Research Letter

Evaluation of fatigue level of the elderly in tourism activity

Ayako Sawada (Hokuriku Gakuin Junior College, sawada@hokurikugakuin.ac.jp, Japan)
Takashi Oyabu (Nihonkai International Exchange Center, oyabu24@gmail.com, Japan)

Abstract

Japan is in the process of a long-term population decline, and there are concerns that the domestic tourism will shrink due to this population decline. However, as the population of people over 65 years old is estimated to increase until around 2042, the elderly are an important segment of the tourism industry. The number of trips by age group is below average for those aged 70 and older. Health reasons are reported as a disincentive to travel for this age group, which is higher than for other age groups, as is the desire not to be troubled by the inability to keep up with the pace of others. The authors are carrying out research on the derivation of tourism activity ability to promote tourism among the elderly. As part of this study, a preliminary experiment of sightseeing tours was conducted and the fatigue level during sightseeing activities was evaluated by objective and subjective indices. Furthermore, this paper discusses the relationship between the degree of fatigue and the amount of daily activity. From these results, it is possible to obtain the beginning stages of deriving tourism activity ability of the elderly.

Keywords

tourism activity, elderly, fatigue, objective index, subjective index

1. Introduction

The tourism industry has suffered a major blow due to the spread of COVID-19 infection. According to the Japan National Tourism Organization, the number of foreign visitors to Japan in 2020 was 4.11 million, down 87.1 % from the previous year. Although the Japanese government has been actively promoting inbound policies since the former Prime Minister Junichiro Koizumi declared Japan a Tourism Nation in January 2003, it is a risky market that is affected by not only infectious diseases but also by the situation and policies of the country. On the other hand, the elderly population of people over 70 years old will continue to increase until around 2048, and their importance in domestic tourism requires attention.

The authors are carrying out research on the derivation of tourism activity ability for the promotion of tourism among the elderly. As part of this study, a preliminary experiment of sightseeing tours was conducted to evaluate the level of fatigue during sightseeing activities by objective and subjective indices. Furthermore, the relationship between the level of fatigue and the amount of daily activity is discussed.

2. Current status of tourism for the elderly

With the world's population aging rapidly over the next half century, the elderly are projected to become the most important segment of the tourism industry in the future [Alén et al., 2014; Wijaya et al., 2018]. Figure 1 shows the estimated total population of Japan. Japan is in a long-term process of population decline, with the population estimated to decrease from 127 million in 2015 to 88 million in 50 years. However, the population of 65 years old and over was 34 million in 2015 and is estimated to increase until around 2042. Therefore, the elderly are an important segment of the tourism industry in Japan, given

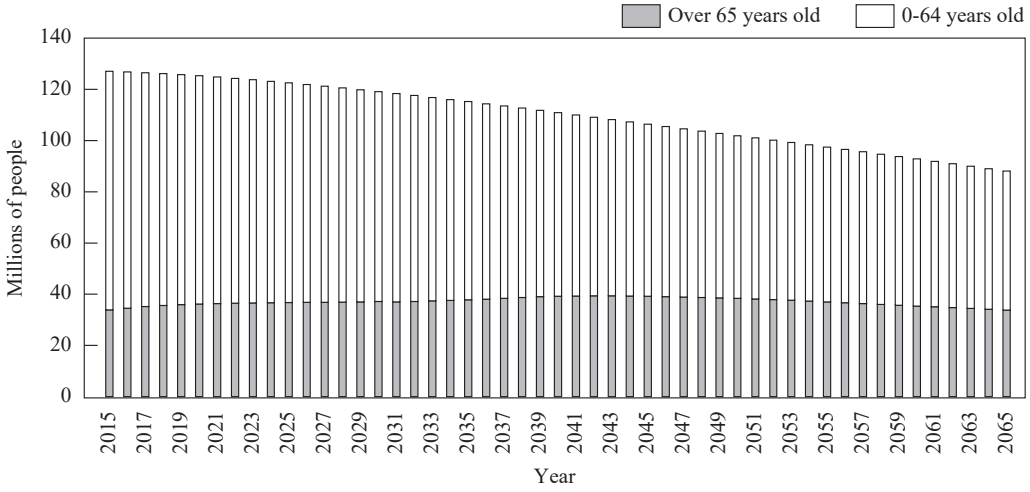


Figure 1: Estimation of total population by age group
Source: Created by the authors based on National Institute of Population and Social Security Research [2017].

the concerns about shrinking domestic tourism due to population decline.

