

# Health & Fitness Journal of Canada

Copyright © 2011 by the CSEP Health & Fitness Program of BC

Volume 4

March 1, 2011

Number 1

## COMMENTARY

### Habitual Physical Activity and Health in the Elderly: the Nakanojo Study

Yukitoshi Aoyagi<sup>1</sup>

I am most honoured to write for the Health & Fitness Journal of Canada regarding my experiences with Dr. Roy J. Shephard and his contribution to our current project “the Nakanojo Study”.

It was at the Symposium of the International Council for Physical Fitness Research, held on September 5-7, 1988 in Osaka, Japan that I met Dr. Shephard for the first time. Dr. Shephard was one of several invited speakers (including world-famous scientists such as Dr. John O. Holloszy), and Dr. Shephard also chaired the scientific session on health and fitness of the aged, where I made my first presentation at a conference. As soon as this session was closed, Dr. Shephard kindly encouraged me to submit a manuscript entitled “Relationship between the starting age of training and physical fitness in old age” to the Canadian Journal of Sport Sciences, where Dr. Shephard had served as an editor-in-chief; the article was published there in 1990 (Aoyagi and Katsuta, 1990; Aoyagi and Shephard, 1992).

**Health & Fitness Journal of Canada  
2011;4(1):9-12.**

*Keywords:* exercise rehabilitation, clinical physiology, community health, aging

From the <sup>1</sup>Exercise Sciences Research Group, Tokyo Metropolitan Institute of Gerontology, Itabashi, Tokyo, Japan. Address correspondence to Yukitoshi Aoyagi email: [aoyagi@tmig.or.jp](mailto:aoyagi@tmig.or.jp)

After that, I was admitted to the University of Toronto as a graduate student under Dr. Shephard’s guidance (and in cooperation with Dr. Tom M. McLellan, Defence Research and Development Canada, Toronto, Ontario, Canada). I completed my Ph.D. dissertation in 1996; it was entitled “Endurance training, heat acclimation, and protective clothing: the thermophysiology of exercising in a hot climate” (Aoyagi, 1996; Aoyagi et al., 1997). Particularly during my stay in Toronto for 6 years, I was inspired greatly by Dr. Shephard’s creative mind and challenging spirit. I will never forget Dr. Shephard’s words such that “Everything is new to everyone, so do not be afraid of making mistakes and do not hesitate to do anything.”

Since 2000, Dr. Shephard and I (with my Japanese and Korean colleagues) have been conducting the Nakanojo Study, an interdisciplinary investigation that has examined associations between habitual physical activity and health in an entire community of elderly people (Aoyagi and Shephard, 2009a; Aoyagi and Shephard, 2009b; Aoyagi and Shephard, 2009c; Aoyagi and Shephard, 2010; Aoyagi and Shephard (in press); Shephard and Aoyagi, 2009; Shephard and Aoyagi, 2010). Details of the Nakanojo Study have been described previously (Aoyagi and Shephard, 2009c; Aoyagi and Shephard, 2010; Aoyagi and Shephard (in press)). In

brief, our potential subjects included all willing community residents  $\geq 65$  years of age with the exception of those who were severely demented or bedridden (giving a sample of some 5,000 participants).

All participants completed a conventional physical activity questionnaire once a year, and in an arbitrarily selected subgroup, about a tenth of the sample, physical activity was assessed continuously, 24 hours per day, for  $>10$  years; this subgroup did not differ from the main sample in terms of either age or sex distribution. Objective measurements were made using a specially adapted uniaxial pedometer/accelerometer (modified Kenz Lifecorder, Suzuken Co., Ltd., Nagoya, Aichi, Japan). This device compares favorably with other pedometers and accelerometers in terms of reliability and validity, offering consistently accurate estimates of both step count (intramodel reliability 0.998; absolute accuracy  $\pm <3\%$ ) and the intensity of ambulatory activity under both controlled and free-living conditions (Shephard and Aoyagi, 2010).

To date, the primary aims of the Nakanojo Study have been to: (i) establish the overall patterns of physical activity most closely associated with good health and the absence of disease in the elderly and (ii) identify personal, social and environmental influences allowing sufficient physical activity to maintain physical condition and delay the aging process. An important secondary objective has been to improve the effectiveness of interventions designed to promote habitual physical activity through: (i) the valid and reliable monitoring of such activity and (ii) the electronic evaluation and feedback of information about personal activity in light of the various criteria and influences noted above.

