J. Phys. Ther. Sci. 32: 529–533, 2020

The Journal of Physical Therapy Science

Original Article

Single question about total lying time for assessing physical inactivity in community-dwelling older adults: a study of reliability and discriminant validity from sleeping time

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Abstract. [Purpose] To investigate reliability and discriminant validity of a single question about total lying time for assessing physical inactivity in community-dwelling older people. [Participants and Methods] The participants were 54 healthy older individuals (mean age, 72.5 years), who were asked to recall retrospectively their mean total lying and sleep times per day in the previous week (7 days). The total lying and sleep times per day in the forthcoming week (7 days) were also investigated prospectively after confirming the mean total lying and sleep times per day in the previous week, and their mean values per day were calculated. [Results] Intraclass reliability of total lying and sleep times per day in the forthcoming week were acceptable [ICC (1, 1) for total lying time=0.835, ICC (1, 1) for sleep time=0.707]. No significant difference in average total lying time between the previous (8.4 ± 2.0 hours/day) and forthcoming (8.7 ± 1.7 hours/day) weeks was seen. In the forthcoming week, average total lying time was significantly higher than average sleep time (7.1 ± 1.3 hours/day). There was low significant correlation between total lying time and sleep time. [Conclusion] Total lying time can be measured with acceptable reliability and discriminant validity, and is a different outcome than sleep time in community-dwelling older adults.

Key words: Single question, Total lying time, Older adults

(This article was submitted Mar. 31, 2020, and was accepted May 13, 2020)

INTRODUCTION

One out of five adults around the world is physically inactive, and physical inactivity is more prevalent, particularly among older adults[1)]. Physical inactivity is defined as "an insufficient physical activity level to meet present physical activity recommendations"[2)], and is associated with adverse sociodemographic characteristics (lack of social interaction and poor self-rated health), problems in activities of daily living, and impaired self-rated health[3)]. In addition, sedentary behavior is defined as "any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture"[2)], and there are relationships of sedentary behavior with geriatric-relevant health outcomes such as physical function, cognitive function, and mental health[4)]. Physical activity promotion is one of the most important interventions to improve health in older adults[5)], and effective physical activity interventions to increase the amount of physical activity and to maintain high physical activity levels may play a major role in reducing and preventing the risk of secondary disuse before frailty and disability progress further[6, 7)]. Accordingly, valid and accurate measurement of physical activity in older adults is key to documenting future physical activity levels and measuring intervention outcomes aimed at reducing the rate of decline in physical activity.

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For the clinical measurement of physical activity and sedentary behavior, device-based[8–10] and self-reported methodologies[11] exist. Previous studies developed and used a self-reported single question to assess sedentary behaviors[12, 13]. The single measure of self-reported total sitting time has acceptable test-retest reliability[14, 15], and is correlated with physical activity estimated by activity monitor and has low systematic reporting errors[16]. However, previous studies about energy expenditure have reported that some sitting activities register lower than the sedentary threshold of 1.5METs[17–19]. Just as sitting is not always sedentary[2], total sitting time is not necessarily reflected as sedentary time. On the other hand, lying is one of the more invariable postures with a resting metabolism ranking it as sedentary behavior. Although any lying activities have the possibility to exceed the sedentary threshold of 1.5METs[2], lying would be more inactive compared with the sitting position. Regardless of sleep time overnight, older adults spent time during the day on activities in the sitting, standing, and lying positions[20]. However, to our knowledge, there is no report focusing on the use of the self-reported single question measuring total lying time to assess sedentary behavior in older adults. Furthermore, lying time is similar to and different from sleep time in the lying position, because total lying time in a 24-hour period includes sleep time in the lying position, but also includes lying quietly in bed awake while reading, watching television, or doing nothing. An important step in establishing the proof of principle for measuring total lying time for use in future studies is to test not only the reliability but also the discriminant validity. Therefore, the purpose of this study is to evaluate the reliability of a self-reported single question measuring total lying time per day in community-dwelling older adults, and to assess the discriminant validity for distinguishing between total lying time and sleep time.

PARTICIPANTS AND METHODS

The participants in this study were 54 healthy community-dwelling older adults aged 65 and older (mean age 72.5 ± 4.9 years, females 68.5%, mean height 154.8 ± 7.6 cm, mean weight 58.1 ± 10.1 kg). Prior to testing, all participants were observed with no cognitive impairment (clinical dementia rating scale[21]=0). Exclusion criteria were neurological, cardiovascular, or major musculoskeletal impairments that complicated participants' ability to recall and to record recent daily physical activity. The sample size was based on the statistical reference of ≥21 participants as the minimum for reliability study[22] and the recommendation in the literature that ≥50 participants are required for reliability study[23]. This study was approved by the Ethics Committee of Kanma memorial hospital (approval number: 17-020), and all participants provided written informed consent.

