



## How active are stroke patients in physiotherapy sessions and is this associated with stroke severity?

Jimmy James & Mark P. McGlinchey

**To cite this article:** Jimmy James & Mark P. McGlinchey (2022) How active are stroke patients in physiotherapy sessions and is this associated with stroke severity?, *Disability and Rehabilitation*, 44:16, 4408-4414, DOI: [10.1080/09638288.2021.1907459](https://doi.org/10.1080/09638288.2021.1907459)

**To link to this article:** <https://doi.org/10.1080/09638288.2021.1907459>



© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 01 Apr 2021.



[Submit your article to this journal](#)



Article views: 5157



[View related articles](#)



[View Crossmark data](#)



Citing articles: 7 [View citing articles](#)

RESEARCH PAPER



## How active are stroke patients in physiotherapy sessions and is this associated with stroke severity?

Jimmy James and Mark P. McGlinchey

Department of Physiotherapy, St. Thomas' Hospital, London, UK

### ABSTRACT

**Purpose:** Exercise improves functional outcome post-stroke, but how long patients with differing severity spend undertaking active exercise within physiotherapy sessions is unknown. We aimed to investigate if stroke severity is associated with time undertaking active exercise in physiotherapy sessions, and if any differences between planned and actual physiotherapy session length existed.

**Materials and methods:** A prospective observational study of 107 stroke rehabilitation sessions in a UK acute stroke unit. Data recorded included patient demographics (age, gender, time post-stroke and Barthel Index score) and session attributes (planned and actual session length, time undertaking active exercise, grade of treating therapist).

**Results:** There was a significant negative association between increasing stroke severity and percentage of time undertaking active exercise in physiotherapy sessions ( $p < 0.001$ ). No other observed factors were associated with time undertaking active exercise. Mean session length across all levels of stroke severity was 32 min (SD 9.26) which was significantly less than planned ( $p < 0.05$ ). There was no difference in mean session length or between planned and actual physiotherapy session length between patients of differing severity.

**Conclusions:** Patients with greater stroke severity participate in less active exercise in physiotherapy sessions than those with lesser stroke severity. Reasons for this disparity warrant further investigation.

### ARTICLE HISTORY

Received 26 September 2020

Revised 15 March 2021

Accepted 19 March 2021

### KEYWORDS

Physiotherapy; stroke; rehabilitation; activity; intensity

### ► IMPLICATIONS FOR REHABILITATION

- Stroke patients with higher levels of severity engage in less active exercise during rehabilitation.
- A discrepancy exists between patients' planned physiotherapy session lengths and actual session lengths during stroke rehabilitation.
- Physiotherapists should be mindful in how to adapt their sessions (particularly with severe stroke patients) to maximise the amount of activity they undertake.
- Physiotherapists should be flexible in their delivery of rehabilitation to ensure that the length of patient sessions reflect patients' needs.

## Introduction

Adults following stroke engage in less activity than healthy age-matched controls [1], and this is a trend that appears to start early after stroke. An observational study of stroke unit care in Australia found patients after stroke spend on average 46% of their day inactive and in bed [2]. They also spend very little time (between 13% and 20% of the day) engaged in activities that would be considered to contribute to their recovery, such as transferring out of bed, standing up or walking [3–5]. Given that targeted active exercise is associated with improved rate of recovery and functional outcomes post-stroke [6], and that high number of repetitions are required to drive neuroplasticity [7], it is important to maximise the time available for active, repetitive exercise in pursuit of improving functional outcomes. One way to increase the amount of time patients are active following stroke is through physiotherapy.

Physiotherapy is an important component of stroke rehabilitation which aims to optimise physical function post-stroke [8]. Whilst time spent in physiotherapy sessions represents an opportunity to be physically active [2,9], physiotherapy contact time accounts for as little as 3% of the day [5]. In addition, a systematic review investigating time spent undertaking physical activity in physiotherapy sessions has demonstrated that patients are spending 40% of this time inactive [10]. However, it is less clear whether time spent being active during physiotherapy sessions is similar for patients with differing levels of stroke severity.

The influence of stroke severity on stroke recovery and the rehabilitation process is increasingly being recognised. Stroke recovery is a complex process which involves both spontaneous neuronal recovery and motor learning. It has been demonstrated that increasing stroke severity is associated with less complete physical recovery post-stroke [11–13]. Stroke severity is also a factor associated with physiotherapy provision after stroke [5,14].

