Relationship Between Sedentary Behavior And Sleep Indicators In Patients With Chronic Schizophrenia

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Abstract

Background: To investigate the relationship between daytime sedentary behavior and physical activity and sleep in patients with chronic schizophrenia, particularly focusing on insomnia symptoms, a hallmark of insomnia in patients with schizophrenia.

Method: The subjects were 20 patients with chronic schizophrenia more than 1 year after onset (12 men and 8 women with a mean age of 59.0 ± 9.8 years), of whom 4 were outpatients and 16 were inpatients. Sedentary behavior performance and physical activity index (Total sedentary behavior time and sedentary behavior bout number, low-intensity physical activity, MVPA, and steps) were assessed by wearing a triaxial accelerometer (GT3X-BT). Total bed time (TIB), total sleep time (TST), sleep latency (SIL), wake after sleep (WASO), and sleep efficiency (SE) were calculated using a small body dynamometer as an objective sleep index. Both the triaxial accelerometer and the small body dynamometer were worn for 1 week, and the average value of each index was calculated.

Results: Total sedentary behavior time was significantly positively associated with TIB and SL (r =. 499, p <. 05; r =. 543, p <. 05). Sedentary behavior bout number was negatively significantly associated with SE (r = -. 592, p <. 01) and positively associated with WASO (r =. 503, p <. 01). MVPA was significantly positively associated with SE (r =. 536, p <. 05) and negatively associated with WASO (r = -. 58, p <. 01).

Conclusion: Daytime sedentary behavior in patients with chronic schizophrenia was associated with insomnia symptoms. It was suggested that decreasing their sedentary behavior time and increasing moderate-to-vigorous intensity activities may improve their sleep quality.

In this study, though the relation has not been recognized in CP conversion value and sedentary behavior position action index, the relation between antipsychotic dose and total sedentary behavioral time needs further investigation.

1. Introduction

Many patients with schizophrenia have insomnia symptoms, and it is difficult to improve the symptoms only by pharmacotherapy. Approximately 80% of patients with schizophrenia have sleep disorders (Laskemoen et al., 2019), and studies comparing sleep in healthy subjects with that in schizophrenic patients without drug therapy suggest that insomnia is an essential feature of schizophrenia, with shorter total sleep time, longer sleep latency, and less sleep efficiency in schizophrenic patients than in healthy subjects (Chouinard, 2004). Main treatment methods of integration incontinence are pharmacotherapy and psychiatry rehabilitation, and the center of pharmacotherapy is the antipsychotic drug. Antipsychotics are effective not only for the symptoms of schizophrenia but also for insomnia. It has been reported that oral administration of clozapine and olanzapine increased total sleep time and shortened sleep latency (Kluge et al., 2014). However, schizophrenia often recurs due to discontinuation of medication, and it is said that the quality of sleep decreases when antipsychotic treatment is discontinued (Cohrs, 2008); therefore, it is difficult to expect improvement of insomnia in patients only

with medication. In addition, qualitative studies interviewing patients with schizophrenia from Faulkner and Bee (2017) reported that patients with schizophrenia were aware of changes in their sleep after onset, and that they were aware that relying on improvised drugs was a temporary coping strategy that was not optimal. From these results, it is necessary to examine the method except for the ingestion for the improvement on insomnia of the integration incontinence patient.

Physical activity to reduce insomnia appropriate for patients with chronic schizophrenia should be considered. Exercise is said to improve the quality of sleep (sleep quality) in patients with psychiatric disorders, and it has been reported that continuing aerobic and resistance exercises, Tai Chi, and yoga for 6 ~ 12 weeks is effective (Lenderman, et al., 2019). In the meantime, it is said that the activity quantity in the daytime lowers on the negative symptom which becomes remarkable in the integration incontinence patient in the chronic stage by losing the sociality and flattening the feeling. In addition, in Japan, there are many psychiatry sickbeds in comparison with foreign countries, and the average hospitalization days is long, and there are also many chronic stage patients who have been hospitalized over 1 year (OECD, 2020; Ministry of Health, Labour and Welfare, 2020). In addition, it seems to be difficult to continuously and independently carry out the motion (exercise), because the population ratio over 65 year-old in 2020 in Japan is 28.7% (Statistics Bureau of Japan, 2021), and the renewal in the past continues, and because the aging of the integration incontinence patient also advances.

