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Regional Difference in Physical Activity is Associated with Inter-prefecture Ranking of Healthy Life Expectancy in Japan

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1. Introduction

With the progression of aging global population, life expectancies (LE) of Japanese in 2013 achieved 80.21 yr for men and 86.61 yr for women.(1) While on the other hand, healthy life expectancies (HALE) in 2013 are 70.24 yr for men and 73.62 yr for women.(1) HALE is defined as the period in the life when people might live without restriction of their daily activities due to health problems. The longer the difference between LE and HALE the larger the cost of medical and nursing cares. Accordingly, the paradigm of medicine is shifting from the extension of LE to the extension of HALE for shortening the gap between them. Unlike the causes of death that shorten LE, the major factor shortening HALE is the inactivation of mental and physical activities that creeps unconsciously under daily life. To cope with this issue, not only conventional medical approaches such as preventions, rescues, and therapies but also the popularization of self-health management is essential. For this purpose, the development of technologies is necessary for continuous self-monitoring that enables the detection and assessment of alterations in physical functions and activities, the accumulation of individual and population's time series data, and modeling and prediction.

As a continuous bio-signal monitoring, Holter electrocardiography (ECG) and related signal processing technologies for modeling and prediction seems one of the most prominent achievements in human history.

Allostatic State Mapping by Ambulatory ECG Repository (ALLSTAR) Research Group has been accumulating 24-hr Holter ECG and physical activity data since 2009 and has built a big data comprising >300 thousands of data, which are associated with date and geographic data (postal codes).

In this study, to examine if physical activities detected by 3-dimensional accelerometer built in Holter ECG monitors can be used for estimating HALE, we analyzed the associations between regional differences in physical activity and those in HALE.

2. Methods

<2.1> Subjects

We studied 3-dimensional acceleration data obtained from Holter ECG recordings that were analyzed between April 2012 and July 2014 at three ECG analysis centers (Sapporo, Tokyo, and Nagoya) in Japan. We used data only from subjects >20 yr of age who have agreed with the usage of their data for the purpose of researches including this study upon the recording. They underwent 24-hr ambulatory Holter ECG monitoring under daily activities for the screening or evaluation of diseases.

The protocol of the present study has been approved by the Research Ethics Committee of Nagoya City University Graduate School of Medical Sciences (No. 709).

<2.2> Data collection

The Holter ECG and acceleration data were recorded by water-resistant micro Holter ECG recorders with built-in 3-dimensional acceleration sensor (Cardy 303 pico, SUZUKEN CO., LTD; size, W28×D42×H9 mm, weight, 13 g). This equipment can record ECG and 3-dimensional acceleration data for >24 hr by a button type lithium battery.

The built-in 3-dimensional acceleration sensor detects accelerations of left-to-right, caudo-cranial, and postero-anterior directions as X, Y, and Z axes, respectively and samples them at a frequency of 31.25 Hz.

3. Data analysis

<3.1> Indices of physical activity

Time series of X-, Y-, and Z-axe accelerations were resampled at 10 Hz and combined into a variable, AC (t), with the equation (1). After removing the direct current component by high-pass filtering, AC(t) was rectified, averaged over 24 hr, and converted into common logarithm; the value thus obtained was used as the index of physical activity (PA).

$$AC(t) = \sqrt{x^2(t)+y^2(t)+z^2(t)} \quad \cdots (1)$$

<3.2> Statistical analysis

The data in each gender were divided into the tertiles (3 subgroups) according to the HALE ranking of prefectures published by the Japanese Health, Labour, Welfare Ministry(1); upper (L1), middle (L2), and lower (L3) HALE areas. Data in each gender were also divided into 5 groups with subject's age; 20-39, 40-49r, 50-59, 60-64, 65-69 yr; and further divided in each group into tertiles with the prefecture HALE ranking.