We operationally defined total lying time as the period within 24 hours each day spent in horizontal or near-horizontal position (e.g., Fowler position[24], semi-Fowler position[25], not involving high-Fowler position[26]) in spite of the presence or absence of sleeping, napping, receiving massage, watching television, listening to radio, and so on, regardless of purpose or location. Firstly, participants were asked to recall retrospectively the average time per day they spent horizontally lying in the previous week in increments of 30 minutes as follows: "How many hours per day did you typically spend lying with or without doing something like sleeping, napping, receiving massage, watching television, listening to radio, or other on a usual day, regardless of purpose or place in the previous week?" The question to measure total lying time is referred to in previous studies as the single question to measure total sitting time[15] and the definition of sedentary behavior[2, 27]. Participants were also asked to recall retrospectively the average time per day they spent sleeping in the previous 1 week in increments of 30 minutes as follows: "How many hours per day did you sleep and nap on a typical day in the previous week, regardless of time of day?" The question to measure total sleep time is referred to as the question to measure sleeping time reported in the previous studies[28, 29]. We used the "previous week (7 days)" as target period for our questions because it would be easier to recall accurately than would the "usual week"[30]. After the day of confirming average total lying time or sleep time per day in the previous week (7 days), participants then recorded prospectively how much time they spent each day lying or sleeping in the forthcoming week (7 days) in increments of 30 minutes. Based on the complete records through the next week (7 days), average total lying time or sleep time per day in the forthcoming week was calculated.

The reliability of the total lying time and sleep time measurement was evaluated using intraclass correlation coefficient (ICC) and 95% confidence interval (95% CI). An ICC (1,1) was used for reliability of the single-measures (single-day measurement) and an ICC (1, 7) was used for reliability of average measures (7 days measurement). Since inactivity pattern may be different depending on the day of the week including weekdays and weekends, one-way repeated analysis of variance (ANOVA) was performed to confirm the differences of total lying time and sleep time among 7 consecutive days of the forthcoming week. The discriminant validity of the total lying time was analyzed either via comparable analysis[31, 32] or correlation analysis[13, 31, 32]. Two-way ANOVA was conducted to assess the differences between total lying time and sleep time in the previous and forthcoming weeks. Additionally, Pearson correlation coefficients were calculated for total lying time and sleep time in the previous and forthcoming weeks. All of these analyses were performed with SPSS (IBM SPSS version 23.0), and level of significance for all statistics was set at $p<0.05$.

RESULTS

The ICCs of single-measures and average measures for the total lying time and the sleep time per day in next 1 week were high (Table 1). There was no significant difference in total lying time and sleep time among 7 days of the next 1 week

(Table 2). Additionally, there were neither significant main effect for the measurement times nor significant interaction, and there was no significant difference in the average of total lying time between in the previous week (8.4 ± 2.0 hours/day) and in the forthcoming week (8.7 ± 1.7 hours/day) (Table 3). In contrast, the average of total lying time was significantly higher than the average of sleep time in each week. There were low significant correlations between the total lying time and sleep time in the previous week (r=0.337, p<0.001) and the forthcoming week (r=0.330, p=0.015), respectively.

DISCUSSION

This present study provides information about the accuracy of a single self-reported assessment estimating total lying time in community-dwelling older adults. The results revealed that the single question about total lying time could measured with acceptable reliability and discriminant validity. To the best of our knowledge, this is the first study to report the reliability and validity for single self-reported measurement to assess total lying time in community-dwelling older adults.

For the total lying time per day investigated in the forthcoming week, there was no significant difference seen among the 7 days. Inactivity patterns were generally consistent within the forthcoming week in the participants of this study, and the ICCs for total lying time in the forthcoming week were above 0.8. The ICC values <0.5 are indicative of "poor" reliability, values between 0.5 and 0.75 indicate "moderate," values between 0.75 and 0.9 indicate "good," and values greater than 0.9 indicate "excellent"[33]; another reference recommended ICC value ≥0.7 as a minimum standard for reliability[23]. The ICCs for total lying time in the forthcoming week showed acceptable reliability as in previous studies[15, 34–36]. In this study, possible reasons for high reproducibility in total lying time measurement were as follows: 1) participants were healthy older adults without any neurologic diseases that might complicate understanding the question and recording total daily lying time per week, 2) lying time including sleep time and other lying activities may be easier to record than various physical activity time in sitting or standing positions. Additionally, the ICC (1, 7) for total lying time in the forthcoming week showed excellent higher reliability than the ICC (1, 1) for that; the average total lying time in the forthcoming week could be represented as the central tendency of total lying time in a week in older adults. Furthermore, comparable analysis showed no significant difference in the average total lying time between in the previous and forthcoming weeks. These results suggest that the total lying time asked to recall the average time per day in the previous week retrospectively and that investigated to calculate the average time per day in the next 1 week prospectively were close enough. Single self-reported assessment in the previous week may be able to assess the central tendency of total lying time in a week in older adults.

