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Frequency of the sit to stand task: an observational study of free-living adults.

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Abstract

The sit to stand movement is a key determinant of functional independence. Knowledge of the frequency with which the sit to stand movement is performed throughout the day could inform workplace ergonomics, but has rarely been examined.

Healthy adults (n = 140) were recruited from the general population. Free-living activity for each participant was reported using an activity monitor. On average, participants performed 60 (± 22) sit to stand movements each day. Participants in indoor sedentary occupations performed significantly more sit to stand movements per day than participants in outdoor active occupations (66 vs. 54; n = 102; p = 0.003). Participants (n = 33) performed significantly more sit to stand movements on working days than on non working days (65 vs. 55; p = 0.018).

This analysis provides contemporary data for sit to stand frequency in a predominantly working population, and demonstrates that work and employment have a significant effect on that frequency.

Key words

Sit to stand movement; activity monitoring; work-place activity

1. Introduction

The ability to stand up from a chair (sit to stand; STS) is a key factor in the maintenance of functional independence (Kerr et al., 1994). However, for individuals with compromised mobility the STS movement can be problematic(Cheng et al., 2004, Guralnik et al., 1994, Inkster and Eng, 2004). Moments across lower limb joints during the STS movement are high, as much as 4.7 times body weight (Khemlani et al., 1999), and the mechanical difficulty of the task is likely to present a substantial challenge to population groups with reduced muscle strength (Hughes et al., 1996). In addition, a high demand is placed on the balance system; the STS movement is destabilising in nature, as the body rapidly changes from a stable seated position to a position with a relatively small base of support and a higher centre of mass. This presents a higher risk of falling, which may explain the longer time that individuals prone to falling take to perform the movement (Nevitt et al., 1991).

Considering the difficulty of the task and its importance to mobility, the STS movement is relevant for a number of populations and professionals involved in workplace ergonomics and rehabilitation. Rehabilitation strategies, including those with the aim of returning individuals to employment, would benefit from a greater understanding of this common movement. Although many features of the STS movement have been studied, including its kinetics and kinematics (Eriksund and Bohannon, 2003, Hirschfeld et al., 1999), little information exists on how frequently this demanding task is performed in everyday life.

There is a paucity of information regarding the frequency with which the STS movement is performed, especially with respect to a working environment. A small group (n = 9) of young healthy participants, predominantly recorded in a domestic setting, performed between 3 and 9 chair rises per hour, giving a daily average of 92 chair rises (McLeod et al., 1975). Daily averages were calculated from 50 non-consecutive hours of data, recorded between 7 am and 10 pm. A continuous record of STS frequency would provide a more complete picture of daily activity.

The purpose of this study, therefore, was to provide contemporary data on the frequency of the STS movement in a predominantly working population, in a free-living environment, and recorded continuously over a period of several days. A secondary aim was to explore the effect of employment on the frequency with which STS movements were performed.

2. Methods

This study reports on data collected in three separate studies. All the studies used the same make of activity monitor to record the activity of asymptomatic participants in a free-living environment for a continuous period of at least three days. The number of sit to stand movements during the data collection period was recorded by the monitor.

2.1 Participants

The data from 140 participants were included in this review. Participants were recruited to be: asymptomatic control participants for a study on chronic low back pain (S1; n = 16); participants working as security guards at universities within Glasgow (S2; n = 17); participants working as postal workers within Glasgow (S3; n = 107). Participants were all aged between 18 and 65. None of the participants had limitations which affected their ability to undertake normal employment activities.. Ethical approval was obtained from the Greater Glasgow National Health Service research and ethics committee (S1), and the ethical committees of Glasgow Caledonian (S1; S2; S3) and Strathclyde (S2) Universities. Written, informed consent was obtained from all participants prior to their inclusion in a study.

2.2 Equipment

A uni-axial accelerometer based activity monitor (*activ*PAL™, PAL *Technologies*, Glasgow, UK) was used to record the physical activity of the participants. The monitor is worn on the anterior aspect of the thigh, and is secured using double-sided, hypoallergenic sticky pads. The output algorithm of the *activ*PAL™ monitor classifies the acceleration output into one of three postural or activity based categories: sitting/lying; standing; or walking. A sit to stand movement is defined as a change between a sitting/lying posture and a standing posture. The *activ*PAL™ monitor has been validated for postural classification and for transitions between the postures in a general population (Grant et al., 2006).

