were not covered by this questionnaire?
 8. Do you have any other comments about this questionnaire to help us with our research?
-

Table 3: Six phases of thematic analysis (Braun and Clark 2006)

1	Familiarizing yourself with your data	Transcribing reading and re-reading the data, noting initial ideas
2	Generating initial codes:	Coding interesting features of the data systematically across the entire data set, collating data relevant to each code.
3	Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme
4	Reviewing themes	Checking if the themes work in relation to the coded extracts and the entire data set.
5	Defining and naming themes	Ongoing analysis to refine the specifics of each theme, generating clear definitions and names for each theme.
6	Producing the report	Selection of extract examples, final analysis of selected extracts, relating the analysis to the research question, producing a report of the analysis.

Table 4: Participant demographic information

Study ID	Sex	Age (Years)	Disease Duration (years)	Patient Determined Disease Steps (PDDS)	Employment
1	F	49	5 years	1	Full time
2	M	48	6 months	0	Full time
3	F	34	8 years	3	Not employed
4	F	51	24 years	4	Full time
5	F	29	18 months	0	Full time
6	F	60	18 years	4	Part time
7	M	68	20 years	2	Retired
8	M	47	8 years	2	Not

9	F	59	11 years	3	employed
10	F	42	6 years	4	Full time
					Not
11	F	45	18 months	0	employed
					Full time
12	F	68	17 years	7	student
13	F	48	24 years	6	Retired
					Not
14	F	29	5 years	3	employed
15	F	69	6 years	3	Part time
					Retired

Table 5: Mean (SD) minutes spent in sedentary behaviours on weekdays and weekend days

Questionnaire	Weekday (minutes)	Weekend day (minutes)
LASA	782 (322)	664 (297)
Marshall Sitting	592 (200) ^{a, b}	492 (249) ^{a, b}
IPAQ	484 (248) ^{a, b}	443 (287) ^b
MOST	470 (260) ^{a, b}	470 (260) ^b
SBQ	488 (185) ^{a, b}	466 (130) ^{a, b}
SIT-Q	716 (236)	638 (215)
Overall Mean	589 (133)	529 (96)

^a= significantly different from LASA, $p < .05$, ^b= significantly different from SIT-Q, $p < .05$

Table 6: Mean (SD) evaluation scores for each of the questionnaires and results of Analyses of Variance

Measures	LASA	Marshall sitting	IPAQ	MOST	SBQ	SIT-Q	F-value	p-value	η^2
How clear are the instructions on the questionnaire? ^a	2.57 (1.18)	2.47 (1.55)	2.23 (1.74)	1.96 (1.09)	1.43 (0.51)	2.71 (1.73)	3.03	.04	.252
How easy was the questionnaire to complete? ^a	2.57 (1.76)	2.40 (1.80)	2.89 (2.42)	2.46 (1.69)	1.36 ^b (0.50)	3.07 (1.87)	2.09	.129	.148
How accurate an account of your sedentary activities does this questionnaire give? ^a	3.31 (1.49)	3.43 (1.82)	3.00 (2.50)	1.65 ^c (0.85)	1.85 ^d (1.14)	3.03 (1.56)	3.87	.037	.326
How suitable is this questionnaire for people of your age? ^a	2.43 (1.43)	2.73 (1.76)	3.00 (1.48)	1.50 (0.80)	1.64 (1.01)	3.11 (1.67)	4.48	.015	.359
Chosen as favourite questionnaire by	1	2		2	10				
Chosen as least favourite questionnaire by	2		1			9			

Note: ^a scored on a scale from 1 ‘very clear, easy, etc...’ to 10 ‘very unclear, difficult, etc’, η^2 measure of effect size

^bSignificantly different from all other questionnaires, $p < .05$

^cSignificantly different from LASA, Marshall Sitting, and SIT-Q, $p < .05$.

^dSignificantly different from LASA, Marshall Sitting, IPAQ and SIT-Q, $p < .05$