CONTACT Jimmy James ✉ [jimmy.james@gstt.nhs.uk](mailto:jimmy.james@gstt.nhs.uk) Department of Physiotherapy, St. Thomas' Hospital, London, UK  
This article has been corrected with minor changes. These changes do not impact the academic content of the article.

© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Patients with higher stroke severity receive less intensity of physiotherapy and participate in less physical activity during inpatient rehabilitation [4,5,14]. Given that high-intensity repetitive practice helps promote recovery [15], lower levels of active exercise undertaken in these patients may be a contributing factor to poorer functional recovery. As international clinical guidelines for stroke rehabilitation do not specify how to tailor physiotherapy according to stroke severity [8,16–18], it is important to understand the reality of physiotherapy provision according to stroke severity. In particular, it is important to understand how time undertaking active exercise within physiotherapy sessions differs across all levels of stroke severity.

Another factor that may influence the time spent undertaking active exercise within physiotherapy sessions is the length of the physiotherapy session. During stroke rehabilitation, physiotherapists may use a written schedule, or timetable, to allocate patient treatment sessions to assigned staff members [19]. Timetabling also enables physiotherapists to specify the length of a physiotherapy session in order to achieve the aims of the session [19,20]. A longer physiotherapy session may potentially allow more time to undertake active exercise than a shorter physiotherapy session. However, it is not known if the planned or actual length of a physiotherapy session differs according to stroke severity.

## Aims

The primary aim of this study was to investigate the association between time spent undertaking active exercise within physiotherapy sessions and stroke severity, measured using the Barthel index (BI). The secondary aim of this study was to describe differences between planned and actual physiotherapy session length according to stroke severity.

## Materials and methods

### Study design

The prospective observational study took place between June 2018 and August 2019 on an acute stroke unit in a large teaching hospital in London, UK. All physiotherapists working on the stroke unit during the study period were eligible for participation. Any patient with a diagnosis of acute stroke (either on CT, MRI or being treated as a stroke clinically) who was receiving physiotherapy by these physiotherapists was eligible for observation. Prior stroke or cognitive impairment was not a reason for exclusion.

As the study was governed as a service evaluation project, ethical approval was granted by the Guy's and St Thomas' NHS Foundation Trust Therapies and Rehabilitation Directorate Governance Committee (project number 18/CT8538). In line with the study's protocol, informed verbal consent was obtained for physiotherapists and patients able to provide consent. Implied consent was obtained for patients with impaired capacity after discussion with an independent research consultee. Study participation was documented in the patient's clinical record. Once consent was obtained from physiotherapists and patients, individual physiotherapy sessions were observed by one of four research physiotherapists (observers). Observers were briefed prior to observation commencement to ensure they were familiar with the protocol for data collection (see [Appendix 1](#)). Observers were instructed not to verbally or physically interact with the treating physiotherapist or the patients, and were advised to observe the session from a distance if possible, to reduce any reactivity to being present. Treating physiotherapists were aware of sessions

planned for observation, but were requested to complete the session as per usual care. There were no observed sessions involving more than one patient being treated at the same time e.g., group therapy.

To ensure observers were familiar with the observation protocol, all observers either watched two treatment session videos, or completed two jointly observed physiotherapy sessions and were asked to record the data as per the protocol in [Appendix 1](#). The lead observer (JJ) also collected data for these sessions and each observer had opportunity to discuss any questions with the lead observer. To ensure each observer adhered to the observation protocol interrater reliability was formally assessed during the study by comparing results between two observers observing 12 sessions.

A pragmatic approach to observation was adopted for the study. Potential observation sessions were identified by the lead observer, with an aim to gain a spread of distribution across severity. Patients were then informed of the specific session in which their activity was due to be monitored. If a patient declined, the patient's usual therapy session proceeded without being observed. If a patient agreed to be observed, the whole physiotherapy session was observed, even if the session ended before the planned session time for any reason. Patient sessions were observed until a pre-determined sample size of 100 observation sessions was achieved. This sample size was based upon observing 25 patients by severity group, which was consistent with similar observational studies [21–23].

Definitions and observational criteria for analysing the content of physiotherapy sessions are presented in [Appendix 1](#) and are adapted from similar studies observing physical activity post-stroke [9,21,23].

### Data collection

Patient demographics, including age, gender, date of stroke, time post-stroke and BI, were recorded from patients' medical notes. Grade of treating physiotherapist(s), planned session length, actual session length, time undertaking active exercise and time spent inactive were recorded by the observers directly within the session. In the UK, there are four grades of qualified physiotherapists ranging from Band 5 (newly qualified or limited clinical experience) to Band 8 (advanced practitioner with extensive clinical experience). In addition, there are two grades of physiotherapy assistants (Bands 3 and 4). A stopwatch with lap timer function was used to record times.