By clarifying the relation between sedentary behavior behavior and sleep of the chronic stage integration incontinence patient, it is possible to examine the new intervention method to the sleep. Daytime physical activity is divided into sedentary behavior, low-intensity physical activity, and intermediate-intensity physical activity. Sedentary behavior behavior (Sedentary Behaviour) is defined as "All arousal behaviors with energy expenditure < 1.5 METs while seated, semi-recumbent, and recumbent" (Sedentary Behaviour Research Network, 2019). Moderate physical activity is defined as physical activity over 3 METs, and low intensity physical activity as physical activity of 1.5 ~ 3.0 METs. Hospitalized patients with chronic schizophrenia have been reported to sit longer (9.6 h vs 5.6 h) and take fewer steps (6,628 steps vs 10,976 steps) per day than healthy controls (Stubbs, et al., 2017a). And, the sedentary behavior hour in a day occupies 8.8 h and 58.7% of the awakening hour in chronic stage integration incontinence patients under ambulatory (Bueno-Antequera, et al., 2018).

On the relation between physical activity and sleep of the integration incontinence patient, the research which focused on the sedentary behavior behavior has seldom been observed. However, it is possible to examine the physical activity which can be continued more autonomously for improving the sleep by observing the relation between sleep and physical activity including not only physical activity strength but also sedentary behavior behavior.

The purpose of this study was to investigate the relationship between daytime sedentary behavior and physical activity and sleep in patients with chronic schizophrenia, especially focusing on insomnia symptoms, a hallmark of insomnia in patients with schizophrenia. In this study, it was decided that the

sleep with problems such as sleep onset disorder, arousal in the middle, early morning arousal and sound sleep disorder was defined as insomnia.

Ii. Research Methods

1. Target Audience

The object satisfied all following four conditions. The 4 conditions were as follows: 1) Schizophrenia is diagnosed in DSM -5 and the disease name is recognized, 2) the description content on the research can be understood, 3) the filling in consent forms, etc. can be done, and 4) there is no physical functional problem on the mounting of the measuring instrument.

The selection of the object was carried out, when the patient who matched the condition was introduced from the ward manager of the research cooperation facilities, and when the researcher directly talked with the person, it was selected.

2. Measurement Item

Daily physical activity and insomnia symptom index were assessed by wearing measuring instruments for 1 week.

1) Sedentary behavior behavior and physical activity indicators

The subjects wore the ActiGraph GT3X-BT (ActiGraph, LLC, Pensacola, FL, USA) on their lumbar region for one week, excluding bathing time, from waking up in the morning to going to bed at night, and obtained physical activity for one week after equipment recovery using the memory function. The support person of the subject was asked to appropriately confirm whether the equipment can be fixed except for the bathing. From the obtained data, the mean values of total sedentary behavior time and sedentary behavior bout number, low intensity physical activity (light physical activity; LPA), moderate or more physical activity (moderate-to-vigorous physical activity; MVPA), and steps per day were calculated and adopted as quantitative indices of sedentary behavior behavior and physical activity. Total sedentary behavior time represents the total time of less than 1.5 METs of physical activity while awake, and the sedentary behavior bout number represents the total number of interruptions in sedentary behavior time of more than 5 minutes.

Low-intensity physical activity represents the total time of physical activity between 1.5 Ets and 3.0 METs, and MVPA represents the total time of physical activity over 3.0 METs.

The data of sedentary behavior action hour and low intensity activity hour, MVPA can know what kind of intensity activity the chronic phase integration incontinence patient carries out in the arousal hour except for the bed time. In addition, the effect of the interruption of the sedentary behavior action can be observed by the data of the sedentary behavior bout number.