2.3 Protocol

An *activ*PAL™ monitor was provided to each participant, who wore the monitor for either three (S2) or seven (S1; S3) consecutive calendar days. Written and verbal instructions were provided, and the monitor was attached and removed by the participant. The monitor was worn continuously, except when the participant was showering, bathing or swimming.

Demographic information was recorded for each participant (age; gender; weight; body mass index (BMI)). The employment status and the type of employment was reported for each participant, and information regarding days when the participant was not working (i.e. weekends, days off) were recorded (S1; S2).

2.4 Data Analysis

For analysis in this article, the primary outcome measure was the number of STS movements performed. The number of STS movements performed by each participant was calculated for each day of data recording. For each participant, the mean number of STS movements performed per day was calculated. In addition, the number of STS movements performed in each hour between 7 am and 10 pm were calculated.

Participants were separated into two groups according to their employment type and location: indoor sedentary workers (sorting office postman, S3; n = 54); or outdoor active workers (security guard, S2; delivery postman, S3; n = 70). Participants in Study 1 had a wide range of different occupation types, including students and people who were not in paid employment, and were not included in this sub-analysis.

Days when the participant was working were separated from those when the participant was not working (S1; S2; n = 33). For participants who were not in paid employment (n = 7), a weekday was defined as a working day, and a weekend day as a non working day.

2.5 Statistical Analysis

All statistical analyses were performed using SPSS (version 15.0). A one way ANOVA was used to investigate the effect of the different studies on the number of STS movements performed per day. The number of STS movements per day performed by the different occupation groups were compared using an independent samples t-test. The number of STS movements per day performed during working and non-working days were compared using a paired t-test. A p-value of 0.05 was considered significant.

3. Results

Monitors were provided to participants for three (S2) or seven (S1; S3) consecutive calendar days. Data from 140 participants was included in the analysis (91 seven days; 24 six days; 4 five days; 2 four days; 18 three days; 1 two days).

There was no significant difference in age among participants ($p = 0.086$) in the three studies (table 1), however the weight ($p = 0.001$) and BMI ($p = 0.004$) of participants in study 1 were significantly lower than those in studies 2 and 3, which could be due to the significantly higher ratio of female participants in that study ($p < 0.001$).

Participants took a mean of 60 (± 22) STS movements per day, which ranged between 10 and 124. There was no significant difference in the daily mean number of STS movements performed between the studies ($p = 0.768$). For the participants in studies 2 and 3 (n = 124), employment type was used to divide participants into indoor sedentary workers (n = 54; office postal workers) or outdoor active workers (n = 70; delivery postal workers and security guards). Those participants who had outdoor active jobs performed significantly fewer STS movements (54 ± 23) than those with indoor sedentary jobs (66 ± 21; $p = 0.003$). For the participants in studies 1 and 2 (n = 33), data collection days were divided between working and non-working days. During working days participants performed significantly more STS movements (65 ± 24) than during the non-working days (55 ± 17; $p = 0.018$).

The median number of STS movements performed in a single hour was three, which ranged between 0 and 43. The mode number of STS movements performed in an hour was zero, which constituted 21% (n = 2,715) of the hours analysed. In contrast, in only five percent of the hours assessed did individuals perform more than ten STS movements per hour. There appeared to be a pattern to the number of hourly STS movements performed across the day (figure 1).

4. Discussion

The purpose of this study was to report contemporary data on the daily frequency of the STS movements, data which could be used to inform the design of workplace ergonomics and rehabilitation programmes. A daily average of 60 (± 22) STS movements was recorded from 140 healthy free living adults. Individuals in outdoor active employment performed significantly fewer movements than those in sedentary office employment, perhaps reflecting the increased need of individuals employed in an office to sit at a desk, and therefore to use a STS movement to rise and move around their work environment. Individuals performed more STS movements on work days than on non-work days, perhaps reflecting the additional choices of both action and inaction available to those participants when not at work.

In any single hour, between 0 and 43 STS movements were performed. Performing more than 10 STS movements in an hour formed only a small percentage of the hours assessed. Those individuals who performed a large number of STS movements in a single hour (e.g. > 20), often displayed a pattern where the large numbers of STS movements occurred in a particular hour of the day (e.g. 9-10 am) on five days of the week. This implied an employment based activity which either required or inclined the participant towards performing a large number of STS movement in that particular hour. In the absence of associated contextual evidence, such an implication is necessarily speculative. In contrast, the most common number of STS performed in an hour was zero, and the median number was three, demonstrating that, in general, only a small number of STS movements was performed in any single hour long period.