Figure 2 shows the average number of domestic trips for sightseeing and recreation with overnight stays by age group. The average number of trips per capita was 1.36, with an average of 1.32 for all ages of males and 1.40 for females. While both men and women in their 60s exceeded the average, the number of trips in their 70s decreased to 1.24 for men and 1.09 for women, and even less for those in their 80s.

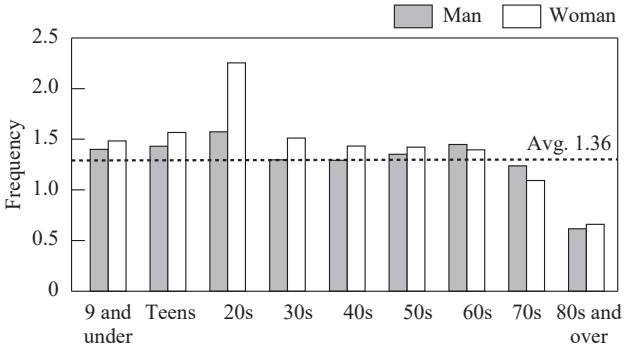


Figure 2: Number of domestic sightseeing trips by age group
Source: Created by the authors based on Japan Tourism Agency [2020].

Reasons for not taking an overnight sightseeing trip are shown in Figure 3 by age group. Economic and time constraints tend to be the most common reasons, but are statistically significantly lower in the 60-69 and 70+ age groups than in the other age groups. In addition, health reasons are significantly higher among the 70+ age group than among other groups. According to the JTB Research Institute [JTB Tourism Research & Consulting, 2016], one of the major factors reported to reduce the number of trips among those aged 70 and older is a stronger desire not to be troubled by the inability to keep up with the pace of others.

3. Derivation of tourism activity ability

Previous studies on walking among the elderly have measured step count characteristics and vital sign characteristics during walking, and revealed the potential of walking to maintain health [Oyabu et al., 2016]. It has also been shown that elderly people walk more than usual on a tour, which leaves them tired the following day and unable to fully enjoy the remaining part of the trip [Oyabu et al., 2017]. It is important not only to be able to keep up with the tour, but also to avoid fatigue the following day. In order to eliminate these concerns, it is important to show individual elderly people the ability to join in tourism based on scientific verification.

The authors define "the ability to enjoy sightseeing without being tired the next day at the destination" as "tourism activity ability," and conducted research on the promotion of travel among the elderly by deriving tourism activity ability. Figure 4 shows the entire research process. The research consists of the following four parts:

(1) Conduct self-monitoring of daily activity and measurement of walking ability [Sawada and Oyabu, 2021].
(2) Conduct sightseeing tours and measure the number of steps, heart rate, and activity as objective indicators, and evaluate fatigue as a subjective indicator.
(3) Based on the data in (2), derive the tourism activity in three levels. In addition, factors influencing the tourism activity power will be analyzed using the data in (1).