2) Insomnia symptom index

In this study, there was the correlation in the sleep polygraph, and it was made that the insomnia symptom index was objectively obtained using the actigraphy of the wrist watch type which is simply wearable. A small body dynamometer (AW-L, Mini-Mitter) was worn on the wrist of the non-dominant hand of the subject continuously for one week except for the bathing hour, and the rising and the rising time were recorded in the sleep diary. Using Actiware (Ver 5.57, Mini-Mitter), the following data on sleep variables were obtained from body movement data and time of waking and going to bed recorded in 1 min interval on the actigraph: total bed time (Time to rise from bed: TIB), total sleep time (The sum of the time spent in sleep among the total time spent in bed: TST), sleep latency (Time from going to bed to falling asleep: SL), wake after sleep (The sum of the waking hours from falling asleep to waking up: WASO), and sleep efficiency (Ratio of total sleep time to total bed time: SE). If the sleep efficiency is over 85%, it can be called good sleep.

3. Analytical method

All data were expressed as mean ± standard deviation (SD). The relationships between sedentary behavior behavior and physical activity indices and insomnia symptom indices and between sedentary behavior behavior and physical activity indices were analyzed using Pearson's correlation coefficients. The significance level was set at less than 5%.

Iii. Results

1. Audience Summary

Of 31 participants who provided informed consent to participate in this study, 20 who had no missing data were included in the analysis. Basic information on the subjects is presented in Table 1. The mean age of the subjects was 59.0. + -. 9.8 years, 12 men (60%), 8 women, 16 inpatients (80%), and 4 outpatients. The mean value of chlorpromazine (CP) equivalent was 896.67 ± 375.89 mg/day, and the prescription was not changed in any subjects during the measurement period.

2. Sedentary behavior Behavior and Physical Activity Index and Insomnia Symptom Index

The mean values of the Sedentary behavior Behavior and Physical Activity Index and Insomnia Symptom Index for 1 week in 20 subjects were as shown in Table 2. Sedentary behavior behavior (Behavior below 1.5 METs during wakefulness) accounted for 73% of the awake time, and MVPA for 4.9%. In addition, 8 patients had MVPA < 30 min (inactive), and the activity of patients with schizophrenia was generally low. There was the significant and positive relation on total sedentary behavior time with bed time and sleep latency. MVPA showed a significant positive correlation with sleep efficiency and a significant negative correlation with wake after sleep onset. A significant negative correlation was found between the number of sedentary behavior bout and sleep efficiency, and a positive correlation was found between the number of sedentary behavior bout and wake after sleep. Furthermore, low-intensity physical activity was

significantly negatively associated with bed time, total sleep time, and sleep latency, respectively (Table3).

3. Sedentary behavior Behavior and Physical Activity Index

The total sedentary behavior time showed a significant positive correlation with the sedentary behavior bout number and a negative correlation with the amount of low intensity physical activity. Furthermore, the sedentary behavior bout number was significantly negatively associated with MVPA and step number, respectively (Table4).

4. CP-Converted Values and Sedentary behavior Behavior and Physical Activity Index/Insomnia Symptom Index

There was no significant correlation between the CP-equivalent value and the sedentary behavior behavior and physical activity index (Total sedentary behavior time and sedentary behavior bout number, low intensity physical activity, MVPA) or the insomnia symptom index (Total bedtime, total sleep time, sleep latency, wake during sleep, and sleep efficiency).

Iv. Discussion

The purpose of this study was to clarify the relationship between insomnia symptoms and sedentary behavior behavior and physical activity in patients with chronic schizophrenia. The total sedentary behavior time objectively evaluated in this study showed a significant positive association between bedtime and sleep latency. There was a significant negative correlation between the number of sedentary behavior bout and sleep efficiency, and a positive correlation between the number of sedentary behavior bout and wake after sleep. In the correlation between physical activity index and sleep index, MVPA and increase in the number of steps were related to good sleep, while increase in light physical activity (LPA) was related to deteriorated sleep index. These results suggest that daytime sedentary behavior in schizophrenic patients is associated with insomnia symptoms and that a decrease in sedentary behavior may lead to an improvement in insomnia symptoms, and that physical activity, especially more than moderate intensity activity, may improve sleep quality.