### Data analysis

Data were recorded anonymously into a password protected Microsoft Excel spread sheet (Microsoft office plus 2013). The BI is a measure of activities of daily living performance routinely used on the stroke unit and used in research as a measure of stroke severity [24]. If a BI was incomplete or outdated, then it was completed by the observing physiotherapist in conjunction with the patient's treating nurse to reflect their function at the time of observation. Stroke severity was calculated from BI scores into four categories: very severe (0–4), severe (5–9), moderate (10–14) and mild (15–19) [25].

To investigate the influence of multiple independent variables on percentage of time undertaking active exercise within sessions a multivariate regression was applied using a backward stepwise approach. Initially all independent variables were included in the multiple regression and those which did not reach significance

were removed from the model. Although stroke severity was the primary independent variable of interest, other variables investigated in the linear regression were gender, age, days post-stroke (known to be associated with rehabilitation outcome post-stroke [14]) and highest grade of treating physiotherapist. These variables were chosen as we hypothesised that they may also influence outcome post-stroke). The primary null hypothesis was that there was no association between stroke severity and percentage of time spent undertaking active exercise in physiotherapy sessions. The significance level was set at  $\alpha = 0.05$  and confidence intervals at 95%. Interrater reliability of therapists observing therapy sessions was assessed using the intraclass correlation coefficient (ICC). Planned and actual physiotherapy session lengths and percentage of active exercise were compared across severity categories using analysis of variance (ANOVA). Baseline demographics were compared using ANOVA for ratio data and Chi-square for categorical data. All statistical tests were completed using SPSS (SPSS Statistics for Windows, version 26.0, IBM Corp., Armonk, NY).

## Results

Data from 107 patient observations across 78 individual patients were included in the analysis. Mean observed patient age was 70.5 years and 55 observations involved males (51.4%). Mean time post-stroke was 32.6 days (median 23 days) and mean BI score was 6.5 (Table 1). There were no significant differences between severity category in terms of age, days post-stroke or gender ( $p > 0.05$ ).

The results of the backwards stepwise linear regression are presented in Table 2 with active exercise plotted against BI in Figure 1. The regression model with all five variables yielded an adjusted  $R^2$  of 0.279, removing variables that were not significant in the model ( $p > 0.1$ ) in a backwards stepwise approach resulted in a final model which included only BI and highest grade of treating therapist with an adjusted  $R^2$  value of 0.293. The regression demonstrated a negative association between increasing stroke severity and percentage of time undertaking active exercise in physiotherapy sessions ( $p < 0.0001$ , CI = 1.422–2.614). A standardised  $\beta$  coefficient of 0.557 means that every increase in the BI by one point is associated with an increase in percentage of active

exercise in sessions by 0.6%. The highest grade of treating therapist was also associated with percentage of time undertaking active exercise in physiotherapy sessions ( $p = 0.33$ , CI 0.292–6.779, standardised  $\beta = 0.179$ ).

There was also a significant difference in percentage of active exercise time between severity categories ( $p < 0.0001$ , degrees of freedom between groups = 3,  $F = 10.425$ ) (Figure 2). Post hoc analysis revealed that this significance only existed between the very severe and mild, and very severe and moderate categories.

Inter-rater reliability of percentage of active exercise time was very high in a sample of 12 sessions (ICC = 0.996, CI = 0.985–0.999).

Mean session length across all severities of stroke was 32 min (SD 9.26, range 11.05–55.97) with a mean planned session length of 44 min (SD 3.95, range 20–45) (Table 3). There was no significant difference in planned or actual session length amongst the different severity categories ( $p = 0.660$ ,  $p = 0.562$ , respectively). Within each severity category, all patients received significantly shorter physiotherapy sessions than those planned ( $p < 0.001$ ). However, the differences between planned and actual session length were not significantly different between the severity groups ( $p = 0.783$ ).

## Discussion

Previous studies have investigated activity in patients' post-stroke. Many of these record activity patterns during patients' hospital stay over a whole day or more, monitoring activity both within and outside of physiotherapy [2–5]. There are few studies that investigate activity specifically during physiotherapy sessions [9,21,23], and any association between this activity and stroke severity is not extensively reported across the range of severity seen in clinical practice [23].

This study demonstrated that time undertaking active exercise within physiotherapy sessions is negatively associated with stroke severity i.e., less time is spent undertaking active exercise with greater stroke severity and amount of active exercise is not uniform across levels of disability.

