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Effect of Different Environments on Respiratory Function of Ambulatory Elderly Community Dwellers and Institutional Residents in Increased Age

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The purpose of this investigation was to determine whether different living places would exert some influences on respiratory function in increased age. The spirometric parameters including vital capacity (VC), forced expiratory volume in one second (FEV1.0) and the maximal flow at 50% level of the vital capacity (V50) were measured in 159 subjects (47 men and 112 women). The population was divided by sex (men or women), living place (community or institution) and decade (seventies and eighties). All parameters for men and women of the same age groups decreased in Institutional group compared to Community one. In the institution, the mean values of FEV1.0 and V50 in women of 80's were characteristically greater than those of 70's.

The results suggest 1) that the respiratory function in women might be clearly differentiated than men from the viewpoint of environment and age, 2) that the function of Institutional group in women would not exert as great an influence with age as that of Community group, and 3) that it would be important to pay more attention to the environment of the elderly, when considering their respiratory function. In clinical settings the simple and easy-to-manage method of spirometry to assess lung function with increased aging may be of value to provide elderly subjects with effective exercise programs applied to the activities of daily living.

Key words

Elderly,
Respiratory function,
Community,
Institution.

INTRODUCTION

During the last several decades the number of people over 70 years has

progressively increased. In order to give therapists in clinical settings effective information about rehabilitation programs, a clear understanding of the physiological changes that occur with aging is needed, but it remains unclarified. Since lung is directly connected with the outer world, various harmful factors such as smoking, auto exhausts, or air pollutants could adversely affect respiratory function.¹⁻⁷⁾ Moreover, the function decreases with increased aging and a decline in its dynamics is commonly observed. Several studies have been devoted to the function in advanced age 1) to standardize the

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norm for normal elderly subjects⁸⁻¹²⁾ and the norm with extrapolation beyond the range of ages.¹³⁻¹⁵⁾ 2) to examine the relationship among various spirometric parameters,¹⁶⁻¹⁹⁾ and 3) to demonstrate respiratory effects of physical conditioning on older subjects.²⁰⁻²⁴⁾ However, studies have neither looked at the relationship of ambulatory elderly subjects in different living environments, that is, in the community and the institution, nor shown respiratory function measures in association with the living environments to provide elderly subjects with important rehabilitation findings in clinical practice.

In this study we determine if different living environments would exert some influences on respiratory function in advanced age: the seventies and the eighties. The respiratory function is discussed in relation to sex, environmental difference in the same decade, and age difference in the same environment.

SUBJECTS AND METHODS

Study population

Subjects were 159 (47 men and 112 women) healthy elderly volunteers in the seventies and the eighties, without neuromuscular disease or cognitive impairment. All were ambulatory and living either at home or in institutions. The community dwellers were independent in activities of daily living, while the institutional residents (the elderly subjects living in one health facility (keihi roujin) were also independent except bathing helped by care workers. In-

formation regarding their life habits: previous health, leisure habits, occupation, and smoking history²⁵⁾ was obtained by questionnaire. Oral informed consent was obtained from each of the subjects before a measurement was carried out.

They met the following criteria defining 'normal'. They have not had any previous cardiorespiratory disease except cold. Moreover, they answered in the negative all questions concerning chronic cough, chest pain, persistent chest wheezing or shortness of breath. Concerning life style characteristics of the study population as a function of age, nobody smoked and partook in more than 2 hours per week leisure time physical activity²⁵⁾ Its level was in the range of 11-14 on the category scale of Rating of Perceived Exertion.²⁶⁾ It represents activities at a level which is light to somewhat heavy. No one got physical and/or occupational therapy programs anywhere. All the subjects were city dwellers and their life style was sedentary.

The subjects were divided into four groups by living place (community or institution) and sex (men or women); groups C-70 and C-80, that is, seventies and eighties in the community, respectively, and groups I-70 and I-80: those in institutions, respectively (Tables 1 and 2).

Methods

Before testing, the subjects were shown the spirometric apparatus (Minato Medical Inc., Japan: as-300) to get accustomed to the procedure, and they were told, if they would, to say 'Stop' at any time during testing.