At the same time, there was significant difference between total lying time and sleep time, the average of total lying time was significantly higher than average sleep time in the previous or forthcoming week. In this study, sleep time in the previous or forthcoming week was approximately 7.1 hours/day, and the difference between weeks was not significant. The total sleep

Table 1. Intraclass correlation coefficient for total lying time and sleep time in the next 1 week

	ICC (1, 1)	95%CI	ICC (1, 7)	95%CI
Total lying time during next 1 week	0.835	0.773–0.889	0.973	0.960–0.982
Sleep time during next 1 week	0.701	0.596–0.781	0.940	0.912–0.961

ICC: intraclass correlation coefficient; 95%CI: 95% confidence interval.

Table 2. Results of 1-way repeated ANOVA for analysis of the differences among days of the next 1 week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	F	p
Total lying time (hrs)	8.4 ± 1.6	8.7 ± 1.8	8.6 ± 1.9	8.7 ± 1.7	8.5 ± 1.9	8.7 ± 1.8	8.6 ± 1.8	0.950	0.459
Sleep time (hrs)	7.0 ± 1.2	7.1 ± 1.3	7.0 ± 1.1	7.2 ± 1.3	7.0 ± 1.2	7.0 ± 1.2	7.1 ± 1.4	0.760	0.602

Values are mean ± SD.
The threshold for significance was p<0.05.

Table 3. Results of 2-way ANOVA for total lying time and sleep time in the last and next 1 week

	Last 1 week	Next 1 week
Average of total lying time (hrs)	8.4 ± 2.0	8.7 ± 1.7
Average of sleep time (hrs)	7.1 ± 1.3*	7.1 ± 1.2*

Main effect (last 1 week/next 1 week): F=0.820, p=0.367.
Main effect (total lying time/sleep time): F=28.164, p<0.001.
Interaction: F=0.871, p=0.353.
*Significant difference between total lying time and sleep time in each week (p<0.001).

time per day measured by objective devise-based methodology reported in recent studies for older adults were 6.9[37] and 7.7 hours/day[38], and the amount of sleep time in this study was similar to previous reports. Additionally, although the reports on total lying time are limited, it was reported that most disabled home-dwelling older adults had total lying time of 11 hours or more[39]. The amount of total lying time approximately 8 to 9 hours of healthy older adults in this study was lower as compared with that of disabled home-dwelling older adults. Both total lying time and sleep time in this study seemed to be conceivable values for general healthy older adults, and the significant differences between total lying time and sleep time indicated that total lying time is not the same as sleep time. Total lying time included not only sleep time but also nap and other lying activity time[39]. The difference of approximately 1 hour between total lying time and sleep time in this study reflects the time spent napping and performing lying activities other than sleep, which may suggest discriminant validity of the total lying time. In previous studies, the discriminant validity has been interpreted as the significant difference[31, 32] or lower relationship[13, 40–42] between two outcomes to assess different characteristics. In addition, the total lying time showed low correlation with sleep time in this study. A measurement can be invalidated by too high correlations with other measurements purporting to assess different characteristics[43], and moderate[41, 42] or lower[13, 40] correlation between measurements have been interpreted as good discriminant validity. The significant difference and lower relationship between the total lying time and the sleep time suggests that the total lying time was assumed to have discriminant validity as an outcome to distinguish from sleep time.

This study had several limitations. Single self-reported assessments of total lying time have potential disadvantages[30, 44, 45], and device-based assessments may be more suitable to assess physical activity depending on the purpose of assessment. Additionally, this study was conducted with community-dwelling healthy older adults, and the results may not be generalizable to institutionalized older adults with disabilities. Moreover, for older adults with cognitive impairments and other neurological disorders that complicate recalling and recording recent daily physical activity, observational assessment by others would be needed to investigate total lying time accurately rather than using a question-based assessment. Despite these study limitations, total lying time could be measured by single self-reported assessment with acceptable reliability and discriminant validity, and is an outcome that differs from sleep time in community-dwelling older adults.

Conflict of interest

There are no conflicts of interest to declare.

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