Our findings are similar to those of Ada et al. [9], who found patients spent 48% of their time with therapists engaged in task

Table 1. Demographic baseline data.

|                                       | Very severe | Severe  | Moderate  | Mild     | All       |
|---------------------------------------|-------------|---------|-----------|----------|-----------|
| Observed patient sessions             | 49          | 20      | 29        | 9        | 107       |
| Number of unique patients observed    | 31          | 15      | 23        | 9        | 78        |
| Median (range) of repeat observations | 3 (1–6)     | 1 (1)   | 1 (1–2)   | 0        | 1 (1–6)   |
| Male <sup>b</sup>                     | 23 (46.9)   | 10 (50) | 17 (58.6) | 5 (55.6) | 55 (51.4) |
| Female <sup>b</sup>                   | 26 (53.1)   | 10 (50) | 12 (41.4) | 4 (44.4) | 52 (48.6) |
| Age <sup>a</sup>                      | 70.8        | 71.5    | 71.6      | 63.3     | 70.5      |
| Days post-stroke <sup>a</sup>         | 31.3        | 34.1    | 32.7      | 35.9     | 32.6      |
| BI Score <sup>a</sup>                 | 1.7         | 7.4     | 11.3      | 15.9     | 6.5       |

<sup>a</sup>Mean values.

<sup>b</sup>Number (percentage).

Table 2. Results from backwards stepwise regression at the first step and the final model.

| Independent variable in regression | Step 1 Standardised Beta coefficient | Step 1 significance ( $p$ ) | 95% Confidence interval | Final model Standardised Beta coefficient | Final model significance ( $p$ ) | 95% Confidence interval |
|------------------------------------|--------------------------------------|-----------------------------|-------------------------|-------------------------------------------|----------------------------------|-------------------------|
| Barthel index                      | 0.548                                | <0.001*                     | 1.377 to 2.596          | 0.557                                     | <0.001                           | 1.422–2.614             |
| Gender                             | 0.059                                | 0.510                       | –4.404 to 8.812         | –                                         | –                                | –                       |
| Age                                | –0.43                                | 0.654                       | –0.299 to 0.189         | –                                         | –                                | –                       |
| Days post-stroke                   | –0.049                               | 0.587                       | –0.139 to 0.079         | –                                         | –                                | –                       |
| Grade of treating PT               | 0.162                                | 0.062*                      | –0.168 to 6.553         | 0.179                                     | 0.33                             | 0.292–6.779             |

\* $p < 0.1$  and included in final regression model.  $R^2$  value of final regression model = 0.293.

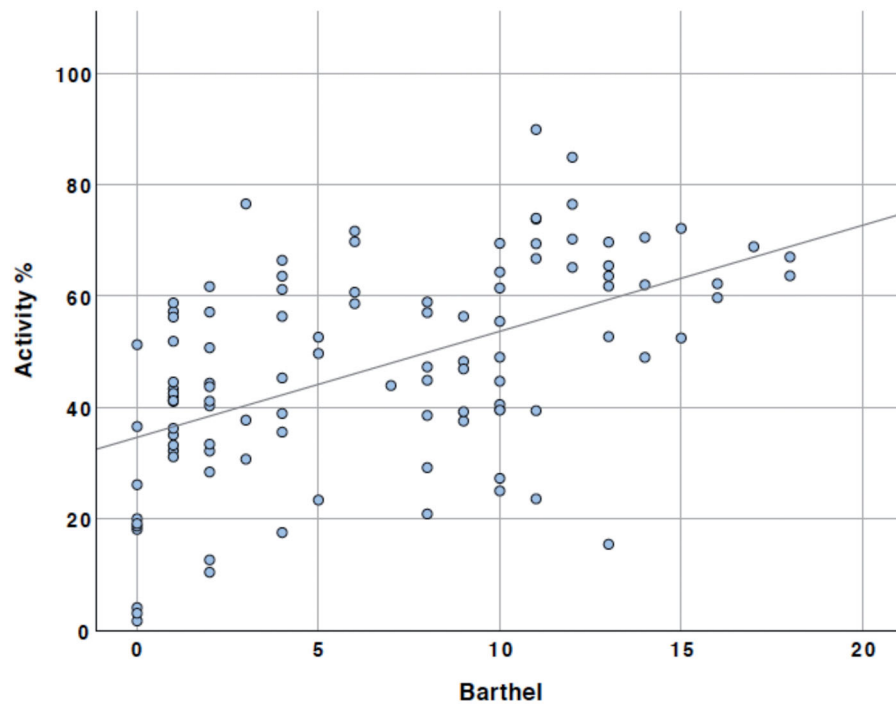


Figure 1. Scatter plot showing BI versus active exercise in physiotherapy sessions as percentage of the session.