The test was always conducted by two same operators; an occupational and a physical therapists. The subjects' height was measured without shoes. All tests were carried out with the subjects in the sitting position and a nose-clip was used. The test was performed in the morning or in the afternoon, at least two hours after feeding. During testing, the subjects were observed for coughing or wheezing. Only when the spirometric function values were judged 'wrong' or 'abnormal', a test was repeated. The respiratory parameters consisted of vital capacity (VC), forced expiratory volume in one second (FEV1.0) and the maximal flow at 50% level of the vital capacity (V50).

Statistical analysis

For computing statistical analyses are carried out on StatView 4.5 (Abacus Concepts Inc., USA) and data were expressed as mean standard deviation. The results of the parameters were analyzed for difference using unpaired t-test between the same decade in the two different living places. Values of P equal or

smaller than 0.05 were considered to reflect statistical significance. Moreover, personal values of the three variables were chronologically displayed as scatter diagrams, after which linear correlation coefficient was obtained and regression analysis was conducted.

RESULTS

A total of 159 ambulatory elderly men and women selected were included in this study. The distribution by living place and decade, and the mean values and standard deviations for physical characteristics (age and height) and respiratory function measurements (VC, FEV1.0 and V50) are listed in Table 1 for men and Table 2 for women. Weight and body surface area as physical characteristics were not included, since weight had little or no correlation with any of the spirometric parameters.^{9,27)} Age and height data comparisons demonstrated no significant differences between C and I groups at the same decade (Tables 1 and 2).

Figure 1 shows that C group in men had a greater value than I group

Table 1. Distribution of subjects by decades and mean values and standard deviations for physical characteristics and respiratory function measurements for men

	C-70	I-70	C-80	I-80
No. of subjects	19	7	13	8
Age, years	74.3±2.4	75.0±2.8	84.6±3.0	85.3±2.0
Height, cms	160.3±5.6	160.9±9.4	159.8±6.6	154.2±10.0
VC, liter	2.54±0.57	1.99±0.98	2.41±0.49	1.93±0.98
FEV1.0, liter	1.71±0.58	1.45±0.82	1.46±0.43	1.08±0.40
V50, liter/second	1.78±0.95	1.76±1.19	1.57±1.06	1.40±0.98

Mean value±Standard deviation

in the same decade without any significance. Age being taken into account in the same environment, VC of the two environments decreased slightly without significance ($r=0.09$ and $p=0.644$ in C group, and $r=0.09$ and $p=0.762$ in I group) (Figure 2 (a)). In women, however, the descending rate of VC significantly differed between C and I groups in the seventies ($p<0.01$) and the eighties ($p<0.05$) (Table 2). Moreover, it should be noted that VC of C group portrayed a more appreciable linear regression ($r=0.49$ and $p=0.001$ vs $r=0.29$ and $p=0.016$ in I group), clearly representing the yearly declining rate of 46ml (Figure 2(b)).

Figure 3 depicts that in the same decade for both sexes FEV1.0 of C group showed a greater mean value than that of I group, and a significant difference was observed in women between C- and I-70 ($p<0.01$). Moreover, it was characteristic that FEV1.0 of C group in women apparently decreased with increasing age at the more falling rate of 34ml per year ($r=0.50$ and $p=0.001$) (Figure 4 (b)). However, it was noteworthy that the regression coeffi-

cient of institutional women showed almost no change for 20 years ($r=0.002$ and $p=0.989$). The correlation in men between the variable and age was not found ($p=0.302$ and $p=0.308$ in C- and I-group, respectively) (Figure 4(a)).

Figure 5 illustrates the same characteristic as the two other parameters: in both sexes the mean values of C group showed a more increase than those of I group at the same decade and a significant difference was noted only between C- and I-70 in women ($p<0.01$). Only in C group of women, mild linear correlation was observed between age and V50 with statistical difference ($r=0.42$ and $p=0.007$) (Figure 6(a) and (b)).