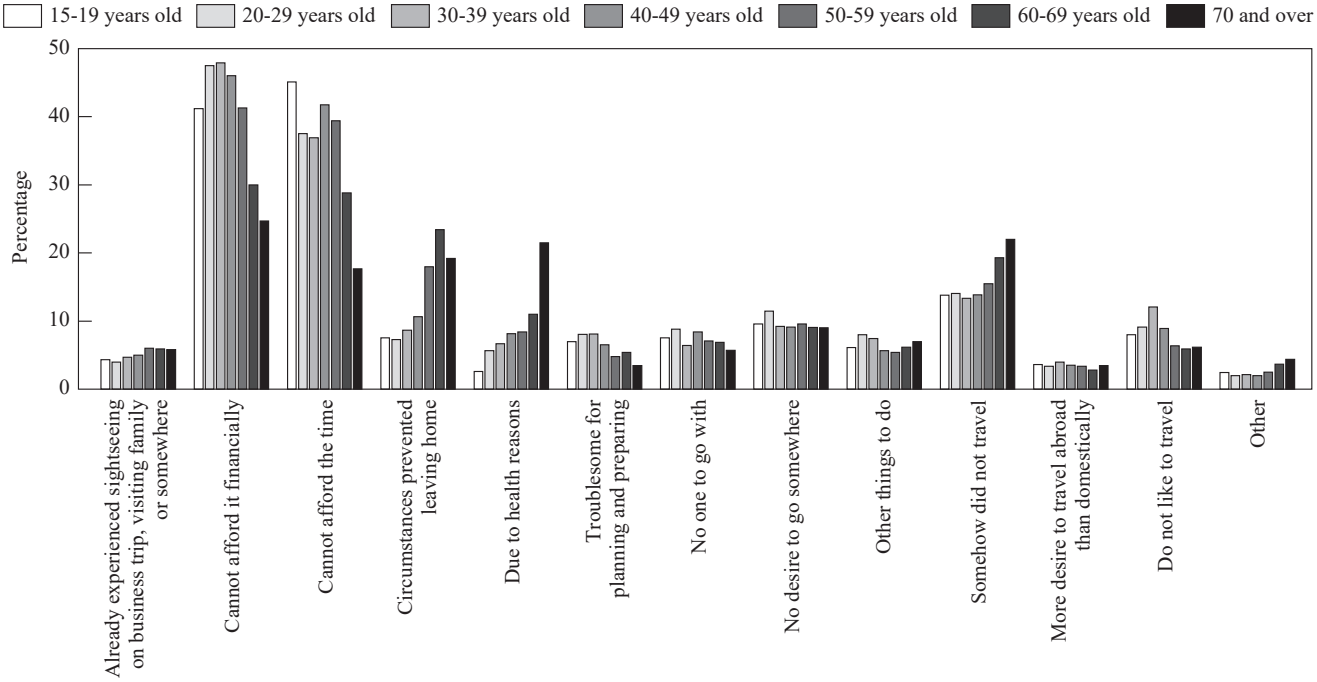


Figure 3: Disincentives for overnight sightseeing travel by age group
Source: Created by the authors based on Japan Travel and Tourism Association [2020].

(4) Subjects will be presented with the tourism activity and the main factors influencing the tourism activity. A questionnaire survey will be conducted to determine whether understanding one's own tourism activity ability will lead to increased motivation to go on a sightseeing trip.

This study conducted a preliminary experiment for (2) in the figure, and the fatigue level during tourism activities evaluated by objective and subjective indices. Furthermore, the relationship between the level of fatigue and the amount of daily activity is discussed.

4. Experimental Methods

4.1 Sightseeing tour course

A sightseeing tour was conducted within Kenrokuen Garden, which is designated as a special national scenic beauty spot in Kanazawa City. The webpage of Kenrokuen Garden lists a 500-meter course that takes 40 minutes and is barrier-free, and a 1,300-meter course that takes 90 minutes and is with steep stairs. As an intermediate course with some ups and downs, a 60-minute, 900-meter course was created, and together with the two existing courses, these three courses were arranged.

4.2 Measurements

4.2.1 Objective index

As objective indicators, the number of steps taken and calories burned were measured by an activity meter (Omron Healthcare: HJA-306) equipped with an acceleration sensor. Figure 5 shows a photograph of the activity meter. In addition, the heart rate was measured by a wearable heart rate sensor (Union Tool Corporation: MyBeat WHS-3). Electrode pads were used. A photograph of the device is shown in Figure 6.

