Age and gender differences in relationships between physical activity and sense of coherence in community-dwelling older adults

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Purpose: The present study aimed to investigate the relationships between leisure-time, household, and work-related physical activity (PA) and sense of coherence (SOC) by age groups (young-old and old-old) and gender in community-dwelling older adults.

Methods: The self-administered questionnaires were sent to 508 community-dwelling older adults aged 65 to 85 years old who expressed their intention to participate in physical performance tests. A total of 394 people who participated in these tests completed the questionnaires (valid response rate, 77.6\%). We used the Physical Activity Scale for the Elderly to assess PA variables and the 13-item 5-point version of the Sense of Coherence Scale to assess SOC variables. Multiple linear regression analysis with controlling demographic variables (education, living arrangement and clinical histories) and social network (family and friend) was applied to confirm relations between PA and SOC by age groups (young-old or old-old) and gender.

Results: In young-old men, leisure-time PA was related positively to SOC ($\beta = 0.233$, $p < 0.05$). In old-old men, work-related PA related positively to SOC ($\beta = 0.273$, $p < 0.05$), whereas young-old women showed a significantly negative relation between these variables ($\beta = -0.285$, $p < 0.01$).

Conclusions: Leisure-time PA in young-old men and work-related in old-old men PA would enhance SOC, whereas any types of PA would not enhance SOC in young-old and old-old women. This study showed specific PA strategies for primary prevention with consideration of age and gender in community-dwelling older adults.

Key words: sense of coherence, physical activity, community-dwelling older adults, age and gender differences

I Introduction

Although the longevity of the Japanese people is well known, the gap between mean life expectancy and healthy life expectancy is increasing, reaching 9.13 years for men and 12.68 years for women in 2010\textsuperscript{1}. Establishing approaches to extending healthy life expectancy is therefore important\textsuperscript{1}.

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“Sense of coherence” (SOC) as proposed by Antonovsky describes a personal coping resource that may facilitate and contribute to resisting stress and promoting health\(^2\). In addition, since strong SOC is related to mental health\(^3,4\), health–related quality of life\(^5\), disability\(^6\), and longevity\(^7\), improvements in SOC could extend healthy life expectancy.

Antonovsky assumed that individual SOC is stabilized by the end of early adulthood, with only minor temporary changes seen later in life\(^2\). However, a systematic review by Eriksson and Lindström suggested that SOC might not be as stable as Antonovsky initially assumed\(^8\). A recent large-scale study in Sweden reported that SOC improved as a function of age until the mid–70s on a population level\(^9\). The SOC of older individuals is thus able to be enhanced.

One effective daily habit for enhancing SOC would be physical activity (PA). Numerous studies have shown that PA can reduce many clinical conditions, including disability\(^10\), cardiovascular disease\(^11\), cancer\(^11\), and dementia\(^12\). Moreover, PA appears effective in improving mental health\(^13\)-\(^15\) and psychological well-being\(^16\) in older adults.

PA would enhance psychological well-being through both physiological and psychological mechanisms\(^17\). Improved physical fitness, alterations in central monoamine activity, reduced activity of the hypothalamo–pituitary–adrenocortical axis, distraction and reduction of negative thought patterns are believed to explain the positive effects of PA\(^17\). PA such as sports and exercise with others may also provide social interaction and thus promote psychological well-being\(^18,19\).

Furthermore, Antonovsky assumed that SOC is developed by life experience characterized by consistency, underload–overload balance, and participation in shaping outcomes\(^2\). PA is thought to offer these life-experience characteristics. For example, sports, even recreational sports for older adults, include consistent rules and challenging tasks. In group sports, players encounter many opportunities to participate in decision-making to achieve goals. Furthermore, although purposes of life are considered to gradually decrease with age in older adults\(^20\), PA with work and volunteer activities would enhance purposes of life, which are positively related to SOC\(^21\). PA could thus have a significant effect on SOC.

Four longitudinal studies have reported that PA leads to an increase in SOC. For example, among adults with psychiatric disabilities, a 12–month health intervention program including PA and diet sessions was found to improve SOC\(^22\). Another found that SOC was increased with improvements in the exercise habits of middle-aged male office workers\(^23\). Moreover, among healthy older adults, SOC was improved by 10–month interventions involving aerobic exercise\(^24,25\) and flexibility/resistance exercise\(^25\).