DISCUSSION

Aging has a close relation to a decrease in respiratory function of elderly subjects, resulting in a reduction of the physiological reserve.^{4,10,12,13,18,28-32} The structural changes may be mainly due to the two progressive losses: 1) the aging lung's static recoil forces, producing airway closure at lung reserves, and 2) mus-

Table 2. Distribution of subjects by decades and mean values and standard deviations for physical characteristics and respiratory function measurements for women

	C-70	I-70	C-80	I-80
No. of subjects	22	32	19	39
Age, years	75.4±2.1	76.5±2.4	83.8±3.5	84.8±2.6
Height, cms	147.6±4.4	145.3±6.8	143.7±6.7	142.1±8.5
VC, liter	1.93±0.52	1.38±0.48**	1.47±0.42	1.25±0.35*
FEV1.0, liter	1.40±0.34	0.85±0.37**	1.03±0.44	0.89±0.34
V50, liter/second	1.76±0.60	0.94±0.55**	1.28±0.71	1.13±0.59

Mean value±Standard deviation

* $p<0.05$ compared to C-80 ** $p<0.01$ compared to C-70

cle strength of the respiratory apparatus, resulting in stiffer chest wall with increase in age, which attributes to a decline of inspiratory and expiratory pressure.^{2,5,33)} Few investigations of normal respiratory capacity

in people over 75 years have been carried out^{2,10,12)} and the predicted spirometric values were mainly obtained by extrapolation to older age.¹³⁻¹⁵⁾ The paucity of appropriate information about respiratory

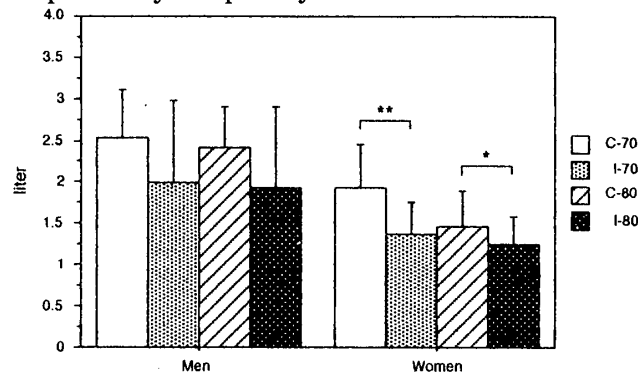


Figure 1. Mean values ($\pm$ SD) of the seventies and eighties in the community and institutions for Vital Capacity (VC) for men and women.

* $p < 0.05$ vs. C-80 and ** $p < 0.01$ vs. C-70

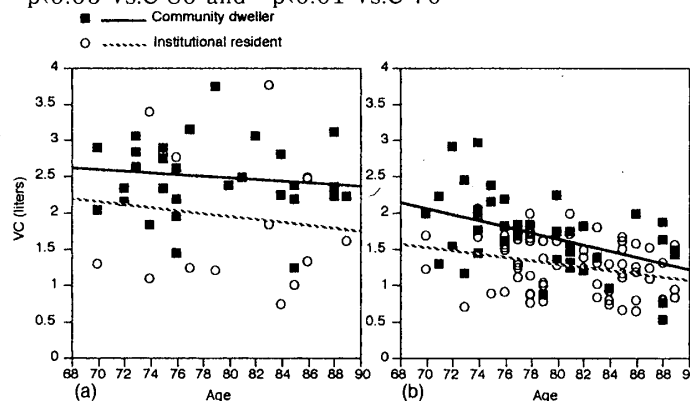


Figure 2. Scattered diagram with linear regression representing personal values of male (a) and female (b) subjects of community dwellers and institutional residents.

(a) Community: $VC = 3.103 - 0.008 \cdot \text{Age}$, $r = 0.09$, $p = 0.644$

Institution: $VC = 3.077 - 0.014 \cdot \text{Age}$, $r = 0.09$, $p = 0.762$

(b) Community: $VC = 5.326 - 0.046 \cdot \text{Age}$, $r = 0.49$, $p = 0.001$

Institution: $VC = 3.085 - 0.022 \cdot \text{Age}$, $r = 0.29$, $p = 0.016$

capacity in older subjects may be thought to leave some difficulties in the clinical settings. However, no published comparative studies have been found of the effect of different living places, that is, the community and institutions, on respiratory function in ambulatory elderly subjects.

