Comparison of sedentary behaviour questionnaires in people with multiple sclerosis

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Abstract

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

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

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

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

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

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

Background

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

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

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

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

Methods

Participants

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

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

Procedure

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

Questionnaires

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

Sedentary Behaviour Questionnaires

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

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

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

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

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

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

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

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

Perceived ease and accuracy of questionnaires

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

Open-ended interview questions

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

Data analysis

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

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

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

Results

Participants

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

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

Self-reported sedentary time

Mean self-reported sedentary time is reported in Table 5. Sedentary time during weekdays ranged between 470 ± 260 minutes per day measured by the MOST and 782 ± 322 minutes assessed per day by the LASA. For weekend days, mean self-reported sedentary time was 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, η^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, η^2= .091). There was also no significant day by questionnaire
195 interaction (F (3,37) = 0.55, p=.639, η^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, η^2 = .252), accuracy of the questionnaires (F (2,18) =3.87, p=.037, η^2=.326), and
201 perceived suitability for their age (F (3,22) = 4.48, p = .015, η^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**

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

[Table 3 to be inserted near here]

1) Issues around questionnaire completion and suitability for MS

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

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

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

2) Feelings about reporting sedentary behaviour

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

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

People felt particularly negatively about spending long periods watching the television. *"You look at it and think '70 hours watching the television.' Did I really do that?*" Participant 12.

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

3) Recording of additional sedentary behaviours

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

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

Discussion

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

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

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

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

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

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

visit, and may not have been the case if asked to complete a single questionnaire, or in conjunction with questionnaires regarding physical activity. However, there is evidence that people with MS share a belief that sedentary behaviour has a harmful impact on their health [35]. Some were surprised by the length of time that they spent undertaking some sedentary behaviours, particularly watching television and mentioned feeling 'lazy' as they were adding up the hours. Other studies [39], [37] similarly found that participants reported having little awareness of the amount of time that they spent sedentary before taking part in the study. Our study did not include any attempts to change sedentary behaviour but several participants stated that they intended to increase their activity levels after taking part. *"Looking at it on paper I've realised …. how long I sit down and that I should make myself move more."* *Participant 6*

Limitations of the study

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

The self-reported nature of the targeted questionnaires should be acknowledged. As 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**

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

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Declaration of interest

The authors report no conflicts of interest.