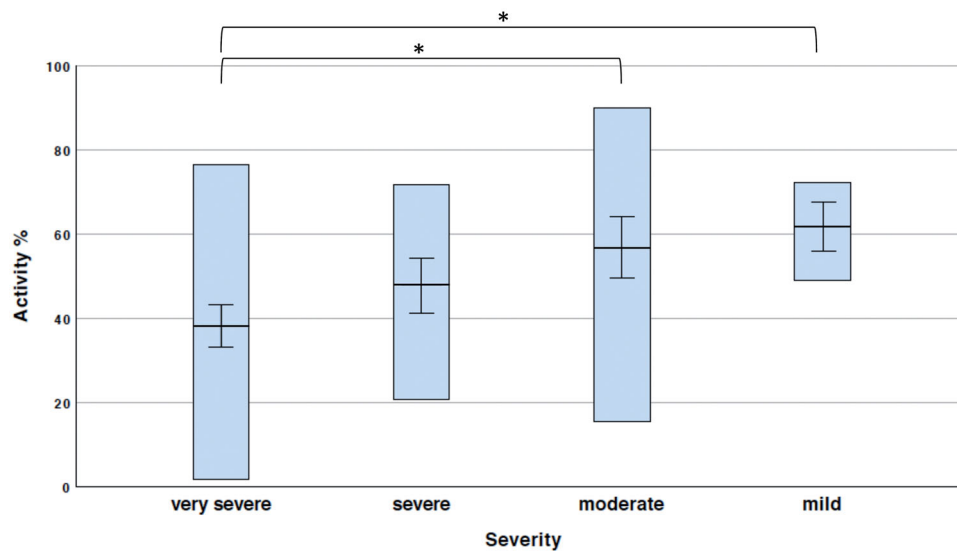


Figure 2. Range bar showing mean active exercise percentage by stroke severity. Bars represent range of patient values with mean shown as horizontal lines with 95% confidence intervals. \*Difference between group means significant at  $p = 0.001$ .

Table 3. Physiotherapy session times.

| Stroke severity | Percentage of sessions planned for 45 min | Mean planned session length | Mean session length | Mean difference between planned and session length | Mean active exercise time | Mean active exercise percentage |
|-----------------|-------------------------------------------|-----------------------------|---------------------|----------------------------------------------------|---------------------------|---------------------------------|
| Very severe     | 98                                        | 44.49                       | 33.06               | 11.43*                                             | 12.95                     | 38.22                           |
| Severe          | 95                                        | 44.25                       | 31.94               | 12.31*                                             | 15.35                     | 47.77                           |
| Moderate        | 90                                        | 43.45                       | 31.51               | 11.94*                                             | 18.37                     | 56.85                           |
| Mild            | 89                                        | 43.33                       | 28.41               | 14.92*                                             | 17.38                     | 61.88                           |
| All             | 94                                        | 44.07                       | 32.04               | 12.03                                              | 15.24                     | 47.04                           |

\*Difference is significant at 0.05 level when comparing planned session length and session length using paired *t*-test.

practice or exercise. However, our results showed a much lower level of active exercise time when compared to those of Elson et al. [21] and English et al. [23] who demonstrated session activity times of 72% and 68%, respectively. One reason for this

disparity in exercise time is likely influenced by patients' stroke severity. Both Elson et al. [21] and English et al. [23] recruited patients with mild to moderate stroke severity and many were mobile. Our study included more severely impaired patients,

similar to those recruited by Ada et al. [9] and many of whom required assistance to stand.

Our finding of a moderate correlation between stroke severity and time undertaking active exercise is supported by the findings from English et al. [23]. However, they reported only 5% of the variance in activity time was explained by stroke severity, whereas our findings suggest severity accounted for 29% of the variance. We included patients across all levels of severity, whilst English et al. [23] only recruited those with a moderate stroke. It is possible that their more homogenous and higher functioning cohort of patients demonstrated less variance in activity than what we observed. Other authors have found no association between stroke severity and activity [26]; however, this is likely due to the method of observation. Barrett et al. [26] observed patient's activity continuously over two weeklong blocks using activity logs and cardiac monitoring. Although these time periods included therapy sessions which alone demonstrated an increase in activity, the authors did not investigate if the activity within these sessions was associated with severity. As physiotherapy sessions represent a small portion of the day any variation in activity between patients of different severity that may exist (such as we have found) is likely to be lost when using data over a whole week.

