Physical activity and health of the elderly: the Nakanojo Study

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Our overall purposes are to develop new methodologies for the study of physical activity and to provide exercise prescription guidelines for the elderly. Since 2000, we have thus been conducting a longitudinal interdisciplinary study on physical activity and health of the elderly in the typical medium-sized residential town of Nakanojo, Gunma Prefecture, central Japan (the Nakanojo Study). Nakanojo is about 150 km northwest of Tokyo. In 2004, it had a population of 17,942 (8,706 men and 9,236 women), 28.6% of whom were aged >65 years (25.3% of men and 31.9% of women).

Our primary research aims are to determine 1) what pattern of habitual physical activity is most effective to promote health and prevent disease in the elderly, with emphasis on the quantity, quality, pattern, and timing of activity and 2) what factors are most important in allowing the elderly to continue such physical activity and delay aging, with emphasis on personal, social, genetical, and environmental factors. Our secondary research aims are to improve interventions by 1) objectively and accurately monitoring physical activity using an accelerometer and 2) electronically evaluating and feeding back activity information based on the various criteria noted above.

Subjects include all >5000 willing individuals (excluding those severely demented or bedridden) >65 years of age, resident in Nakanojo. In about one-tenth of these subjects, physical activity has been being assessed over >4 years to date, using not only a simple conventional questionnaire that asks about light, moderate, and vigorous physical activity during a typical recent week, but also by means of a specially adapted accelerometer that distinguishes 11 intensities of physical activity. Variables measured include physiological, medical, genetical, nutritional, physical, psychological, and sociological factors.

To date, we have examined cross-sectionally associations between the quantity and quality of habitual physical activity and several aspects of physical and mental health in older people. As a first step, physical activity patterns were studied over an entire year, noting on a daily basis the number of steps taken and the duration of moderate-intensity physical activity [>3 metabolic equivalents (METs)]. The year-averaged daily step count and the year-averaged daily duration of physical activity >3 METs were significantly greater in men than in women (6500-7500 vs. 5500-6500 steps/day; 15-20 vs. 10-15 min/day, respectively). Further, these two variables were significantly correlated with each other in both men and women (r = 0.85). The magnitude of the effect was such that subjects taking <4000 steps/day averaged <5 min/day at an intensity >3 METs, whereas those taking >10000 steps/day averaged >30 min/day at an intensity >3 METs. In addition, significant negative correlations were observed between age and both the average number of steps per day and the average daily duration of physical activity >3 METs in men but <3 METs in women.

Many measures of physical and mental health in older adults are associated with both the intensity and the total volume of physical activity undertaken. In men, better health is
associated most closely with the daily duration of moderate-intensity exercise. In women, the association is with the daily step count, large fractions of which reflect minor movements (at an intensity <3 METs) rather than definitive pacing. We suggest that many older women in rural Japan spend long periods performing low-intensity household tasks.

Certainly, it seems important to encourage older people to engage in physical activity, even if they reach only low intensities of effort for much of the time that they are active.

Aspects of poor mental health such as a depressive mood state and a poor quality of life (QOL) are less likely in elderly individuals meeting empirical minimum standards of habitual physical activity: in both sexes, >4000 steps/day and/or >5 min/day at an intensity >3 METs. Among those with a clinical diagnosis of depression, all except one male were taking <4000 steps/day; the exceptional individual took 8057 steps/day, but at a low intensity (only 6.6 min/day at an intensity >3 METs). A 450-day analysis of 41 older adults has shown that activity decreases exponentially to approximately 4000 steps/day as precipitation increases; a count <4000 steps/day is likely evidence that an elderly person is remaining indoors, a situation where most of the recorded counts reflect low-intensity movements. Although we need more precise data on relationships between step count, exercise intensity, and the frequency of going outdoors, the present findings suggest that outdoor activity helps generate movement at an intensity >3 METs, and is associated with better mental health.

The threshold dose of daily physical activity associated with better physical health, including freedom from musculoskeletal diseases such as osteoporosis and sarcopenia, is higher than that for psychological health: in both men and women, >8000 steps/day and/or >20 min/day at an intensity >3 METs. Of the present subjects that met these criteria, none either had osteoporosis (a T-score <-2.5) or were below fracture threshold (a conservative T-score of -2.0). Furthermore, when data for physical activity were categorized into quartiles, the age-adjusted odds ratio as calculated by logistic regression analysis showed significant relationships between the year-averaged daily step count and the incidence of osteoporosis in elderly women. The risk of osteoporosis in the lowest two quartiles (with means of <4000 and 6000 steps/day) was 2.5-3.0 times higher than that in the top quartile (>10000 steps/day), although the risk for the latter group did not differ significantly from that of the second highest quartile (mean 8000 steps/day). Normal older persons showed a seasonal variation in the month-averaged daily step count (6000-8000 steps/day), whereas the count was relatively stable (4000-4500 steps/day) in osteoporotic individuals. In typical elderly people, the daily step count peaks at a mean outdoor temperature of around 17°C; above and especially below this level, physical activity decreases quadratically.

In conclusion, the cross-sectional data from this project indicates that the overall health of older people is associated with both the quantity (as measured by the daily number of steps) and the quality (as measured by the daily duration at an intensity >3 METs) of habitual physical activity undertaken. In men, the advantage of health is associated more closely with the daily duration of moderate exercise, and in women with the daily step count.

The threshold dose of daily physical activity associated with better health depends on whether physical or mental components are considered. A longitudinal analysis is needed to give a more definitive interpretation of the present preliminary findings.