Figure 5: Photograph of activity meter

Figure 6: Photograph of heart rate sensor

4.2.2 Subjective indicators

Two indices were used to assess subjective fatigue. One is the Japanese version of the Multidimensional Fatigue Inventory (hereinafter referred to as MFI) [Sugaya et al., 2005]. The MFI is a 20-item scale consisting of five factors: "general fatigue," "physical fatigue," "reduced activity," "reduced motivation," and "mental fatigue. Each factor is quantified as a total of 100 points on a scale of 4 to 20, with higher scores indicating a higher subjective sense of fatigue. The other is the Visual-analog Scale (hereinafter referred to as VAS). The VAS was created as a scale to evaluate subjective pain intensity, however, it is also used for fatigue evaluation [Mizuno, 2019; Moritaki et al., 2018]. The left end of a 100 mm straight line is defined as "tired" and the right end as "not tired," and the length from the right end to the mark made by the subject is used as the index.

4.3 Experimental procedure

The experimental procedure is shown in Figure 7. The subject was one person, 71-year-old male. Each of the three courses was conducted on a different day.

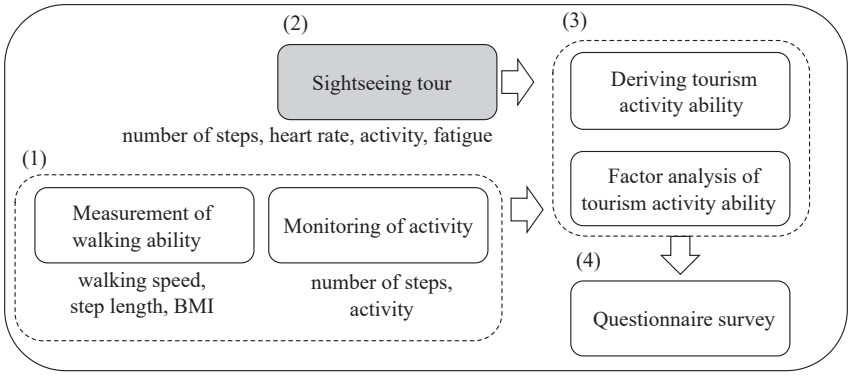


Figure 4: Entire research process

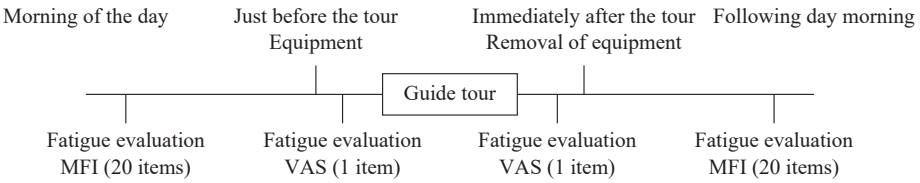


Figure 7: Experimental procedure

5. Results of experiment

5.1 Heart rate

Heart Rate Reserved (HRR) is an index of exercise intensity using the heart rate. In this study, the Karvonen method was used to calculate HRR using equation (1).

$$\text{HRR } \% = \frac{C - R}{M - R} \times 100 \quad (1)$$

C is the current heart rate, R is the resting heart rate, and M is the maximum heart rate. The subject's resting heart rate was measured in the sitting position and was 78 (beats/minute). The maximum heart rate was estimated by equation (2) [Yamaji, 2013: 50], because it tends to be estimated lower in people over 40 years of age, although the method of estimating the maximum heart rate by subtracting age from 220 is simple and widely used.

$$M = 207 - (\text{Age} \times 0.7) \quad (2)$$

A representative index of subjective exercise intensity is the Borg Scale [Borg, 1970] shown in Table 1. The Japanese language of Onodera and Miyashita [1976] is also shown in the table. There is a directly proportional relationship between the numbers 6-20 in the table and the heart rate, and multiplying the numbers by 10 gives the approximate heart rate. However, since heart rate fluctuates with age, Yamaji [1997] created an age-specific correspondence table for the relationship between the Borg scale and heart rate. Therefore, in this study, estimates of heart rate relative to HRR are shown in Table 1, based on the subjects' resting heart rate and age.

