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Total Daily Physical Activity and Longevity in Old Age

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To the Editor

Increased levels of exercise are currently recommended to improve health and increase longevity, but gaps in our knowledge impede the formulation of evidence-based recommendations particularly in older individuals.¹ In particular, most studies of physical activity in old age have focused on self-reported physical activity measures which are affected by recall bias. Moreover, few studies have examined the contribution of non-exercise physical activity to survival in old age.^{2–4} We tested the hypothesis that an objective measure of total daily activity, including both exercise and non-exercise physical activity, is associated with longevity in community-dwelling older persons.

Methods

We used clinical data from participants of the Memory and Aging Project, a longitudinal cohort study of aging.⁵ The study was approved by Rush University Medical Center Institutional Review Board. Total daily physical activity (exercise and non-exercise physical activity) was measured at baseline for up to 10 days with actigraphs (Actical®; Philips Healthcare, Bend, OR) worn on the wrist 24 hours/day.⁶ All participants underwent structured annual clinical exam as previously described.⁵

Results

There were 893 participants, mean age 82.0 (SD=7.30) years; 76.3% were women, mean education 14.8 (2.97) years and 11.8% had clinical dementia. Total daily physical activity was measured for 9.3 days (SD=1.2 days). Total daily physical activity ranged from 0.06×10^5 counts/day to 13.56×10^5 counts/day (mean: 2.88×10^5 counts/day; SD= 1.57×10^5 counts/day).

During an average follow-up of 4 years, there were 212 deaths (23.7% of cohort). In a Cox proportional hazards model adjusting for age, sex and education, a higher level of total daily physical activity was associated with a decreased risk of death (hazard ratio=0.71; 95% CI: 0.63, 0.79). Thus, an individual with high total daily physical activity (90th percentile) had about ¼ the risk of death as compared to an individual with low total daily physical activity (10th percentile).

In further sensitivity analyses, the association of total daily activity and death remained significant even after excluding: A) individuals with clinical dementia (HR 0.77, 95%CI 0.68, 0.88), B) cases with a history of stroke or PD (HR 0.73, 95%CI 0.64, 0.83) or C) cases dying during the first 3 years of follow-up, leaving 79 incident cases of death (HR 0.81, 95%CI 0.68, 0.97). Total daily physical activity was associated with death even after adjusting for several possible confounders including traditional self-report physical activity and the frequency of other late-life social and cognitive activities, level of motor and cognitive function, chronic health conditions and depressive symptoms alone (Table 1). The association between total daily activity and risk of death did not vary by age, sex or education (results not shown). Although total daily activity was lower in persons with clinical dementia, the association of total daily activity and death did not vary by dementia status. (Total daily activity*dementia, HR 0.89, 95%CI 0.67, 1.19)

Comment

A higher level of total daily physical activity, measured with actigraphy, in nearly 900 older community-dwelling individuals, was associated with a reduced risk of death. Total daily physical activity captures aspects of physical activity not assessed by traditional physical activity measures and remained associated with risk of death even after adjusting for a wide range of late-life physical, cognitive and social activities. Further, the association between total daily physical activity and risk of death persisted after adjustment for possible confounders including motor and cognitive function and chronic health conditions, did not vary with age, sex, education, or dementia status and persisted even after excluding persons dying during the first 3 years of follow-up. These data support the link between total daily physical activity and risk of death in very old persons and suggest that an active lifestyle including not only physical exercise but also non-exercise physical activities may augment health and longevity in old age.

Delineating the role of physical activity in older individuals is especially challenging since older individuals are commonly affected by chronic health conditions, low fitness levels and functional limitations which occur concomitantly with age-related loss of cognitive and motor function. Until recently, objective measures of physical activity could only be obtained in the laboratory setting, thereby excluding older more debilitated individuals unable to participate in testing.¹ Moreover, recent studies suggest that laboratory testing may not reflect the level and patterns of physical activity in the community-setting.⁷ Furthermore, energy expenditure from non-exercise physical activities may have a substantial role when considering the benefits which accrue from physical activity.^{2,4} Thus, it may be particularly important to employ techniques which measure both exercise and non-exercise activities to explicate the role of physical activity in older persons.⁸ The current study took advantage of recent technology which makes it feasible to collect quantitative measures of total daily physical activity for prolonged periods of time in the community-setting with devices that are minimally intrusive and do not rely on participant recall. Findings from the current study underscore the potential benefits of higher levels of non-exercise physical activity as well as exercise and leisure activity²⁻⁴ Since older persons who have underlying health problems may not be able to engage in formal exercise, the option of increasing non-exercise physical activities may have important translational consequences for the design of physical activity intervention studies and public policy goals. Finally these results lend support for efforts to encourage a more active lifestyle for all older adults even those with chronic health conditions and functional impairments.