The daily average number of STS movements reported here, is around a third less than previously reported (60 compared with 92 (McLeod et al., 1975)), although the range of STS movements in each hour was greater (0 to 43 compared with 3 to 9). Such differences may be a reflection of the changes in sedentary behaviour over the past 30 years, could reflect the different settings in which the two studies were conducted, or could perhaps be explained by methodological differences. In calculating a daily average from non-consecutive hours, the earlier study (McLeod et al., 1975) may have been open to a selection bias of the participants, who may have chosen not to collect data in an hour where they anticipated performing few STS movements.

The practical relevance of this analysis touches upon a number of different areas. For rehabilitation, the successful training of this functional movement may hold real benefit to individuals in terms of restoring the capacity for employment, whether in an office or active outdoor employment. A daily number of 60 STS movements with a rate of around three per hour, presents a real and realistic target for the rehabilitation of an individual (Britton et al., 2008). Therefore, these results could help shape training parameters in terms of volume of STS and the rate necessary for typical everyday life. Employment had a significant impact on the number of STS movements performed in a day, and it was the work environment which would usually be considered less strenuous (i.e. an office) which reflected an increased requirement to perform the relatively strenuous STS movement. The STS movement represents an additional aspect to be considered as part of an assessment for the suitability of an individual to return to employment, or the suitability of the work environment for that individual. Aspects of chair design, such as the height of the seat or the use of arm rests (Janssen et al., 2002) impact on the difficulty associated with performing the STS movement. Solutions to increase the suitability of the work environment for individuals returning to work, could use chair design to ameliorate the exertion of performing STS movements. Finally, the design of workplace ergonomics is likely to have an effect on the performance of STS movements, perhaps though the design of the office layout, or by giving consideration to those employment specific tasks which may considerably increase the number of STS movements performed in a short period of time.

This analysis had a number of weaknesses. The data were drawn from three different sources with significant demographic differences between studies, although there was no discernable effect of study on the number of STS movements performed each day. The overlap of information on employment type and working days was not available for sufficient participants to allow an investigation of the interaction between employment category and working day on the performance of the STS movement. In addition, outdoor sedentary and indoor active employment types were not considered.

The clinical utility of the analysis was limited by the lack of an old or pathological population.

Further research is required to measure the frequency and variation of performance of the STS movement, both to confirm these findings in the general working population, and to assess differences in a populations with restricted mobility, such as the elderly or individuals with physical disabilities. Within a specific occupational environment, interviewing participants could provide a context for the requirements, environmental, and occupational demands for a large volume of STS movements in a short duration. This would be crucial towards establishing the use of STS requirements within risk assessment for return to work. The STS movement could be used as an outcome measure for assessment of physical activity, alongside traditional outcomes, to provide a richer picture of activity, especially within an occupational environment.

5. Conclusions

This study presents contemporary data on the daily frequency of the STS movement. Participants performed a daily average of 60 (± 22) STS movements, with a rate of around 3 per hour, which could be used as a realistic target in the development of rehabilitation strategies for return to work. Employment type and location and working day had a significant effect on the number of STS movements performed in a day. Such information could be used to assist the design of workplace ergonomics, and future investigation of the relationship of the performance of the STS movement with specific tasks could be used within risk assessment.

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Figure 1

Title:

Pattern of the hourly number of STS movements performed between 7am and 10pm.

Description:

Each column represents the 868 participant-days which were available for analysis. The number of STS movements performed in a specific hour were categorised, and the number of hours in each category is displayed in the graph.

Table 1

Demographic information and number of sit to stand movements.

	All (n=140)	**S1** (n=16)	**S2** (n=17)	**S3** (n=107)
age [years]	40 (9)	40 (11)	45 (12)	40 (8)
gender	32 (23)	13 (81)	4 (24)	15 (14)
weight [kg]	79 (15)	67 (14)	83 (19)	80 (13)
BMI [kgm^{-2}]	27 (4)	24 (3)	28 (5)	27 (4)
StS	60 (22)	65 (19)	59 (20)	59 (23)

Age, weight, BMI and daily average sit to stand movements presented as mean (and standard deviation), gender presented as number (and %) female.