The results of the heart rate obtained from the heart rate sensor during the sightseeing tour for the three courses are summarized in Figure 8. During the 40-minute tour, the average heart rate (beats/minute) was 85.2 and the highest value was 91. Referring to Table 1, it can be seen that the condition is in the "very very light" to "very light" range. During the 60-minute tour, the average heart rate was 86.8 and the highest was 101. The heart rate was in the "very very light" to "fairly light" range. During the 90-minute tour, the average value was 89.5 and the highest value was 108. Although 108 was measured twice after 50 minutes, Table 1 indicates that it was in the "fairly light" state.

5.2 VAS

The results of the VAS conducted immediately before and after the sightseeing tours are shown in Figure 9. Higher values indicate more fatigue. The VAS values for the 40-minute tour remained about the same, while those for the 60- and 90-minute tours rose slightly immediately afterward.

Table 1: Subjective exercise intensity and subject's heart rate

	Borg scale [Borg, 1970]	Japanese expression [Onodera and Miyashita, 1976]	HRR (%)	Heart rate (Beats/minutes)
20			100.0	157
19	Very very hard	非常にきつい	92.9	152
18			85.7	146
17	Very hard	かなりきつい	78.6	140
16			71.4	135
15	Hard	きつい	64.3	129
14			57.1	123
13	Somewhat hard	ややきつい	50.0	117
12			42.9	112
11	Fairly light	楽である	35.7	106
10			28.6	100
9	Very light	かなり楽である	21.4	95
8			14.3	89
7	Vey very light	非常に楽である	7.1	83
6			0.0	78

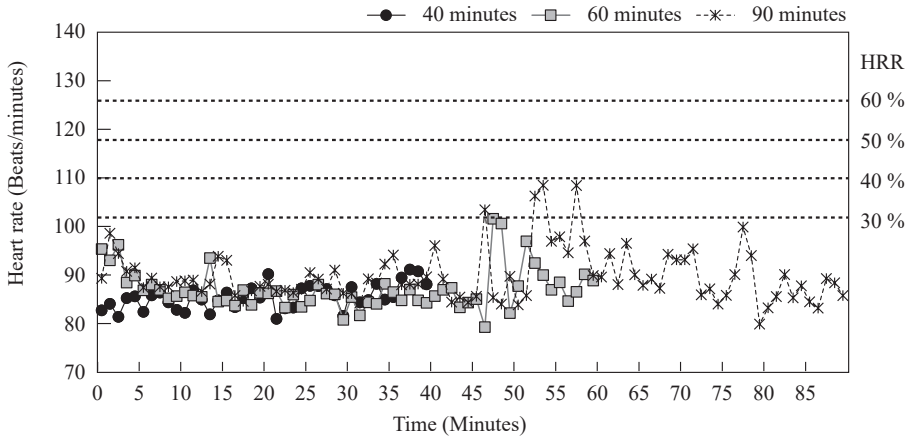


Figure 8: Heart rate during participation in three sightseeing tours

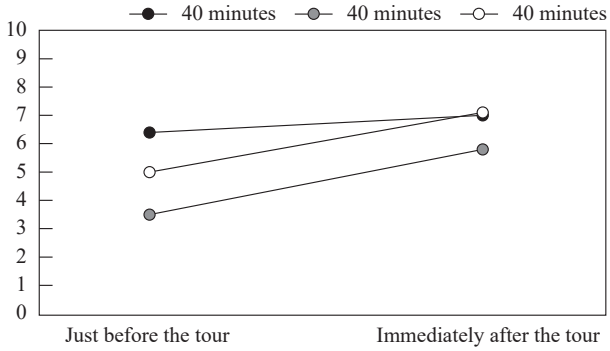


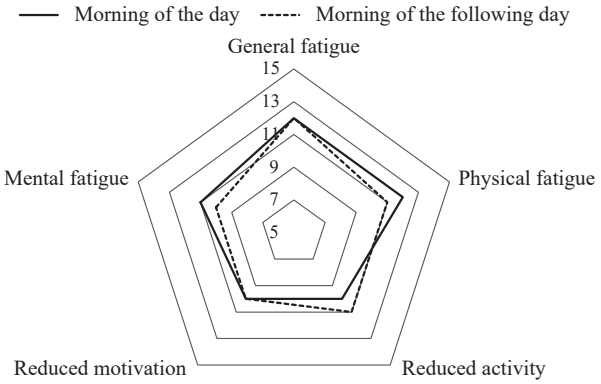
Figure 9: VAS immediately before and after a sightseeing tour

