THE LONGITUDINAL STUDY OF ASTRONAUT HEALTH

Newsletter

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Physical Activity for a Healthy Lifestyle

Physical activity has long been regarded as a key component of a healthy lifestyle. Medical benefits of physical activity include increased mental health and health-related quality of life as well as a decreased risk of cardiovascular diseases, cancer of the colon, diabetes, musculoskeletal related conditions, and obesity. Physical inactivity is second only to tobacco use in causing the most preventable deaths in the United States with at least 300,000 annual attributable deaths. Contrary to the mounting evidence of the positive effects of physical activity, over 60% of U.S. adults do not attain the recommended level of physical activity, while 25% are not active at all. Inactivity is more prevalent among women, minorities, older adults, and the less affluent.

The first national effort to encourage physical activity in young Americans took place in the 1950's. This movement was the first of its kind in the world. In the 1970's, another health education effort enlightened Americans on the cardiovascular benefits of vigorous activity. In the 1980's and 90's, new information on the benefits of moderate intensity activities was brought forward. Traditional beliefs toward exercise and fitness may have led most Americans to believe that an effective exercise program must be rigorous and strenuous; however, scientific studies have dispelled this belief. This idea has now been expanded even further. In a 1994 report issued by the Surgeon General, a public health recommendation was made for a moderate-intensity physical activity schedule to be carried out on most, if not all, days of the week. It is hoped that this revised public health recommendation will start a new movement that will save lives and allow the maintenance of a high quality of life.

The term physical activity is used loosely when compared to the terms exercise and physical fitness. It refers to a lifestyle of casual activities that result in the expenditure of energy. The term moderate refers to an intensity of activities that

continued on page 2

The 2000 Astronaut Class

Seventeen individuals have been selected to be in the 2000 astronaut class, with women comprising 18% (3 out of 17) of the total. The men have a mean age of 35.6 years, with a mean Body Mass Index (BMI) of 25.5. The mean age for the women is 31.7 years, while their mean BMI is 20.1. BMI is a surrogate measure for fatness which is more accurate for a group of people than for an individual; it is calculated by dividing the weight in kilograms by the height in meters squared. The standard range for the U.S. general population is 20.7-27.8 for males and 19.1-27.3 for females.

Table 1 presents the values for mean age and BMI at selection for all astronaut classes, so that comparison between the new class and those chosen earlier may be made.

Table 1

Selection Yr	Selected M	Selected F	Mean Age M	Mean Age F	Mean BMI M	Mean BMI F
1959	7	0	34.7	n/a	23.9	n/a
1962	9	0	33.0	n/a	23.3	n/a
1963	14	0	31.5	n/a	23.4	n/a
1965	6	0	31.9	n/a	23.5	n/a
1966	19	0	33.3	n/a	23.6	n/a
1967	11	0	32.0	n/a	25.6	n/a
1969	7	0	33.2	n/a	23.1	n/a
1978	29	6	33.2	29.2	23.7	22.4
1980	17	2	33.3	31.9	23.4	19.3
1984	14	3	34.9	31.9	23.7	19.8
1985	11	2	32.7	29.5	23.5	20.6
1987	13	2	34.1	32.3	23.5	21.6
1990	18	5	34.7	32.2	23.6	21.0
1992	16	3	36.7	31.6	24.0	22.3
1995	16	5	36.9	34.3	24.7	21.1
1996	27	8	37.1	33.7	24.8	21.8
1998	21	4	36.5	36.0	26.0	20.3
2000	14	3	35.6	31.7	25.5	20.1
Total	**269**	**43**	**34.2**	**32.2**	**24.0**	**20.9**

The new class of male astronauts continues the trend started with the 1992 selection class of mean age higher than 35 years. These new astronauts also possess a comparatively higher value for average BMI, though still well within the standard range.

As compared to the astronaut classes after 1969, this new class falls near the upper part of the range (from 11% to 22%) in terms of its representation of women. These new female astronauts also display a typical mean BMI value. On average, this group has a slightly younger age as compared to previous classes of female astronauts. ■

continued from page 1

utilizes 3 to 6 metabolic equivalents (METs). One MET is defined as the amount of oxygen utilized while the body is at rest, which is 3.5 ml/kg of body weight/minute. Table 1 gives examples of common activities and the number of METs utilized while performing that activity. Intermittent activities performed throughout the day are also beneficial to one's health. Individuals who are currently physically active will reap additional benefits by increasing the duration or intensity of their current activities.