The average total sedentary behavior time of the subjects in this study was very high, 11.6 h/day. A study comparing the sedentary behavior behavior of 76 schizophrenic patients with that of 38 age-, sex-, and BMI-matched normal controls (Vancampfort et al., 2012) showed that the total sedentary behavior time (8.5 h vs 6.2 h) of schizophrenics was significantly longer. In addition, a previous study that objectively evaluated total sedentary behavior time in hospitalized adolescent patients with schizophrenia showed an increase in total sedentary behavior time in the latter half of adolescence (Mean 8.5 h/day: Vancampfort et al., 2012) at an average age of 37.0 years compared with the first half of adolescence (Mean 6.9 h/day — Strassnig et al., 2012) at an average age of 25.1 years. And, it was average 9.7 h/day (Stubbs et al., 2017a) in integration incontinence patient of 199 persons (Average age: 44.0 years) in the first half in the late prime, and the sedentary behavior time of integration incontinence patients seemed to

be longer than the general healthy subject, and it tended to extend with the age, when the result (Average 11.6 h/day) in latter half of prime (Average age: 59.0 years) of this study was considered. One study of patients with mild cognitive impairment reported a higher incidence of anxiety, depression, and diabetes in addition to sleep disturbances among those seated for 8 h or more per day (Vancampfort et al., 2019). And, in the research which examined the relation between sedentary behavior action time and recognition function in 119 patients with schizophrenia, it was reported that the patients who sedentary behavior for long time had inferior motor reaction time and recognition processing than the patients who sedentary behavior for short time ($p < .05$) (Stubbs et al., 2017b). In this study, too, the relation with sleep disorder such as the extension of sleep latency was shown in respect of the long total sedentary behavior time, and it was guessed that the decrease in total sedentary behavior time contributed to improvement of mental disorder including sleep disorder, reduction of body disease risk including diabetes mellitus prevention, lowering control of the recognition function, when it was considered with these previous research result.

Vancampfort et al. (2017) suggested that there may be regional differences in total sedentary behavior time. Sedentary behavior times as long as 9.7 h/day have been reported in North America (9.8 h/day), South America (9.3 h/day), and Asia (Vancampfort et al., 2017), for example, compared with European regions (Average 6.9 h/day). However, even when compared with these study results, the total sedentary behavior time in this study was very long, 11.6 h/day. The long total sedentary behavior time shown in this study may reflect the characteristics of psychiatric care in Japan. In Japan, hospitalization number of the integration incontinence patient and dosage of the antipsychotic drug are also more than foreign countries. Actually, the average of CP conversion value of the subject in this study was high with 896.67 mg/day, and the subject who exceeded 1,000 mg/day which is said to be a large dose of the antipsychotic drug in the schizophrenia pharmacotherapy guideline also included 8 persons. Compared with previous studies in which the CP-equivalent value and sedentary behavior time were shown (Vancampfort et al., 2012), the CP-equivalent value and sedentary behavior time in this study were 1.3 ~ 1.4 times higher.

In this study, the sedentary behavior bout number, i.e., the number of interruptions in sedentary behavior for more than 5 min, showed a positive association with WASO, a sleep indicator, and a negative association with SE. In general, because longer total sedentary behavior time increases the risk of health hazards (Stubbs et al., 2016; Stubbs et al., 2017a; Ellingson et al., 2018; Vancomprort et al., 2019), an increase in the number of sedentary behavior bouts that breaks sedentary behavior can be considered a favorable situation. In fact, it has been reported that the higher the sedentary behavior bout number, the lower the waist circumference and body mass index, and the better the triglyceride value as an index of neutral fat and the glucose value as an index of diabetes in healthy people regardless of the total sedentary behavior time (Owen et al., 2010). However, in this study, the more the sedentary behavior bout number was, the more the negative effect was caused for the sleep. The mean sedentary behavior bout number in this study was 121.7 time/day, which was also higher than in previous studies (43.8 ~ 92.1 time/day : Diaz , et al . , 2017), but this higher number of sedentary behavior time interruptions may represent restless symptoms of schizophrenia. In fact, the mean value of LPA from 1.5 METs to 3.0 METs

in the subjects of this study was 204.1 mim/day, accounting for 13% of daily physical activity, which is similar to the results of recent previous studies (Engh et al., 2019 Snethen et al., 2014). The results of this study, in which the total sedentary behavior time and the sedentary behavior bout number were larger than those of previous studies, while the LPA was almost the same, seemed to reflect the symptoms of restless schizophrenia.