5.3 MFI

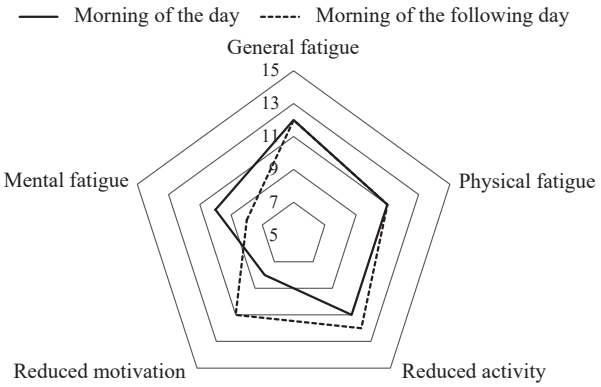
Figure 10 shows the results of the MFI conducted on the morning of the day of the sightseeing tour and the morning of the following day. The highest score for each of the five factors, "general fatigue," "physical fatigue," "reduced activity," "reduced motivation," and "mental fatigue," was 20 points, with higher scores indicating greater fatigue. In the 40-minute tour, there was no significant change between the day of the tour and the following day for the five factors. In the 60-minute tour, the degree of "low motivation" was higher on the following day than on the previous day. In the 90-minute tour, the degree of "low motivation" improved on the following day compared to the previous day.

The results of the total scores for the five factors of the MFI are shown in Figure 11. The 40-minute tour decreased by 1 point and the 90-minute tour decreased by 2 points. The 60-minute tour increased by 2 points, however, the range of variation was small for both results.

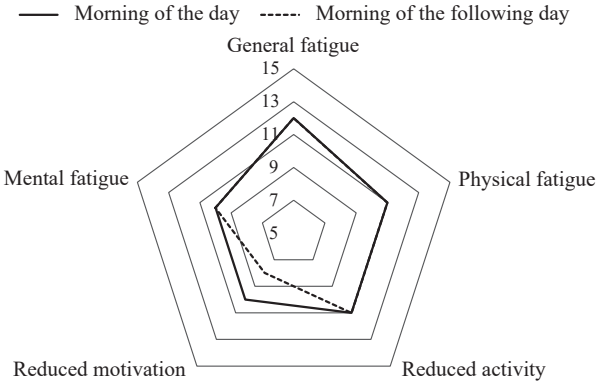
These results indicate that in all of the tours, some fatigue was observed immediately after the tour (VAS), but the heart rate during the tour was below the "fairly light" state, and the MFI was not considered to leave fatigue on the following day, since some variations were observed at the factor level but no significant difference was observed between the day of activity and the following day in the total value.



(a) 40-minute course



(b) 60-minute course



(c) 90-minute course

Figure 10: MFI on the mornings of the day and following day of sightseeing tour

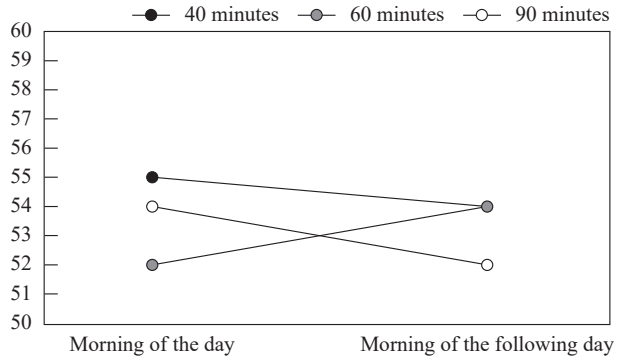


Figure 11: Total score of 5 factors of MFI on the mornings of the day and following day

6. Discussion

In this study, we defined tourist activity ability as "the ability to enjoy sightseeing without being tired the next day at the destination". Although the subject was slightly tired immediately after the tour, he did not remain tired the following day in all three courses. In other words, the subject was considered to have tourism activity ability to enjoy the 90-minute course. However, it is necessary to obtain more data from a larger number of subjects in order to derive the tourism activity ability.