To assess the activity level within the LSAH population, information from the LSAH Health Lifestyle Questionnaire (LSQ) was compiled and compared with data from the 1990 National Health Interview Survey (NHIS). Information from the NHIS was gathered from 22,760 noninstitutionalized U.S. civilians at least 18 years of age. NHIS participants were divided into four basic categories based on the intensity, frequency, and duration of physical activity:

Table 1. Examples of MET Intensities of Common Activities

Light Activities (< 3.0 METs)	Moderate Activities (3.0-6.0 METs)	Vigorous Activities (> 6.0 METs)
Walking, pushing a stroller	Walking, brisk	Race walking
Bicycling, stationary, light effort	Bicycling, for pleasure	Bicycling, moderate effort
CE*: sitting in a Whirlpool	CE*: water aerobics	CE*: vigorous calisthenics
Dancing, very light ballroom	Dancing, low impact	Dancing, high impact
Swimming, slow treading	Swimming, leisurely	Swimming laps, freestyle
Sweeping floors	Mopping floors	Scrubbing floors, vigorously
Mowing lawn with a riding mower	Mowing lawn with power mower	Mowing lawn with a hand mower
Sports: darts, playing catch	Sports: frisbee, golf, softball	Sports: football, roller skating

*CE=conditioning exercise

Sedentary, Irregular, Moderate, and Vigorous. Sedentary indicates no leisure activity, Irregular indicates leisure activity that does not meet the current public health recommendation. Moderate refers to activities with an intensity of 3 to 6 METs performed a minimum of 30 minutes at least five days per week. Vigorous refers to activities with an intensity of greater than 6 METs performed a minimum of 20 minutes at least 3 days per week. The LSQ was developed in 1993 to collect essential data on NASA astronauts and LSAH comparisons. Two hundred twenty out of 272 astronauts and 780 out of 889 comparisons have completed this questionnaire. The physical activities of LSAH participants were categorized according to the NHIS definitions; however, their data were gathered using different time intervals, so both Moderate and Vigorous categories refer to activities performed a minimum of 20 minutes. Walking was categorized as a Moderate activity. Since the number of METs of an activity refers to the intensity with which it is performed, the assumption is made that the remaining activities listed on the LSQ were performed in a vigorous, energetic manner. These activities are running, swimming, bicycling, weight lifting, skating, aerobics/dancing, racquet sports, rowing, and other organized sports.

Figure 1. Reported Levels of Physical Activity

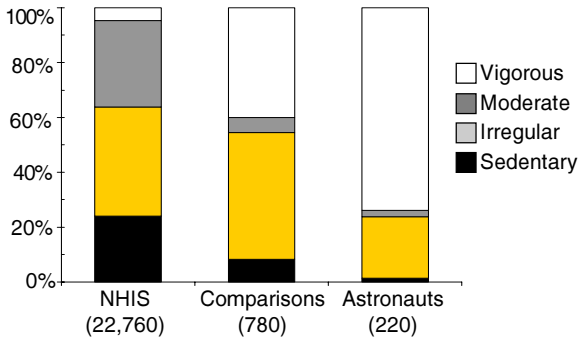
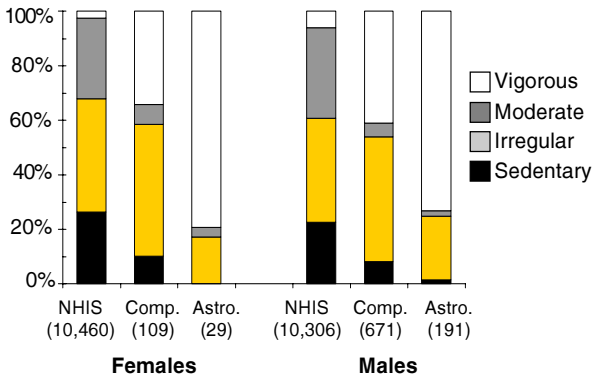


Figure 2. Reported Levels of Physical Activity by Sex



About one third of the NHIS participants reported a level of physical activity that meets the current public health recommendation. This is compared with nearly half of the comparisons and two-thirds of the astronauts (Fig. 1). The higher degree of physical activity of LSAH comparisons as compared to the NHIS population may be a manifestation of the healthy worker effect. The latter simply describes the phenomenon in which an employed population exhibits healthier characteristics than the general population. This effect is even more pronounced in the astronaut corps because it is in their interest to remain physically active in order to perform their duties effectively.