On the other hand, from the perspective of salutogenesis, individuals with a strong SOC would engage in adaptive health behaviors more often than those with weak SOC. This is because that people with a strong SOC are more likely to accurately identify the nature and dimensions of the instrumental problem and more likely to select from their repertoire of resources that are appropriate to the problem and employ them rationally\(^2\). Elderly adults with a strong SOC could thus actively engage in PA.

While 8 previous studies have been based on this assumption, only two were longitudinal studies. First, SOC predicted the frequency of leisure–time PA throughout 13 years of follow–up among myocardial infarction patients under 65 years old\(^26\). Second, a strong SOC induced highly frequent attendance at a resistance training program in older adults at 0.5–7 years after hip fracture\(^27\). The other 6 were cross-sectional studies of adolescents\(^28\).
adults, elderly individuals, and patients with type 1 diabetes. From the above, close relationships seem to exist between PA and SOC among older adults. However, previous studies investigating the associations between PA and SOC have focused only on leisure-time PA, with no emphasis on non-leisure-time PA such as household or work-related PA. Since non-leisure-time PA represents the majority of total PA among older adults, and also provides health benefits such as prevention of disability and longevity, non-leisure-time PA may also relate to SOC in the same manner.

Furthermore, differences in the relationships of PA to SOC by age and gender remain unclear. Previous studies have reported that the effect of PA on healthy mental status and physical function differs by age and gender. Relationships between PA and SOC might thus also differ by age and gender.

The objective of this study was to investigate relationships between leisure-time, household, and work-related PA and SOC by stratified age groups (young-old and old-old) and gender among community-dwelling older adults.

II Methods

1. Participants and Procedures

The present study was carried out from July to August 2011 and from July to August 2012 in Kasama City, in a rural region of Ibaraki Prefecture, Japan. Attributes of Kasama City are provided in Table 1.

This study was part of the “Kasama study”, which was started as a prospective cohort study in 2009. The survey was conducted with older adults who expressed their intention to participate in physical performance tests. These physical performance tests were carried out at three health centers in Kasama City. We assessed 11 physical performance tests for measuring muscle strength, balance, flexibility, lower extremity function, hand dexterity, and reaction speed. Furthermore, the survey also included comprehensive measurements of factors such as physical and mental health, social network, and sleep status. The results of these tests and measurements were provided as feedback to participants. Since no transportation service to health centers was provided, participants had to get to the nearest health center on their own or with the help of others.

We mailed invitation letters for physical performance tests to 2147 people aged between 65 and 85 years old (1347 individuals in 2011, 800 individuals in 2012) randomly drawn from the Basic Resident Register. To avoid overlapping samples, names were drawn from a different geographical area of the region each year. People ≥86 years old were excluded from the study, because the life expectancy of Japanese women was 86 years, and individuals ≥86 years old show rapid decreases in physical function and amount of physical activity. A week after sending the first invitation letter, we sent a second invitation letter to those individuals who had not responded.

### Table 1 Attributes of Kasama City

<table>
<thead>
<tr>
<th>Population (n)</th>
<th>77,424</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population aging rate (%)</td>
<td>26.9</td>
</tr>
<tr>
<td>Population density (n/km²)</td>
<td>322.2</td>
</tr>
<tr>
<td>Total area (km²)</td>
<td>240.3</td>
</tr>
<tr>
<td>Building area (km²)</td>
<td>22.3</td>
</tr>
<tr>
<td>Forest area (km²)</td>
<td>85.6</td>
</tr>
<tr>
<td>Farmland area (km²)</td>
<td>63.4</td>
</tr>
<tr>
<td>Other area (km²)</td>
<td>69.0</td>
</tr>
<tr>
<td>Population ratio by industry (%)</td>
<td></td>
</tr>
<tr>
<td>Primary industry</td>
<td>5.4</td>
</tr>
<tr>
<td>Secondary industry</td>
<td>26.4</td>
</tr>
<tr>
<td>Tertiary industry</td>
<td>62.8</td>
</tr>
<tr>
<td>Non-classifiable industry</td>
<td>5.5</td>
</tr>
</tbody>
</table>
A total of 508 individuals (360 in 2011, 148 in 2012) expressed an intention to participate in physical performance tests. We mailed a self-administered questionnaire to these individuals in the third week of July. A group of 427 elderly individuals brought completed questionnaires to the nearest health center in Kasama City in the first or second week of August in each year (response rate, 84.1%). Of these, 33 individuals were excluded because of incomplete data. Data from a final total of 394 participants (valid response rate, 77.6%) were analyzed (Fig. 1). All participants provided written informed consent. The present study was approved by the ethics committee of the University of Tsukuba.