Cross-sectional data from the Nakanojo Study have indicated that many measures of health are associated with both the year-averaged daily step count and the year-averaged daily duration of moderately vigorous physical activity (intensity  $>3$  metabolic equivalents [METs]) (Aoyagi and Shephard, 2009c; Aoyagi and Shephard, 2010; Aoyagi and Shephard (in press)).

Most authors recognize that for the elderly, any level of physical activity is better than none, but the relationships found in Nakanojo suggest that statistically and clinically significant health benefits are not observed unless certain minima of habitual physical activity are maintained. The thresholds of step count and/or duration of physical activity  $>3$  METs associated with avoidance of health problems are:  $>4,000$  steps/day and/or  $>5$  min/day for a lower risk of mental health disorders including depression;  $>5,000$  steps/day and/or  $>7.5$  min/day for a lower risk of impaired psychosocial health including a poor health-related quality of life; at least 7,000-8,000 steps/day and/or at least 15-20 min/day for lower risks of aortic arteriosclerosis, osteoporosis and sarcopenia, and a higher level of physical fitness (particularly lower-extremity strength and gait speed in  $\geq 75$ -year-old adults); and  $>8,000$  and  $>10,000$  steps/day and/or  $>20$  and  $>30$  min/day for better metabolic health including a lower risk of hypertension and hyperglycemia in adults aged  $\geq 75$  and  $<75$  years, respectively.

The application of exponential regression models to our yearlong data has suggested that overall health is better in elderly individuals who take an average of  $>8,000$  steps/day and/or spend  $>20$  min/day of physical activity  $>3$  METs. Furthermore, physical and

psychosocial health seem better in older adults who, at any given step count, undertake a larger proportion of their daily activity at an intensity >3 METs. Plainly, the observed associations between physical activity and health outcomes appear important to public health recommendations, but need examining longitudinally in order to test causal inferences. With reference to earlier key papers, Dr. Shephard has to date provided us with various ideas appropriate to such analyses.

Dr. Shephard has also emphasized that policies aimed at increasing physical activity must take due account of mediating variables. Our data have shown that both the intensity and the total amount of physical activity are influenced by meteorological factors, particularly precipitation and mean ambient temperature (Aoyagi and Shephard, 2009c; Aoyagi and Shephard, 2010; Shephard and Aoyagi, 2009).

In older Nakanojo residents, habitual physical activity decreases exponentially from approximately 7,000 to an asymptote of 4,000 steps/day as precipitation increases. A count <4,000 steps/day might provide a simple objective criterion that an elderly person has become housebound. Such restriction of activity might induce a vicious circle of depression and insomnia. Excluding days when precipitation is  $\geq 1$  mm and thus the influence of rainfall, the daily step count peaks at a mean outdoor temperature of around 17°C; above and especially below this temperature, physical activity decreases in a quadratic fashion. Seasonal variations in our study amount to some 1,500 steps/day, but effects could well be larger in areas with more extreme climates.

The month-averaged daily step count and the daily durations of physical

activity <3 and >3 METs peak in spring and/or autumn and reach their nadir in the winter months. In summer, when the daily step count approximates the average for the year, the proportion of activity <3 METs is increased at the expense of that >3 METs. Also, physical activity <3 METs peaks in May or June, when mean ambient temperature is increasing, whereas >3 METs peaks in November, when the temperature is decreasing. These findings might be explained mainly by behavioural thermoregulation to maintain core body temperature within its proper range of 36-37°C (Aoyagi, 1996; Aoyagi et al., 1997). Clearly, seasonal changes in microclimate need to be taken into account when designing interventions to increase the physical activity of elderly people throughout the entire year.

Based on data from the Nakanojo Study, we have already developed new tactics in preventive medicine as part of a national project, using a pedometer/accelerometer and other information and communication technologies, such as a global positioning system and a mobile phone. This system, which is and will be available in selected areas of Japan, should contribute to health promotion, disease prevention and thus a reduction in medical expenses for elderly people as well as for younger adults (Aoyagi and Shephard (in press)).