In this study, we found a significant association between the level of physical activity intensity and sleep indices, in which high LPA deteriorated sleep indices, and high MVPA, representing physical activity of 3 Mets or more, improved sleep indices. The percentages of LPA and MVPA in daily physical activity in this study were 13% and 5%, respectively, which were both lower than those in previous studies in general healthy subjects (LPA: 15.3%, MVPA: 8.8%; Kruisdijk et al., 2017). A study examining factors associated with physical activity in schizophrenic patients reported that low physical activity was associated with sleep disturbance and limitation as well as aging (Stubbs et al., 2018), and stated that failure to meet international physical activity recommendations increased the likelihood of sleep disturbance independent of depression and anxiety (Vancomprort et al., 2018). The WHO Guidelines on Physical Activity and Sedentary Behavior recommend that for adults aged 18 ~ 64 years, moderate-intensity aerobic exercise for 150 to 300 min/wk, or high-intensity aerobic exercise for 75 to 150 min, or a combination of both for equivalent time and intensity exercise, and 2-day/wk strength training with moderate-intensity or greater stress should be included for physical activity; sedentary behavior should be kept to a minimum, and low-intensity exercise should be substituted. In qualitative research interviewing schizophrenic patients by Faulkner and Bee (2017), it is shown that the sleep problem which patients want to improve the most is WASO. In this study, WASO was positively correlated with MVPA and step count, suggesting that MVPA and walking are effective in reducing sleep onset, one of the insomnia symptoms in schizophrenic patients. Takenouchi et al. (2019) reported in their study of inpatients with chronic schizophrenia in Japan that the higher the number of steps taken, the longer the total sleep duration and the higher the sleep efficiency. Physical activity above normal walking speed is considered MVPA, which partly supports the results of this study. And, it seemed to contribute to the sleep quality improvement of chronic integration incontinence hospitalized patient by replacing sedentary behavior time and LPA with MVPA, since the life hour in a day is limited.

In the symptom of integration incontinence, there are positive symptoms such as hallucination, delusion and annihilation thought and negative symptoms such as flattening of the feeling and hypobulia, etc., and the negative symptom often shows strongly in the chronic stage. However, Taliercio et al. (2020) reported that decreased physical activity in patients with schizophrenia was not associated with the severity of symptoms, suggesting that it is feasible to increase physical activity to enhance sleep quality in patients with chronic schizophrenia. In a study that incorporated physical therapy to promote physical activity in patients with schizophrenia and affective disorder (Gyllensten et al., 2020), it was reported that patients with affective disorder were able to reach recommended levels of moderate physical activity according to the World Health Organization guidelines, while those with schizophrenia showed a positive attitude but showed no change in behavior. It was considered that the support which leads to the behavior change, for example, that the purpose which increases the physical activity is individually set,

and that it stimulates the action change in which MVPA increases in usual walking and stair ascent and descent, etc. in the activity of daily living, when the sedentary behavior action is interrupted, leads to the security of arousal hour in the middle and collective sleep time, and that it can improve insomnia symptom of the integration incontinence patient.

8. Limitation

In this study, though the relation has not been recognized in CP conversion value and sedentary behavior position action index, antipsychotic drug dose seemed to affect the total sedentary behavior time in some ways, and it seemed to be future examination subject.