2. Questionnaire

1) Demographic variables

Demographic variables included age, gender, years of education, living arrangement (living alone or with someone), and clinical histories (heart disease, stroke, low back pain, and knee pain).

2) Physical Activity

PA was assessed using the Japanese version of the Physical Activity Scale for the Elderly (PASE)\textsuperscript{50,51}. The PASE is a reliable, validated, self-reported measure of habitual PA among older adults of varying health status. The scale has 12...
components pertaining to leisure–time PA (five components), household PA (six components), and work–related PA (one component) over the preceding 7 days.

Leisure–time PA includes walking outside the home, light–, moderate–, and strenuous–intensity sports and recreational activities, and muscle strength training. Each component was measured by frequency (days during the previous 7 days) and time spent each day. Household PA includes light housework, heavy housework or chores, home repairs, lawn work or yard care, outdoor gardening, and caring for another person. Household–related components were rated on a dichotomized (yes or no) scale. Work–related PA was evaluated by checking whether the subject performed paid and/or volunteer work and how many hours were spent on such activities during the previous 7 days.

These items were weighted based on intensity of each activity. PASE (total PA) score is the sum of the 12 weighted items. In addition to total PA score, we calculated a score for each type of PA: leisure–time; household; and work–related. A higher value for each score indicates greater PA.

3) Sense of Coherence
SOC was assessed with the 13–item 5–point version Sense of Coherence Scale. Each question was rated on a scale from 1 (lowest) to 5 (highest), with the total sum score ranging from 13 (low SOC) to 65 (high SOC). Higher total score indicates greater SOC. Cronbach’s alpha for the SOC scale in this study was 0.82.

4) Social Network
Social network was assessed using the Lubben Social Network Scale. In this study, 6 items measuring family and friend network were used.

3. Statistical Analyses
Participants were divided into four groups based on gender and age: 65–74 years, young–old; or 75–85 years, old–old.

Pearson’s chi–square test, one–way analysis of variance and the Kruskal–Wallis test were used to compare means or proportions of demographic variables, PA, and SOC between groups. Furthermore, if significant differences were identified in these analyses, multiple comparisons with Bonferroni adjustment were conducted.

To investigate relationships between each type of PA and SOC, we used multiple linear regression analysis. In this analysis, work–related PA was divided into two groups: “active” or “inactive”, because more than 70% of our participants did not perform these PA. Covariates included education, living arrangement, clinical histories, and social network. The level of significance for all analyses was set at p<0.05. All statistical analyses were performed using IBM SPSS version 21.0.

III Results

Descriptive statistics and comparisons of characteristics by age and gender groups are shown Table 2. Household PA score was significantly greater in young–old women than in old–old men and women. Work–related PA score was significantly greater in young–old men than in young–old and old–old women, and was also significantly greater in old–old men than in old–old women. Total PA score was significantly greater in young–old men and women than in old–old women. In contrast, SOC score did not differ significantly between the four groups.

The results of multiple linear regression analysis controlling for education, living arrangement, clinical histories, and social network are presented in Table 3. Relationships between types of PA and SOC were found to differ between the four groups. Leisure–time PA in young–old men related positively to SOC ($\beta =0.233$, p<0.05). In old–old men, work–related PA related positively to SOC ($\beta =$
0.273, p<0.05), whereas young-old women showed a significant negative relation between these variables (β = -0.285, p<0.01). For old-old women, no significant relationships were seen between any types of PA and SOC.