Finally, as non-native speakers of English, my colleagues and I always have difficulty in working in the language (both spoken and written). But Dr. Shephard is always so kind as to give us his very rapid (within-a-day) and appropriate suggestions regarding any manuscript that we are preparing for submission to some journal. They are my treasures. After having completed my Ph.D. work, I took back to Japan hundreds of drafts

with Dr. Shephard's revisions handwritten in blue ink. I also remember that Dr. Shephard's response has been delayed only once during the past 20 years, and I was then very anxious about Dr. Shephard's ill health. However, it was just due to a technical problem of internet connections associated with construction for the Vancouver 2010 Olympic Games around Dr. Shephard's current home. I am absolutely certain that Dr. Shephard is not only the greatest authority on exercise and physical activity science, but also the best coauthor of the Nakanojo Study.

I wish Dr. Shephard to remain healthy forever!

### **Qualifications**

The author's qualifications are as follows: Yukitoshi Aoyagi, Ph.D.



### **References (including selected articles published in collaboration with Dr. Shephard)**

- Aoyagi Y., and Katsuta S. (1990). Relationship between the starting age of training and physical fitness in old age. *Can J Sport Sci*, 15 (1): 65-71. URL: <http://www.ncbi.nlm.nih.gov/pubmed/2331643>
- Aoyagi Y., and Shephard R.J. (1992). Aging and muscle function. *Sports Med*, 14 (6): 376-96. URL: <http://www.ncbi.nlm.nih.gov/pubmed/1470791>
- Aoyagi Y. (1996). *Endurance training, heat acclimation, and protective clothing: the thermophysiology of exercising in a hot climate*. Unpublished Doctors of Philosophy, University of Toronto, Toronto, Ontario, Canada.

- Aoyagi Y., McLellan T.M., and Shephard R.J. (1997). Interactions of physical training and heat acclimation: the thermophysiology of exercising in a hot climate. *Sports Med*, 23 (3): 173-210. URL: <http://www.ncbi.nlm.nih.gov/pubmed?term=Interactions%20of%20physical%20training%20and%20heat%20acclimation%3A%20the%20thermophysiology%20of%20exercising%20in%20a%20hot%20climate>
- Aoyagi Y., and Shephard R.J. (2009a). How many days of pedometer monitoring are needed? *Med Sci Sports Exerc*, 41 (3): 734. URL: <http://www.ncbi.nlm.nih.gov/pubmed/19225363>
- Aoyagi Y., and Shephard R.J. (2009b). How should objectively measured physical activity data be used analytically? *Exerc Sport Sci Rev*, 37 (2): 109. URL: <http://www.ncbi.nlm.nih.gov/pubmed?term=How%20should%20objectively%20measured%20physical%20activity%20data%20be%20used%20analytically>
- Aoyagi Y., and Shephard R.J. (2009c). Steps per day: the road to senior health? *Sports Med*, 39 (6): 423-38. URL: <http://www.ncbi.nlm.nih.gov/pubmed?term=Steps%20per%20day%3A%20the%20road%20to%20senior%20health>
- Aoyagi Y., and Shephard R.J. (2010). Habitual physical activity and health in the elderly: the Nakanojo Study. *Geriatr Gerontol Int*, 10 (1 Suppl.): 236S-43S. URL: <http://www.ncbi.nlm.nih.gov/pubmed/20590838>
- Aoyagi Y., and Shephard R.J. (2011). A model to estimate the potential for a physical activity-induced reduction in health care costs for the elderly, based on pedometer/accelerometer data from the Nakanojo Study. *Sports Med*. In press.
- Shephard R.J., and Aoyagi Y. (2009). Seasonal variations in physical activity and implications for human health. *Eur J Appl Physiol*, 107 (3): 251-71. URL: <http://www.ncbi.nlm.nih.gov/pubmed/19609553>
- Shephard R.J., and Aoyagi Y. (2010). Objective monitoring of physical activity in older adults: clinical and practical implications. *Phys Ther Rev*, 15 (3): 170-82. URL: <http://www.ingentaconnect.com/content/maney/ptr/2010/00000015/00000003/art00006?crawler=true>