The regression model did demonstrate an association between the grade of treating therapist and active exercise time. However, a standardised beta value of 0.179 (every increase in one NHS band is associated with a 0.2% increase in active exercise time) is unlikely to represent any clinical significance.

Capturing and measuring amount of physiotherapy to attribute its effect on patient outcomes is difficult. In part this is due to the differences between type and focus of interventions but also having no agreed way in which to measure or record patient activity. Lohse [27] used time scheduled for therapy as a surrogate for "amount" in a meta-analysis to demonstrate effects of increasing physiotherapy contact on functional outcomes. However, this surrogate does not give a clear indication of the amount of therapeutic active exercise within therapy sessions. Other authors have also reported activity differently, from measurement of repetitions of movement [28,29] to time spent undertaking activity [22,23], making comparisons between studies difficult. Furthermore, there is also no agreed term of what "activity" constitutes. We have used the term "active exercise" rather than activity to help distinguish between all movement delivered by skeletal muscles that expend energy (physical activity), and activity that is planned, structured, repetitive and purposive in aiming to contribute to improving or maintaining physical fitness or functional outcome (active exercise) [9,30]. The rationale for using this term was to highlight that activity may not be viewed as absolute across levels of severity, and the relative demands of the same activity with more severely impaired patients may be higher than those with milder impairments. For example, sitting on the edge of a bed may be less physically demanding for a patient with a mild stroke who is independently mobile compared to a patient with a very severe stroke who has no independent sitting ability. We acknowledge there is potential bias toward how active exercise is recorded in our protocol toward functional activities such as standing and walking. These activities are not necessarily directed by treating physiotherapists for the purpose of improving function in those who are independently mobile, but as a means of moving patients to the gym environment to work on other specific functional goals, but are recorded as "active exercise." There is, therefore, a possible over estimation of active exercise in those with

milder stroke severity compared to those with higher severity who are less likely to be able to engage in standing and walking [5,31].

Although time is not an agreed measure of physiotherapy provision, its use here has allowed comparisons between severity groups across a range of active intervention types. The fact that 60% of very severe patients' sessions are spent inactive was surprising. It is possible that physical fatigue and reduced concentration as experienced amongst those with more severe strokes is a factor [32], but logistical reasons such as hoisting and transporting patients to the gym area are also a consideration. Additional research is required to investigate this matter further.

The direct time in which patients spend with physiotherapists was substantially less than that planned but broadly comparable to similar observational studies [5,33]. However, there does appear to be a large spread of physiotherapist-patient contact time in these studies, ranging from 24.5 [5,8] to 52 min [22]. Our findings of session length were similar to those found by Elson et al. [21] – 31 min- and English et al. [23] – 35 min. The length of physiotherapy sessions in our study could be related to how long patients are able to tolerate dependant on fatigue, concentration or in completing the aims of the session before the planned session time. However, it could also be due to the need for physiotherapists to allocate time for administrative tasks, which is a component of therapist practice common in UK stroke units [22,34]. Given that the Royal College of Physicians (RCP) national clinical guideline for stroke recommends at least 45 min of each rehabilitation therapy [5], the amount of time patients receive physiotherapy for is of upmost importance. The practice of providing at least 45 min of planned therapy in our unit may, therefore, be driven more by complying with national audit than for perceived patient benefit, as identified by Clarke et al. [19] and Taylor et al. [20]. However, other factors known to influence the length of a physiotherapy session identified by McGlinchey and Davenport [35], such as patient tolerance and the time taken to perform interventions to achieve patient goals should take precedence in the scheduling of physiotherapy sessions post-stroke.

There are several strengths to this study that need to be reported. It is the largest observational study of active exercise time within physiotherapy sessions. To our knowledge, it is the first study to include patients with severe and very severe strokes, a population who are greatly underrepresented in the literature [36]. Consequently, the inclusion of patients presenting with a range of stroke severity levels increases the generalisability of findings to clinical practice. Limitations to this study include the smaller number of patients with milder stroke observed and the use of active exercise time alone as a marker of perceived benefit for patients. However, in the UK, inpatient rehabilitation is usually provided to patients presenting with moderate to severe stroke severity whereas community-based rehabilitation is usually provided to patients with milder stroke severity. Therefore, the relatively smaller number of patients with milder stroke in our study may be indicative of rehabilitation practice in the UK. Another limitation is the use of observational methods to measure active exercise time. It is possible that observed physiotherapists may have altered their practice due to being observed. However, a review of the patient's documentation indicated that the session content of observed and non-observed sessions were similar. Finally, the study was conducted in a stroke unit in London, UK. As clinical practice may be different in other stroke units across the UK or in other

countries, caution is required in generalising findings to local contexts.