The variables in this study represent a trend of a constant decline with increasing age. Three major findings

are found about the relationship concerning respiratory function of elderly men and women between the different environments in the same decade: 1) In the same decade the mean values of the three respiratory measures in men and women indicated greater in C group than those in I group (Tables 1 and 2). 2) In the same environments the mean values of both FEV1.0 and V50 in I group of women did not fall

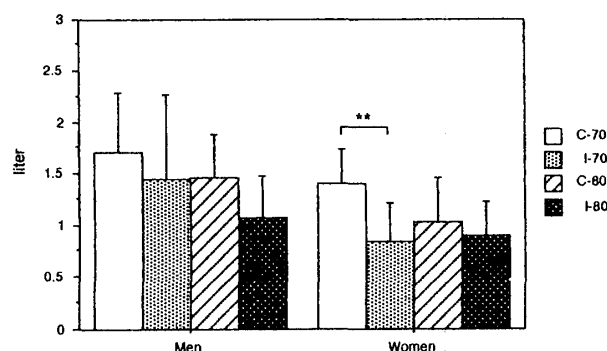


Figure 3. Mean values ($\pm$ SD) of the seventies and eighties in the community and institutions for Forced Expiratory Volume in One Second (FEV1.0) for men and women.
** $p < 0.01$ vs.C-70

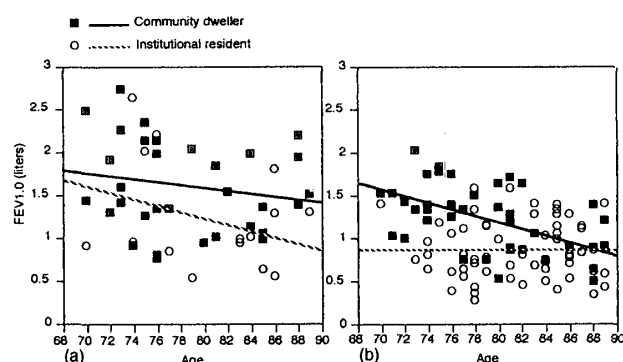


Figure 4. Scattered diagram with linear regression representing personal values of male (a) and female (b) subjects of community dwellers and institutional residents.
(a) Community: $FEV1.0 = 2.964 - 0.017 \cdot \text{Age}$, $r = 0.19$, $p = 0.302$
Institution: $FEV1.0 = 3.762 - 0.031 \cdot \text{Age}$, $r = 0.28$, $p = 0.308$
(b) Community: $FEV1.0 = 3.947 - 0.034 \cdot \text{Age}$, $r = 0.50$, $p = 0.001$
Institution: $FEV1.0 = 0.891 - 0.0001 \cdot \text{Age}$, $r = 0.002$, $p = 0.989$

strongly with increase in age, but showed almost no change or rose slightly (Figures 4 (b), 6 (b) and Table 2). 3) The mean values of C-80 in the parameters were greater in both sexes than those of I-70, with the exception of V50 in men (Tables 1 and 2), which may exhibit greater influences of their environments on respiratory function than of age.

Statistical analysis in the respiratory function measures between C and I groups in the same decade and about personal values in scattered diagrams were performed, and statistical differences in women were appreciably found (Figures 2 (b), 4 (b), 6 (b) and

Table 2), but none of the results in men were statistically significant (Figures 2 (a), 4 (a), 6 (a) and Table 1). There are several factors that may explain why ambulatory elderly community dwellers had superior respiratory function when compared with their institutional counterparts. Even if the subjects in the two groups are independent in their self-care activities and live a daily life within the range of the sedentary life style categorized by Inbar and his colleagues,²⁵⁾ amounts of daily activity level and those of impulses from the outer world may be closely related to keep lung function normal, because