Figure 12 shows the number of steps and activity level of the subject for the month prior to his participation in the tours. The average number of steps taken by the subject was 8,449. According to the 2019 National Health and Nutrition Survey Report [Ministry of Health, Labour and Welfare, 2020] , the average number of steps taken by men aged 65 and over was 5,597, and the target value set by Healthy Japan 21 (second stage) is 7,000 steps. The subject took over 1,000 steps more than this and also had a habit of exercising about once a week. Therefore, his heart rate was stable during the tour, and it is thought that he did not feel tired the following day.

This study was a preliminary experiment and reported on a single subject, however, in the future we plan to increase the number of subjects and conduct a multivariate analysis to derive the tourism activity ability. As shown in Figure 4, factor analysis of tourism activity ability will be performed from daily activity and walking ability. These results will be fed back to the subjects. We will then clarify whether the elderly will improve their motivation to go on sightseeing tours by understanding their own tourism activity ability.

7. Conclusion

In this study, an experimental tour was conducted to evaluate the fatigue level of elderly people in their sightseeing activities. The number of steps, activity, and heart rate were measured as objective indices, and MFI and VAS were used as subjective indices. The male subject showed little or no fatigue during the three courses. Furthermore, the average number of steps taken by the subject in the month prior to participation in the tour was higher than the target value set by the Ministry of Health, Labour and Welfare, suggesting that there may be a relationship between the amount of daily activity and the level of fatigue.

Based on the results of this study, we plan to conduct sightseeing tours for a larger number of subjects and derive their tourism activity ability through multivariate analysis. We will then clarify whether the elderly will improve their motivation to go on sightseeing tours by understanding their own tourism activity ability.

Acknowledgements

This study was supported by JSPS KAKENHI Grant Number 19K12600.

References

Alén, E., Nicolau, J. L., Losada, N., and Domínguez, T. (2014). Determinant factors of senior tourists' length of stay. *Annals of Tourism Research*, Vol. 49, 19-32.

Borg, G. (1970). Perceived exertion as an indicator of somatic stress. *Scandinavian Journal of Rehabilitation Medicine*, Vol. 2, No. 2, 92-98.

Japan Tourism Agency (2020). *2019-nen ryokō kankō shōhi dōkō chōsa* [2019 Travel and Tourism Consumption Trends

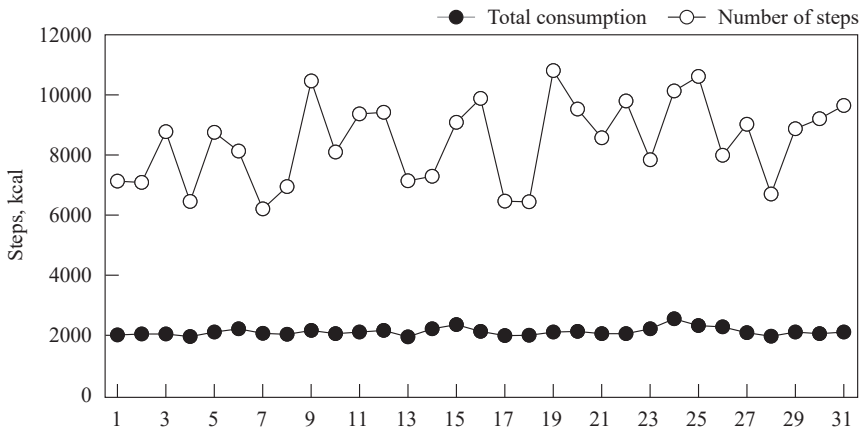


Figure 12: Subjects' steps and activity per month

Survey] (Retrieved March 22, 2022 from https://www.mlit.go.jp/kankocho/siryou/toukei/shouhidoukou.html). (in Japanese)