A higher percentage of male NHIS respondents reported participation in the recom-

continued on page 3

Aging and Cardiopulmonary Function

Previous newsletters have contained articles comparing age-specific values for certain physiological measurements among both the astronauts and comparison participants as part of the process to separate the effects of space flight from the background effects of aging. In this article, we examine the changes in cardiovascular and pulmonary functions of participants as they age. In the general population, cardiopulmonary function decreases with aging. Similar associations were found among the LSAH population.

For the purpose of looking at the association of aging, cross-sectional data for specific age groups were examined. The data were organized by age of examination for all annual examinations for all study participants. The first examination was selected for each participant when he/she entered a new age group. An individual is included in every age group that he/she has achieved but is represented only once in any age group. Due to small sample size, female astronauts and comparisons over 40 years of age were grouped together into one age group represented as 40-59.

VO_2max, the maximum volume of oxygen consumed by the body during exercise, is a measure of an individual's cardiovascular function. It indicates one's maximal capacity to do aerobic work, and is commonly measured in units of milliliter per kilogram of body weight per minute. Dividing the oxygen volume by body weight accounts for differences in body size. LSAH comparisons show values similar to those observed for the general population (data not shown), whereas the astronauts have almost 20% higher VO_2max value than the corresponding comparison groups. These higher VO_2max levels may be a reflection of the higher fitness level of

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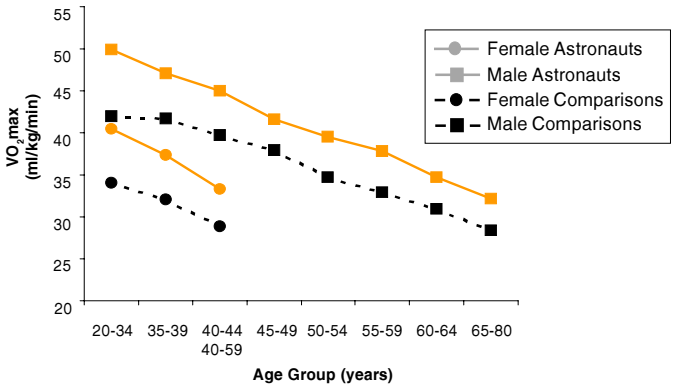
Figure 1. VO_2max–Mean Values by Age (Cross-Sectional Data)



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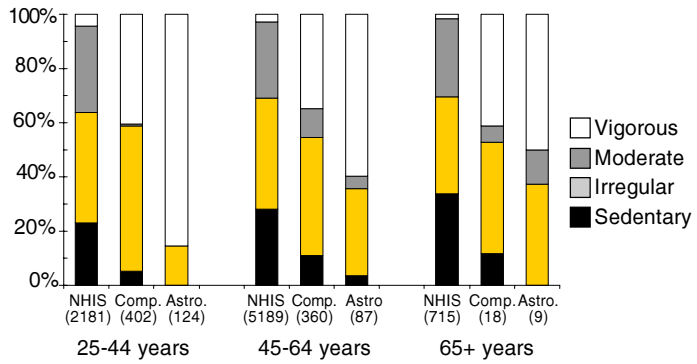
mended level of physical activity as compared to female respondents; this trend is also observed to a lesser extent in the LSAH comparisons. However, female astronauts reported a greater percentage of participation in physical activity than male astronauts did (Fig. 2). This increase may be due to the younger average age of female astronauts as compared with the older average age of male astronauts (data not shown). The results may also be affected by the smaller number of female astronauts.

When the results are broken down by age, older NHIS respondents reported less physical activity than younger respondents, while LSAH comparisons reported about the same level of physical activity across the age groups (Fig. 3). The decrease in physical activity with age was also seen in the astronauts, though in the 25-44 years age group this cohort reported more than double the participation in physical activity as compared to the corresponding age group of NHIS respondents. The higher relative participation of astronauts in moderate and vigorous physical activity was further displayed as more than half of the astronauts in the oldest age group reported participating in such activity. However, keep in mind that the number of astronauts in the oldest age group is much smaller than that of the NHIS respondents.