## Conclusion

Patients who have higher stroke severity post-stroke engage in less active exercise in physiotherapy sessions during inpatient rehabilitation when compared to those with lower stroke severity. In addition, patients across all levels of stroke severity receive shorter physiotherapy sessions than those planned. Further research should aim to identify the reasons underlying these findings in order to identify ways to make sessions more active.

## Disclosure statement

The authors declare that there is no conflict of interest.

## References

- [1] English C, Healy GN, Coates A, et al. Sitting and activity time in people with stroke. *Phys Ther*. 2016;96(2):193–201.
- [2] West T, Bernhardt J. Physical activity patterns of acute stroke patients managed in a rehabilitation focused stroke unit. *Biomed Res Int*. 2013;2013:438679.
- [3] Mackey F, Ada L, Heard R, et al. Stroke rehabilitation: are highly structured units more conducive to physical activity than less structured units. *Arch Phys Med Rehabil*. 1996;77(10):1066–1070.
- [4] Bernhardt J, Dewey H, Thrift A, et al. Inactive and alone: physical activity within the first 14 days of acute stroke unit care. *Stroke*. 2004;35(4):1005–1009.
- [5] Bernhardt J, Chan J, Nicola I, et al. Little therapy, little physical activity: rehabilitation within the first 14 days of organized stroke unit care. *J Rehabil Med*. 2007;39(1):43–48.
- [6] Kwakkel G, Van Peppen R, Wagenaar RC, et al. Effects of augmented exercise therapy time after stroke: a meta-analysis. *Stroke*. 2004;35(11):2529–2539.
- [7] Boyd LA, Vidoni ED, Wessel BD. Motor learning after stroke: is skill acquisition a prerequisite for contralesional neuroplastic change? *Neurosci Lett*. 2010;482(1):21–25.
- [8] Rudd A, Bowen A, James M, et al. National clinical guideline for stroke. 5th ed. London: Royal College of Physicians; 2016.
- [9] Ada L, Mackey F, Heard R, et al. Stroke rehabilitation: does the therapy area provide a physical challenge. *Aust J Physiother*. 1998;44(1):33–38.
- [10] Kaur G, English C, Hillier S. How physically active are people with stroke in physiotherapy sessions aimed at improving motor function? A systematic review. *Stroke Res Treat*. 2012;2012:820673.
- [11] Langhorne P, Bernhardt J, Kwakkel G. Stroke care 2, Stroke rehabilitation. *Lancet*. 2011;377(9778):1693–1702.
- [12] Prabhakaran S, Zarahn E, Riley C, et al. Inter-individual variability in the capacity for motor recovery after ischemic stroke. *Neurorehabil Neural Repair*. 2008;22(1):64–71.
- [13] Byblow WD, Stinear CM, Barber A, et al. Proportional recovery after stroke depends on corticomotor integrity. *Ann Neurol*. 2015;78(6):848–859.
- [14] McGlinchey MP, Paley L, Hoffman A, et al. Physiotherapy provision to hospitalised stroke patients: analysis from the UK sentinel stroke national audit programme. *Eur Stroke J*. 2019;4(1):75–84.
- [15] Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. *Lancet Neurol*. 2009;8(8):741–754.
- [16] Stroke Foundation Clinical guidelines for stroke management – rehabilitation. Melbourne 2019.
- [17] Teasell R, Salbach NM, Foley N, et al. Canadian stroke best practice recommendations: rehabilitation, recovery, and community participation following stroke. Part One: rehabilitation and recovery following stroke. 6th Edition Update 2019, *International Journal of Stroke*. 2020;15(7):726–763.
- [18] Winstein CJ, Stein J, Arena R, et al. Guidelines for adult stroke rehabilitation and recovery: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2016;47(6):98–169.
- [19] Clarke DJ, Burton LJ, Tyson SF, et al. Why do stroke survivors not receive recommended amounts of active therapy? Findings from the ReAcT study, a mixed-methods case-study evaluation in eight stroke units. *Clin Rehabil*. 2018;32(8):1119–1132.
- [20] Taylor E, Jones F, McKeivitt C. How is the audit of therapy intensity influencing rehabilitation in inpatient stroke units in the UK? An ethnographic study. *BMJ Open*. 2018;8(12):e023676.
- [21] Elson T, English C, Hillier S. How much physical activity do people recovering from stroke do during physiotherapy sessions? *Int J Ther Rehabil*. 2009;16(2):78–84.
- [22] English C, Bernhardt J, Hillier S. Circuit class therapy and 7-day-week therapy increase physiotherapy time, but not patient activity: early results from the CIRCIT trial. *Stroke*. 2014;45(10):3002–3007.
- [23] English C, Hillier S, Kaur G, et al. People with stroke spend more time in active task practice, but similar time in walking practice, when physiotherapy rehabilitation is provided in circuit classes compared to individual therapy sessions: an observational study. *J Physiother*. 2014;60(1):50–54.
- [24] Sackley CM, Walker MF, Burton CR, et al.; OTCH Trial Investigators. An occupational therapy intervention for residents with stroke-related disabilities in UK care homes (OTCH): cluster randomised controlled trial. *BMJ*. 2015;350:h468–11.
- [25] Wade D, Hewer R. Functional abilities after stroke: measurement, natural history and prognosis. *J Neurol Neurosurg Psychiatry*. 1987;50(2):177–182.
- [26] Barrett M, Snow JC, Kirkland MC, et al. Excessive sedentary time during in-patient stroke rehabilitation. *Top Stroke Rehabil*. 2018;25:1–374.
- [27] Lohse KR, Lang CE, Boyd LA. Is more better? Using meta-data to explore dose-response relationships in stroke rehabilitation. *Stroke*. 2014;45(7):2053–2058.
- [28] Lang CE, MacDonald JR, Reisman DS, et al. Observation of amounts of movement practice provided during stroke rehabilitation. *Arch Phys Med Rehabil*. 2009;90(10):1692–1698.
- [29] Kimberley TJ, Samargia S, Moore LG, et al. Comparison of amounts and types of practice during rehabilitation for traumatic brain injury and stroke. *JRRD*. 2010;47(9):851–862.
- [30] Casperson CJ, Powell K, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep*. 1985;100:126–131.
- [31] De Wit L, Putman K, Lincoln N, et al. Stroke rehabilitation in Europe: what do physiotherapists and occupational therapists actually do? *Stroke*. 2006;37(6):1483–1489.