Japan Travel and Tourism Association (2020). *Reiwa gannendo ban kankō no jittai to shikō: Dai 38-kai kokumin no kankō ni kansuru jittai chōsa* [2019 tourism facts and intentions: The 38th national survey on tourism]. (in Japanese)

JTB Tourism Research & Consulting (2016). *Shinia no raifu-sutairu to ryokō ni kansuru chōsa* [Survey on lifestyle and travel of senior citizens] (Retrieved March 22, 2022 from https://www.jtbcorp.jp/scripts_hd/image_view.asp?menu=news&id=00044&news_no=40). (in Japanese)

Ministry of Health, Labour and Welfare (2020). *Reiwa gan'nen kokumin kenkō eiyō chōsa hōkoku* [2019 National Health and Nutrition Survey Report] (Retrieved March 22, 2022 from https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/kenkou_iryou/kenkou/eiyou/r1-houkoku_00002.html). (in Japanese)

Mizuno, T. (2019). Effects of different voluntary forces of dynamic stretching on maximal dorsiflexion angle of the ankle joint and subjective fatigue. *Japanese Journal of Physical Fitness and Sports Medicine*, Vol. 68, No. 4, 269-277. (in Japanese)

Moritaki, N., Inoue, K., and Yamazaki, H. (2018). Effect of Japanese dashi on autonomic nervous system activity and mental fatigue in humans. *Journal of Japan Society of Nutrition and Food Sciences*, Vol. 71, No. 3, 133-139. (in Japanese)

National Institute of Population and Social Security Research (2017). *Nihon no shōrai suikei jinkō (Heisei 29-nen suikei) no shussei chūi shibō chūi katei ni yoru suikei* [Estimates based on the medium birth and medium death assumptions of the future population projections for Japan (2017 estimates)] (Retrieved March 22, 2022 from http://www.ipss.go.jp/pp-zenkoku/j/zenkoku2017/db_zenkoku2017/db_zenkoku2017gaiyo.html). (in Japanese)

Onodera, K. and Miyashita, M. (1976). A study on Japanese scale for rating of perceived exertion in endurance exercise. *Japan Journal of Physical Education, Health and Sport Sciences*, Vol. 21, No. 4, 191-203. (in Japanese)

Oyabu, T., Kajiwara, Y., and Kimura, H. (2016). Vital-sign characteristics of an elderly person during walking. *Sensors and Materials*, Vol. 28, No. 4, 379-388.

Oyabu, T., Kimura, H., and Liu, A. (2017). Health care by walking in an aging society and encouragement for tourism. *Journal of Global Tourism Research*, Vol. 2, No. 1, 25-31.

Sawada, A. and Oyabu, T. (2021). Monitoring of elderly for deriving tourism activity ability. *Journal of Global Tourism Research*, Vol. 6, No. 1, 55-59.

Sugaya, N., Kaiya, H., Iwasa, R., and Nomura, S. (2005). Reliability and validity of the Japanese version of multidimensional fatigue inventory (MFI). *Job Stress Research*, Vol. 12, No. 3, 233-240. (in Japanese)

Wijaya, S., Wahyudi, W., Kusuma, C. B., and Sugianto, E. (2018). Travel motivation of Indonesian seniors in choosing destination overseas. *International Journal of Culture, Tourism and Hospitality Research*, Vol. 12, No. 2, 185-197.

Yamaji, K. (1997). Shinpaku-sū (myakuhaku-sū) no sokutei igi hōhō to shukan-teki undō kyōdo [Significance and method of measuring heart rate (pulse rate) and subjective exercise intensity]. *Journal of Running Science*, Vol. 8, No. 1, 15-35. (in Japanese)

Yamaji, K. (2013). *Kokoro to karada o shiru shinpaku-sū* [Heart rate to know your mind and body]. Kyorin-shoin. (in Japanese)

(Received August 30, 2022; accepted September 30, 2022)