Though nearly 40% of U.S. adults participate in physical activities that meet the new public health recommendation, there is still a desire to increase this number so that the nation as well as each individual will reap health benefits. Remember to consult your family physician if you have not previously been involved in physical activities, and gradually work up to your activity goals. A little physical activity now can preserve resources, lifestyles, and lives in the future. ■

Figure 3. Reported Levels of Physical Activity by Age



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astronauts as compared to the comparison participants. However, both groups show about the same rate of decline in VO_2max with aging.

Pulmonary function was assessed through two measurements, FEV_1 and FVC. FEV_1 stands for forced expiratory volume 1, the volume of air that is forcefully exhaled in one second, in liters (L). FVC, or forced vital capacity, is the volume of air that can be maximally forcefully exhaled, in liters – so that FEV_1 is actually a subset of FVC. Values of 3.0 L and 4.0 L are considered average FEV_1 and FVC levels in the general population.

For FEV_1, male astronauts younger than 35 years of age show a higher level than the corresponding comparison group (Fig. 2). This advantage was virtually gone by the next age group, as both male astronauts and comparisons show almost identical FEV_1 values for ages 35-64 years. Only in the oldest age group did male astronauts have higher FEV_1 levels than the comparisons again. Female astronauts younger than 35 years of age have a lower mean FEV_1 value than the female comparisons. However, their FEV_1 values decline less steeply with age as compared to those of the comparisons, so that female astronauts of the 40-59 years age group show a slightly higher value of FEV_1as compared to female comparisons in the same age group.

Figure 2. FEV_1–Mean Values by Age (Cross-Sectional Data)

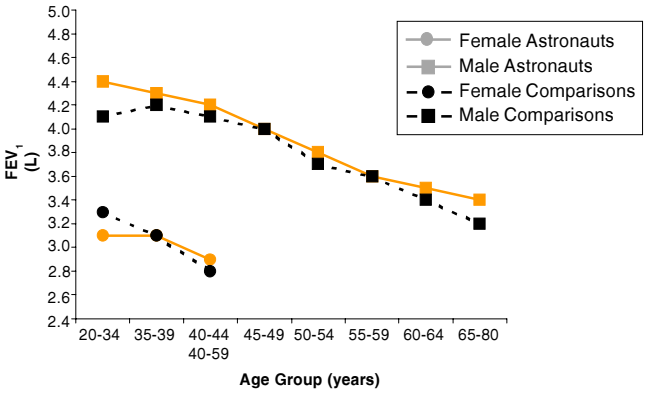
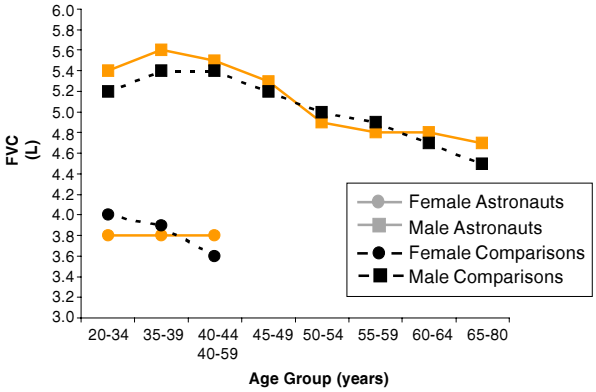


Figure 3. FVC–Mean Values by Age (Cross-Sectional Data)



Similar aging trends are also observed for the astronauts and comparisons for their FVC values (Fig. 3), though the decline rates for all male participants are less steep as compared to their decline of FEV_1 values with age. Male astronauts show higher FVC volumes than male comparisons in the younger age groups, but this advantage evens out in the ages between 40 and 60 years, before reappearing in the oldest age groups.

Female comparisons show a decline in FVC volumes as they age. However, the FVC values for female astronauts hold steady across the age groups instead of showing the expected aging trend, which may be a function of the small sample size or retention of better physical fitness of this participant group.

In general, higher values of cardiopulmonary function obtained for the astronauts are expected. The somewhat unusual trends shown by female astronauts may result from the small sample size of the group. These current observations suggest that cardiopulmonary function in both groups is affected by age in the same ways; further observations will continue, and will be shared with study participants through this newsletter. ■

For your information

If you want a copy of your exam results, please complete and sign a release form while you are visiting the Clinic for your examination. The form is called *Privacy Act Disclosure Authorization and Accounting Record (DAAR)*, or NASA Form 1536.

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