References

1. Compston A, Coles A. Multiple Sclerosis. Lancet. 2008;372:1502-17.
2. Latimer-Cheung AE, Pilutti LA, Hicks AL, et al. Effects of exercise training on fitness, mobility, fatigue, and health-related quality of life among adults with multiple sclerosis: a systematic review to inform guideline development. Arch Phys Med Rehabil. 2013 Sep;94(9):1800-1828 e3. doi: 10.1016/j.apmr.2013.04.020. PubMed PMID: 23669008.
3. Snook EM, Motl RW. Effect of exercise training on walking mobility in multiple sclerosis: A meta-analysis. Neurorehabilitation and Neural Repair. 2009;23(2):108 - 116.
4. Pilutti LA, Greenlee T A, Motl RW, et al. Effects of Exercise Training on fatigue in multiple sclerosis: A meta-analysis. Psychosomatic Medicine. 2013;75:575 - 580. doi: 10.1097/PSY.0b013e31829b4525.
5. Motl RW. Lifestyle physical activity in persons with multiple sclerosis: the new kid on the MS block. Multiple Sclerosis Journal. 2014;20(8):1025 - 1029.
6. Pilutti LA, Platta M, Motl R. W, et al. The safety of exercise training in multiple sclerosis: A systematic review. Journal of the Neurological Sciences,. 2014;343:3-7.
7. Klaren RE, Motl RW, Dlugonski D, et al. Objectively quantified physical activity in persons with multiple sclerosis. Arch Phys Med Rehabil. 2013 Dec;94(12):2342-8. doi: 10.1016/j.apmr.2013.07.011. PubMed PMID: 23906692.
8. Sasaki JE, Motl RW, Cutter G, et al. Factors associated with excessive sitting time in multiple sclerosis. Multiple Sclerosis and Related Disorders. 2018;21:71 - 77.
9. Tremblay MS, Aubert S, Barnes JD, et al. Sedentary Behavior Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioural Nutrition and Physical Activity. 2017;14(75).
10. Biswas A, Oh P, I., Faulkner GE, et al. Sedentary time and its association with risk for disease incidence, mortality and hospitalization in adults, a systematic review and meta-analysis. Annals of Internal Medicine. 2015;162:123 - 132.
11. Thorp AA, Owen N, Neuhaus M, et al. Sedentary Behaviors and Subsequent Health Outcomes in Adults A Systematic Review of Longitudinal Studies, 1996 –2011. American Journal of Preventive Medicine. 2011;41(2):207 - 215.
12. Marrie RA, Reider N, Cohen J, et al. A systematic review of the incidence and prevalence of cardiac, cerebrovascular, and peripheral vascular disease in multiple sclerosis. Multiple Sclerosis Journal. 2015;21(3):318 - 331.
13. Jadidi E, Mohammadi M, Moradi T. High risk of cardiovascular diseases after diagnosis of multiple sclerosis. Mult Scler. 2013;19:1336–1340.
14. Hubbard E, Motl RW, Fernhall B. Sedentary behaviour and blood pressure in patients with multiple sclerosis. International Journal of MS Care. 2018;20(1):1-8.
15. Veldhuijzen van Zanten JCS, Pilutti LA, Duda JL, et al. Sedentary behaviour in people with multiple sclerosis: Is it time to stand up against MS? Mult Scler. 2016;22(10):1250 - 1256.
16. Hubbard EA, Motl RW, Manns PJ. The descriptive epidemiology of daily sitting time as a sedentary behavior in multiple sclerosis. Disabil Health J. 2015 Oct;8(4):594-601. doi: 10.1016/j.dhjo.2015.06.003. PubMed PMID: 26238011.
17. Motl RW, Sandroff BM, Pilutti LA, et al. Physical activity, sedentary behavior, and aerobic capacity in persons with multiple sclerosis. Journal of the Neurological Sciences,. 2017;372:342 - 346.
18. Ezeugwu V, Klaren R, Hubbard EA, et al. Mobility disability and the pattern of accelerometer-derived sedentary and physical activity behaviors in people with multiple sclerosis. Preventive Medicine Reports. 2015:241 - 246.
19. Cavanaugh JT, Gappmaier VO, Dibble LE, et al. Ambulatory Activity in Individuals With Multiple Sclerosis. Journal of Neurological Physical Therapy. 2011;35:26 - 33.