Abbreviations

LPA	Low-intensity physical activity
MVPA	CHECK TEXT / EXISTING GLOSSARY FOR DEFINITION
SE	Sleep efficiency
SL	Sleep latency
TIB	Time in bed
TST	Total sleep time
WASO	Waking after sleep onset

Declarations

Ethics approval and consent to participate

This study was conducted with the approval of the Research Ethics Committee of the Research Institute of Nursing Care for People and Community at the College of Nursing Art and Science, University of Hyogo and the Ethics Review Boards of participating institutions and conducted according to the Declaration of Helsinki and subsequent revisions. Candidates for the study were those who satisfied the four conditions mentioned and who were judged by their physicians to be able to make the decision to participate in the study of their own free will. We thoroughly explained to the candidates, verbally and with documents, the purpose and significance of the study, the methods that would be employed, showing them the actual monitoring equipment to help them visualize the efforts they would be required to make to collect data. We also explained about matters such as the protection of personal information, the viewing of patients' medical records by investigators, the announcement of the study results to the public, and how data would be disposed of after the completion of the study. Only those who gave their written consent were selected as subjects for the study. If a deterioration in the mental state or physical condition of the patient

occurred by participating in the study, monitoring was immediately stopped. We also established a system whereby subjects could contact the lead physician or a nurse at any time as required to have a medical consultation.

Consent for publication

Not applicable.

Availability of data and materials

The datasets during and/or analysed during the current study available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

R. Takenouchi, M. Shibata, I. Kishida and M. Kawada designed the study. R. Takenouchi, M. Shibata, I. Kishida, C. Ishii and N. Ishii acquired the data. R. Takenouchi, M. Shibata I. Kishida and M. Kawada conducted the statistical analysis. R. Takenouchi and M. Shibata, I. Kishida, M. Kawada and M. Buyo managed the literature searches and prepared the manuscript. M. Shibata and M. Kawada and M. Buyo provided feedback about data analysis and interpretation. All authors have approved the final manuscript.

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Tables

Table1. Patient characteristics.

Variables	Value, % or mean (SD)
Age, years	59.0 (9.8)
Height, cm	163.7 (9.5)
Weight, kg	63.0 (12.1)
Chlorpromazine equivalent (mg/day)	896.67 (375.89)
Sex (%)	
Male, n	12, 60
Female, n	8, 40
Patients (%)	
Inpatients, n	16, 80
Outpatients, n	4, 20

Table 2. Mean and SD of objective sleep and activity indices.

Outcome scale	Mean (SD)
Objective sleep index	
Time in bed (h:m)	8:15 (1:01)
Total sleep time (h:m)	6:58 (0:47)
Sleep latency (min)	7.7 (5.9)
Waking after sleep onset (min)	46.3 (27.3)
Sleep efficiency (%)	85.0 (6.0)
Activity index	
Total sedentary time (min)	695.9 (104.3)
Total sedentary bout (time)	121.7 (42.6)
Light physical activity (min)	204.1 (118.6)
MVPA (min)	46 (41)
Steps (steps)	5,755 (2,674)

Table 3. Correlation between Sedentary Behavior/Physical Activity Index/Insomnia Symptom Index

	TIB	TST	SL	WASO	SE
Total Sedentary time	.449*	.320	.543*	.331	−.274
Total sedentary bout	.142	−.207	.376	.503*	−.592*
Light Physical activity	−.722**	−.642*	−.661*	−. 221	.244
MVPA	−.200	.115	−.287	−.577*	.536*
Steps	.076	.337	−.205	−.461*	.389

TIB=Time in bed, TST=Total sleep time, SL=Sleep latency

WASO=Wake after sleep onset, SE=Sleep efficiency

n=20

*p<.05

**<.001

Table 4. Correlation between sedentary behavior and physical activity indices

	Total Sedentary time	Total Sedentary bout	LPA	MVPA	Steps
Total Sedentary time	–	.668*	−.887**	−.217	−.277
Total Sedentary bout	.668*	–	−.402	−.551*	−.618*
LPA	−.887**	−.402	–	−.043	−.091
MVPA	−.217	−.551*	−.043	–	.896**
Steps	−.277	−.618*	−.091	.896**	–

LPA= Light-intensity physical activity, MVPA= Moderate-to-vigorous physical activity

n=20

*p<.05

**<.001