IV Discussion

Multiple linear regression analysis controlling for potential confounders revealed that relationships between PA and SOC differed by stratified age groups (young-old and old-old) and gender; that is, specific PA correlated positively with SOC in young-old and old-old men, whereas there was no positive relationships between any types of PA and SOC in young-old or old-old women. Since the subjects of this study were individuals who participated in physical performance tests, these findings would be applicable to healthy, community-dwelling, older adults.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Young-old</th>
<th>Old-old</th>
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<tbody>
<tr>
<td></td>
<td>Men (n=117)</td>
<td>Women (n=116)</td>
</tr>
<tr>
<td>Demographic variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>M ± SD 70.2 ± 2.5</td>
<td>69.7 ± 2.5</td>
</tr>
<tr>
<td>Education (years)</td>
<td>M ± SD 12.1 ± 2.5</td>
<td>11.7 ± 2.1</td>
</tr>
<tr>
<td>Living arrangement</td>
<td>n(%)</td>
<td></td>
</tr>
<tr>
<td>Living alone</td>
<td>7(5.9)</td>
<td>17(14.5)</td>
</tr>
<tr>
<td>Living with someone</td>
<td>111(94.1)</td>
<td>100(85.5)</td>
</tr>
<tr>
<td>Clinical histories</td>
<td>n(%)</td>
<td></td>
</tr>
<tr>
<td>Heart disease</td>
<td>6(5.1)</td>
<td>5(4.3)</td>
</tr>
<tr>
<td>Stroke</td>
<td>21(17.8)</td>
<td>10(8.5)</td>
</tr>
<tr>
<td>Low back pain</td>
<td>23(19.5)</td>
<td>16(13.7)</td>
</tr>
<tr>
<td>Knee pain</td>
<td>8(6.8)</td>
<td>12(10.3)</td>
</tr>
<tr>
<td>Social network</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family network</td>
<td>12.8 ± 2.9</td>
<td>13.1 ± 2.9</td>
</tr>
<tr>
<td>Friend network</td>
<td>7.8 ± 3.3</td>
<td>8.3 ± 3.0</td>
</tr>
<tr>
<td>Physical activity scores</td>
<td>M ± SD</td>
<td></td>
</tr>
<tr>
<td>Leisure time physical activity</td>
<td>24.0 ± 26.5</td>
<td>21.6 ± 23.7</td>
</tr>
<tr>
<td>Household physical activity</td>
<td>80.9 ± 40.3</td>
<td>90.0 ± 28.9</td>
</tr>
<tr>
<td>Work-related physical activity</td>
<td>27.2 ± 49.4</td>
<td>9.2 ± 23.6</td>
</tr>
<tr>
<td>Total physical activity</td>
<td>132.1 ± 66.1</td>
<td>120.9 ± 45.6</td>
</tr>
<tr>
<td>Sense of coherence scores</td>
<td>M ± SD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>49.7 ± 6.8</td>
<td>48.0 ± 7.5</td>
</tr>
</tbody>
</table>

Note. YM = young-old men; YW = young-old women; OM = old-old men; OW = old-old women.

* p value by one-way analysis of variance. # p value by Pearson’s chi-square test. ª p value by Kruskal-Wallis test. Bonferroni adjustment was used.
SOC with a 10-month aerobic exercise intervention\textsuperscript{24,25} and flexibility/resistance exercise intervention\textsuperscript{26}, Netz et al.\textsuperscript{26} reported that the effect of leisure–time PA on psychological well-being in older adults gradually decreased with age. In addition, a recent study from Japan revealed that leisure–time PA was related to physical function only in the young-old, not in the old-old\textsuperscript{43}, supporting the present finding of a relationship between leisure–time PA and SOC. Physical fitness\textsuperscript{55}, physical function\textsuperscript{55}, and amount of PA\textsuperscript{56} all decline with advancing age in older adults, and thus the close relationship between leisure–time PA and SOC would be found only in the young-old, but not in the old-old.

In old-old men, work–related PA was correlated positively with SOC. Our results agreed with previous studies that have reported that healthy mental status correlates positively with social activity such as working and volunteer activities among community-dwelling old-old men\textsuperscript{44,57,58}. A previous study reported SOC as positively related to purposes of life\textsuperscript{21}. Although purposes of life gradually decreased in the old-old\textsuperscript{20}, social roles such as these activities would enhance purposes of life, which in turn are associated with SOC.

On the other hand, we found no positive relationships between any types of PA and SOC in young-old or old-old women. Furthermore, work–related PA correlated negatively with SOC in young-old women. A previous study reported that lower income correlated with lower SOC\textsuperscript{4}. Young-old women who engaged in work–related PA might need to work because of negative economic reasons. The reasons for engaging in work in later life should be investigated in future studies.