In each sex, PA was compared among L1, L2, and

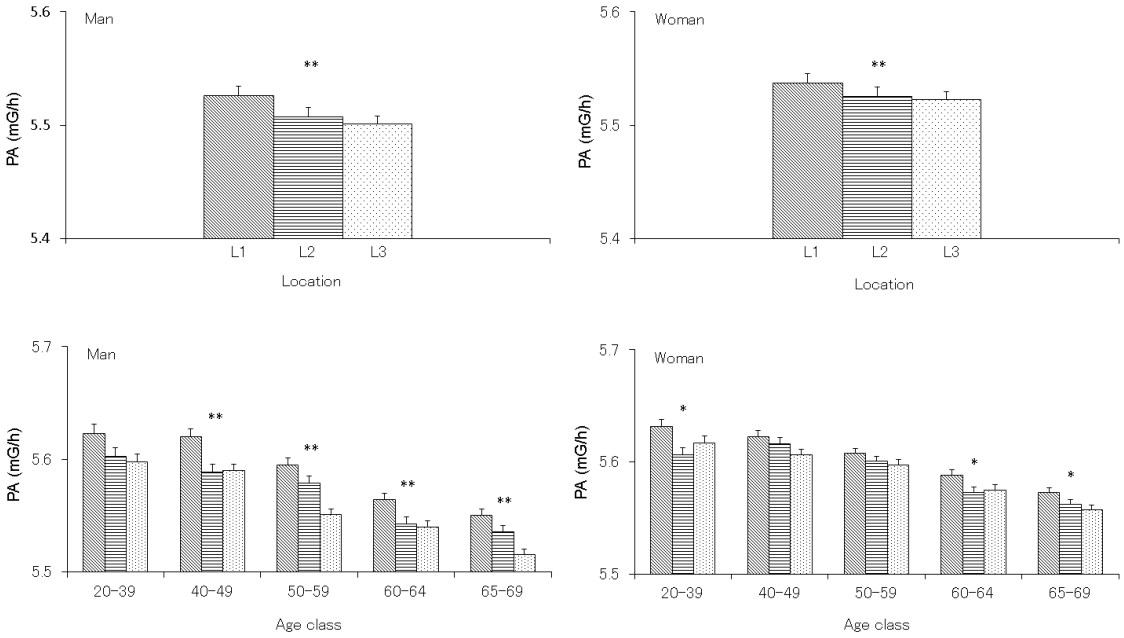

Fig. 1. Physical activity (PA) in the areas divided by the ranking of HALE.
Upper panels: L1, L2, and L3 indicate upper, middle, and lower tertiles of HALE.
Lower panels: fine dotted, horizontal hatched, and coarse dotted bars indicate upper, middle, and lower tertiles of HALE in each age group.
Data are mean ± SE. **P <0.01, *P <0.05.

L3 by ANCOVA using age as covariate. Also, to determine the age when the association between PA and HALE starts, PA was compared among L1, L2, and L3 in each age group by ANOVA. Type 1 error level was set at 0.05 in these analyses. We used Med Calc Ver.14.12.0 for the statistical analysis.

4. Results

Data were obtained from 18875 men (age, 66 ± 14 yr) and 23541 women (69 ± 15 yr) in allover Japan. ANCOVA revealed that PA was highest in the area of highest ranking of HALE and lowest in the lowest ranking of HALE in both sexes. ANOVA in each age group revealed that associations of PA with HALE ranking exist in all age groups but 20-39 yr in men and in 20-39, 60-64, and 65-69 yr in women. Additionally, PA was greater in female than in men (P <0.01) and this difference was observed in all age groups (P <0.05).

5. Discussion

Our observations indicate that PA is greater in the areas of longer HALE and that this relationship exists above 50 yr in men. Also, PA was greater in female than in male.

These gender differences may be related to the difference in work style. The employment trend survey in 2013 by the Japanese Health, Labour, Welfare Ministry[2] reports a higher job separation rate for 25-29 yr in women than in men. In women, quit rate for marriage is highest in 25-29 yr, the rate for childbirth and nursing is highest in 30-34 yr. The quit rate due to nursing care is increasing from 35 yr. Women's work style differs with age generation relating to marriage, childbirth and nursing, and nursing care. While the other hand, the quit rate in men is lower. They can apply themselves to work with lesser change in work style than women, which may explain a part of gender difference in PA.

6. Summary

Regional difference in PA is associated with that in HALE in men after 50 yr of age.

References

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(2) Employment Trend Survey 2013, the Ministry of Health, Welfare, and Labour, http:// www.mhlw.go.jp /toukei/itiran/roudou/ koyou/doukou/14-2/kekka.html