- [32] Tyson SF, Woodward-Nutt K, Plant S. How are balance and mobility problems after stroke treated in England? An observational study of the content, dose and context of physiotherapy. *Clin Rehabil.* 2018;32(8):1145–1152.
- [33] Kuys S, Brauer S, Ada L. Routine physiotherapy does not induce a cardiorespiratory training effect post-stroke, regardless of walking ability. *Physiother Res Int.* 2006;11(4):219–227.
- [34] Putman K, de Wit L, Schupp W, et al. Use of time by physiotherapists and occupational therapists in a stroke rehabilitation unit: a comparison between four European rehabilitation centres. *Disabil Rehabil.* 2006;28(22):1417–1424.
- [35] McGlinchey MP, Davenport S. Exploring the decision-making process in the delivery of physiotherapy in a stroke unit. *Disabil Rehabil.* 2015;37(14):1277–1284.
- [36] McGlinchey MP, James J, McKevitt C, et al. The effect of rehabilitation interventions on physical function and immobility-related complications in severe stroke: a systematic review. *BMJ Open.* 2020;10(2):e033642.

## Appendix

### Observation protocol definitions provided to observers

---

Physiotherapy session – The time that the patient spends in their interaction with the physiotherapist(s) working on rehabilitation.

Beginning of a session – When the physiotherapist(s) begin their interaction with the patient either at their bedside or other area within the ward environment. This includes greeting the patient and any discussion. It does not include reading notes nor any MDT discussion.

End of a session – When the physiotherapist(s) leaves the patient either at their bedside or other area on the ward and the interaction between them ceases without anticipation of commencing again before the next session.

Active exercise – When the patient is engaging in task practice such as (but not limited to) walking, standing, activities in standing, sitting-to-standing, balancing in sitting, activities in sitting (such as using their paretic arm), activities in kneeling, and activities in lying. These may include activities which are assisted by the physiotherapist. If you are unsure whether a task should be classed as active exercise, record this as active exercise.

Inactivity – This includes all other time of the physiotherapy session where active exercise is not taking place including; when the patient is resting in sitting, resting in lying, or receiving passive movements from the physiotherapist(s). Periods of rest during active exercise for longer than 5 seconds should be recorded as inactivity.

---