This is the first study to show a relationship between various types of PA (leisure–time, household, and work–related PA) and SOC in each age and gender group among healthy older individuals. Previous cross-sectional and longitudinal studies have reported a positive relationship between PA and SOC\textsuperscript{22–33}. However, those studies did not consider age or gender differences. Our study presented new findings that PA has a positive influence on SOC only in older men, and the type of PA enhancing SOC would differ by age, involving leisure–time PA for young-old men, and work–related PA for old-old men. In contrast, no PA might have positive influences on SOC in either young-old or old-old women. The strength of our study lies in pointing out the importance of PA strategies for primary prevention by considering age and gender in the elderly.

| Table 3 Relationships between each types of physical activity and sense of coherence |
|---------------------------------|--------|--------|--------|--------|
|                                 | Men    |        | Women  |        |
|                                 | Young-old | Old-old | Young-old | Old-old |
| Leisure–time physical activity | \(0.233\) * | \(0.119\) | \(0.104\) | \(-0.162\) |
| Household physical activity     | \(0.084\) | \(-0.062\) | \(0.040\) | \(-0.029\) |
| Work–related physical activity  | \(0.006\) | \(0.273\) * | \(-0.285\) ** | \(-0.064\) |

Multiple linear regression analyses were controlled by education, living arrangement, clinical histories (heart disease, stroke, low back pain and knee pain), and social network (family and friend network).

Work–related physical activity: 0. inactive, 1. active.

*: \(p < 0.05\), **: \(p < 0.01\)
Some limitations must be considered when interpreting the findings of the present study. First, participants in this study were recruited from a rural district. For consideration of environmental factors, the results reported here should be re-examined in other areas. Second, the cross-sectional design of the present study meant that we could not confirm any causal relationships. The previous study reported that SOC among healthy elderly individuals was improved by aerobic exercise and flexibility/resistance exercise treatment, whereas strong SOC induced highly frequent attendance to a resistance training program in older adults. Third, although the PASE questionnaire is superior for assessing each type of PA in older adults, the self-reported nature of the data might have included reporting bias. As PA is promoted as an excellent method to maintain health, participants might have exaggerated their level of PA. Fourth, our response rate was low. The present study included physical performance tests, and participants had to attend the health center on their own or with the help of others. Therefore, almost all participants in this study would have been healthy and the proportion of individuals who were sedentary and unhealthy might have been underestimated compared to the general population.

V Conclusions

This study investigated relationships between leisure–time, household, and work–related PA and SOC by stratified age groups (young–old; old–old) and gender among community–dwelling older adults who participated in physical performance tests. Leisure–time PA in young–old men and work–related PA in old–old men were positively associated with SOC, whereas work–related PA was negatively correlated to SOC in young–old women. This study has significance in pointing out specific PA strategies for primary prevention with consideration of age and gender in community–dwelling older adults.

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和文抄録

目的：地域在住高齢者における身体活動（余暇活動、家庭内活動、仕事関連活動）とストレス対処力（sense of coherence; SOC）との関連を性・年齢層別に検討した。

方法：2011年および2012年の7～8月に茨城県笠間市に在住する65～85歳の地域在住高齢者のうち、体力テストに参加意思を表明した508名に記名自記式調査を実施した。調査票は体力テスト参加日に回収し、欠損回答のない394名（男性194名、女性200名；有効回答率77.6％）を分析対象とした。調査項目は属性（性、年齢、教育年数、世帯構成、既往症の有無）、身体活動（Physical Activity Scale for the Elderly 日本版；余暇活動、家庭内活動、仕事関連活動の各実施状）、SOC（13項目5件法版 Sense of Coherence Scale）、ソーシャルネットワーク（家族、友人）であった。身体活動とSOCとの関連を、教育年数、世帯構成、既往症の有無、ソーシャルネットワークを統制した重回帰分析により検討した。分析は、性別、年齢層別（前期高齢者：65～74歳、後期高齢者：75～85歳）に分けて実施した。

結果：前期高齢者の男性では、余暇活動量とSOCとの間に有意な正の関連を認めた（β = 0.233, p < 0.05）。また、後期高齢者の男性において仕事関連活動量がSOCと有意な正の関連（β = 0.273, p < 0.05）を認めた一方、前期高齢者の女性では、仕事関連活動量とSOCとの間に有意な負の関連（β = −0.285, p < 0.01）を認めた。

結論：比較的健康な地域在住高齢者において、身体活動とSOCとの関連性は性や年齢層によって異なり、男性では、前期高齢者は余暇活動が、後期高齢者は仕事関連活動が多いほどSOCが高い一方、女性では年齢層に関わらずSOCを高める身体活動はなかった。本研究は、地域在住高齢者に対する一次予防として有効な身体活動の内容を具体的に示した点で、重要な意義をもつと考えられる。