This study has some limitations. While the findings were robust to potential confounding variables and sensitivity analyses, the potential for reverse causality cannot be excluded. Other limitations include the selected nature of the cohort, the self-report chronic diseases,

and the fact that certain types of activities may not have been measured due to placement of the actigraphs on the wrist. Further, the device used in the current study does not differentiate the types of activities that were performed.⁹ Additional studies are needed to determine the relative contributions of exercise and non-exercise physical activity in older individuals and the degree to which they can be independently modified to augment survival.⁸

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REFERENCES

1. Paterson D, Warburton D. Physical activity and functional limitations in older adults: a systematic review related to Canada's Physical Activity Guidelines. *International Journal of Behavioral Nutrition and Physical Activity*. 2010; 7(1):38. [PubMed: 20459782]
2. Levine JA. Nonexercise activity thermogenesis – liberating the life-force. *Journal of Internal Medicine*. 2007; 262(3):273–287. [PubMed: 17697152]
3. Chipperfield JG. Everyday Physical Activity as a Predictor of Late-Life Mortality. *The Gerontologist*. 2008; 48(3):349–357. [PubMed: 18591360]
4. Westerterp K. Assessment of physical activity: a critical appraisal. *European Journal of Applied Physiology*. 2009; 105(6):823–828. [PubMed: 19205725]
5. Bennett DA, Schneider JA, Buchman AS, Mendes de Leon C, Bienias JL, Wilson RS. The Rush Memory and Aging Project: study design and baseline characteristics of the study cohort. *Neuroepidemiology*. 2005; 25(4):163–175. [PubMed: 16103727]
6. Buchman AS, Wilson RS, Bennett DA. Total daily activity is associated with cognition in older persons. *Am J Geriatr Psychiatry*. 2008 Aug; 16(8):697–701. [PubMed: 18669949]
7. Kaye JA, Maxwell SA, Mattek N, et al. Intelligent systems for assessing aging changes: home-based, unobtrusive, and continuous assessment of aging. *J Gerontol B Psychol Sci Soc Sci*. 2011 Jul; 66(Suppl 1):i180–i190. [PubMed: 21743050]
8. Garland T, Schutz H, Chappell MA, et al. The biological control of voluntary exercise, spontaneous physical activity and daily energy expenditure in relation to obesity: human and rodent perspectives. *Journal of Experimental Biology*. 2011 Jan 15; 214(2):206–229. 2011. [PubMed: 21177942]
9. Bonomi AG, Westerterp KR. Advances in physical activity monitoring and lifestyle interventions in obesity: a review. *Int J Obes*. 2011

Table 1

Total Daily Physical Activity, Potential Confounders and Risk of Death

| Models | Terms Added to Core Model* | HR for Total Daily Physical Activity and Risk of Death |
|--------|---|--|
| A | Late-life Physical, Social and Cognitive Activity | 0.77 (0.69, 0.87) |
| B | Cognitive Function | 0.78 (0.69, 0.88) |
| C | Motor Function | 0.85 (0.75, 0.96) |
| D | Chronic Health Conditions | 0.77 (0.68, 0.88) |
| E | Depressive Symptoms | 0.74 (0.65, 0.83) |
| F | Late-life Physical, Social and Cognitive Activity, Cognitive Function, Chronic Health Conditions, Depressive Symptoms | 0.85 (0.75, 0.97) |

* A series of Cox proportional hazard models were examined to determine if potential confounders affected the association of total daily physical activity and the risk of death. **Core Model:** A Cox proportional hazard model was employed to estimate the risk of death and included terms for age, sex, education and total daily physical activity. **Physical Activity:** Self-reported frequency of participation in 5 physical activities (hours/week), a higher score indicates more frequent participation. **Social Activity:** Self-reported frequency of participation in 6 items about activities involving social interaction, a higher score indicates more frequent participation. **Cognitive Activity:** Self reported frequency of participation in 7 cognitive activities, a higher score indicates more frequent participation. **Cognitive Function:** Composite measure of cognition based on performances on 19 cognitive tests (a higher score indicates a higher level of cognition). **Motor Function:** Composite measure summarizing 11 motor performance tests. **Chronic Health Conditions:** included linear and non-linear terms for BMI, as well as a term for the sum of 3 vascular risk factors (hypertension, diabetes and smoking) and a term for the sum of 4 vascular diseases (myocardial infarction, congestive heart failure, claudication and stroke). **Depressive Symptoms:** Modified 10 item Center for Epidemiologic Studies Depression (CES-D) scale, a higher score indicates more depressive symptoms.