20. Dall PM, Coulter EH, Fitzsimons CF, et al. TAxonomy of Self-reported Sedentary behaviour Tools (TASST) framework for development, comparison and evaluation of self-report tools: content analysis and systematic review. BMJ Open. 2017;7(e013844).
21. Hohol MJ, Orav EJ, Weiner HL. Disease Steps in multiple sclerosis: a longitudinal study comparing disease steps and EDSS to evaluate disease progression. . Multiple Sclerosis. 1999;5::349-54.
22. Learmonth Y, Motl RW, Sandroff BM, et al. Validation of patient determined disease steps (PDDS) scale scores in persons with multiple sclerosis. BMC Neurol. 2013;13(37).
23. Visser M, Koster A. Development of a questionnaire to assess sedentary time in older persons - a comparative study using accelerometry. BMC Geriatr. 2013;13(1):80.
24. Marshall AL, Miller YD, Burton NW, et al. Measuring total and domain-specific sitting: A study of reliability and validity. Med Sci Sports Exerc. 2010;42(6):1094 - 1102.
25. Craig CL, Marshall AL, Sjostrom M, et al. International Physical Activity Questionnaire, 12-Country Validity and Reliability, . Medicine and Science in Sports and Exercise, . 2003, ;35(8):1381 - 1395.
26. Gardiner PA, Clark BK, N HG, et al. Measuring older adults sedentary time : validity, reliability and responsiveness. Med Sci Sports Exerc. 2011;43(11):2127 - 2133.
27. Rosenberg DE, Norman DN, Wagner N, et al. Reliability and validity of the Sedentary Behaviour Questionnaire (SBQ) for Adults. J Phys Act Health. 2010, ; 7(6):697 - 705.
28. Lynch B, Friedenreich C, M., Khandwala F, et al. Development and testing of a past year measure of sedentary behavior: the SIT-Q. BMC Public Health. 2014:899.
29. Wijndaele K, De Bourdeauhuij I, Godino J, et al. Reliability and Validity of a Domain-Specific Last 7-d Sedentary Time Questionnaire. Med Sci Sports Exerc. 2014;46(6):1248 - 1260.
30. Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for T-tests and ANOVAs. Frontiers in psychology. 2013;4(863):1-12.
31. Braun V, Clark V. Using thematic analysis in psychology. Qualitative Research in Psychology. 2006;3:77 - 101.
32. Bollaert RE, Motl RW. Physical and Cognitive Functions, Physical Activity, and Sedentary Behavior in Older Adults With Multiple Sclerosis. Journal of Geriatric Physical Therapy. 2017;00:1-9.
33. Blikman L, J., , Van Meeteren J, Horemans H, L.,, et al. Is physical behaviour affected in fatigued persons with multiple sclerosis? Archives of Physical Medicine and Rehabilitation. 2015;96:24- - 29.
34. Matthews CE, Ainsworth BE, Hanby C, et al. Development and Testing of a Short Physical Activity Recall Questionnaire. Med Sci Sports Exerc. 2005;37(6):986 - 994.
35. Owen N, Sparling PB, Healy GN, et al. Sedentary behaviour: Emerging evidence for a new health risk. Mayo Clin Proc. 2010;85(12):1138 - 1141.
36. Kinnett-Hopkins D, Learmonth Y, Hubbard E, et al. The interpretation of physical activity, exercise, and sedentary behaviours by persons with multiple sclerosis. Disability and Rehabilitation. 2017;DOI: 10.1080/09638288.2017.1383519.
37. Aminian S, Ezeugwu VE, Motl RW, et al. Sit less and move more: perspectives of adults with multiple sclerosis. Disability and Rehabilitation. 2017;DOI: 10.1080/09638288.2017.1416499.
38. van Uffelen JGZ, Watson MJ, Dobson AJ, et al. Comparison of Self-Reported Week-Day and Weekend-Day Sitting Time and Weekly Time-Use: Results from the Australian Longitudinal Study on Women's Health. International Journal of Behavioural Medicine. 2011;18:221 - 228.
39. Greenwood-Hickman MA, Renz A, Rosenberg DE. Motivators and barriers to reducing sedentary behavior among overweight and obese older adults. The Gerontologist. 2016;56(4):660 - 668.

40. Sasaki JE, Motl RW, McAuley E. Validity of the Marshall Sitting Questionnaire in people with multiple sclerosis. Journal of Sports Sciences. 2018;https://doi.org/10.1080/02640414.2018.1554614.
41. Yu C, Rouse P, C., , veldhuijzen van Zanten JCS, et al. Subjective and objective levels of physical activity and their association with cardiorespiratory fitness in rheumatoid arthritis patients. Arthritis Research and Therapy. 2015;17:59.
42. Sardinha L, B., , Eklund U, Dos Santos L, et al. Breaking up sedentary time is associated with impairment in activities of daily living. Experimental Gerontology. 2015;72:57 - 62.

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

					employed
9	F	59	11 years	3	Full time
10	F	42	6 years	4	Not employed
11	F	45	18 months	0	Full time student
12	F	68	17 years	7	Retired
13	F	48	24 years	6	Not employed
14	F	29	5 years	3	Part time
15	F	69	6 years	3	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
[b]Significantly different from all other questionnaires, $p<.05$
[c]Significantly different from LASA, Marshall Sitting, and SIT-Q, $p<.05$.
[d]Significantly different from LASA, Marshall Sitting, IPAQ and SIT-Q, $p<.05$