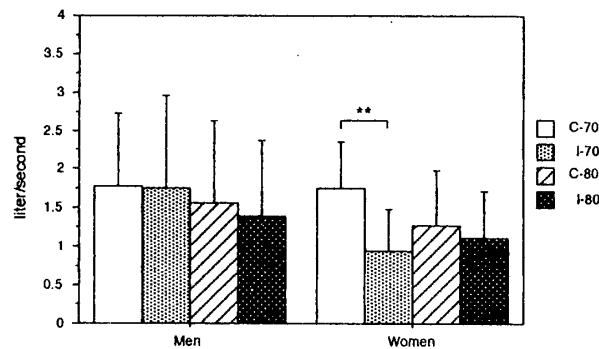


Figure 5. Mean values ($\pm$ SD) of the seventies and eighties in the community and institutions for Maximal Flow at 50% Level of the Vital Capacity (V50) for men and women.
 $**p < 0.01$ vs. C-70

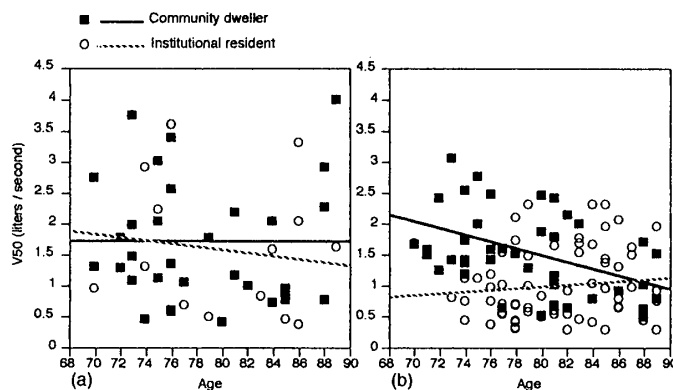


Figure 6. Scattered diagram with linear regression representing personal values of male (a) and female (b) subjects of community dwellers and institutional residents.

- (a) Community: $V50 = 1.733 - 0.001 \cdot \text{Age}$, $r = 0.003$, $p = 0.986$
 Institution: $V50 = 3.487 - 0.024 \cdot \text{Age}$, $r = 0.13$, $p = 0.644$
 (b) Community: $V50 = 5.442 - 0.049 \cdot \text{Age}$, $r = 0.42$, $p = 0.007$
 Institution: $V50 = -0.357 + 0.017 \cdot \text{Age}$, $r = 0.14$, $p = 0.243$

the institutional residents would live a daily life in a so-called "closed" community. And the current data suggest that sex and life style are important variables, since the respiratory function of men may be affected more than that of women with increasing age (Figures 2, 4 and 6), attributed partly to a survival effect as a result of removal of more delicate elements in the very old population. It clearly depicts that the range of personal differences was not so great in women as in men, particularly those in C group, which may result in smaller standard deviation in women (approximately 27 to 59% of the

mean value) than in men (approximately 20 to 70%). These data are not consistent with the previous findings from Tolep and Kelsen 34), and Steen and his colleagues 35), because they did not take into account differences in environments with advancing age.

When the results were analyzed by age difference, there was relatively a parallel decrease in all parameters of men. In women, on the other hand, the declining trend of C group was similar to the men's with increasing age, but its extent was expressed more appreciably at a yearly falling rate of 46ml, 34ml and 49ml versus

22ml, 0.1ml and a increasing rate of 17ml in VC, FEV1.0 and V50, respectively (Figures 2, 4 and 6). In clinical settings for old subjects a shortage of biological deterioration is not unusual. Therefore, biological variables such as stiffness of chest wall and lung,^{33,36,37)} calcification of costal cartilage,³⁸⁾ and atrophy of respiratory muscles^{39,40)} may be thought to produce stronger influences on decline with age in the very old subjects. Our data clearly showed that therapists should pay more attention to the differences in sex and living place, when they evaluate lung function by spirometry. These findings may be of importance especially to point out a parameter of lung function that is sensitive to improvement and predicted disease severity: FEV1.0, and an "effort-independent" parameter: V50.^{41,42)} One possibility may be explained that less impulses from the outer world in monotonous daily life of a "closed" community could get ambulatory elderly women of I group more stable in respiratory function than those of C-group. The reason why it was not shown in C group of men may be attributed to greater adaptation to the flat and quietly sedentary life style in

women.

When different environments and decades are taken into account, it is noteworthy to point out that more impulses and the wider range of daily life whenever and wherever subjects can go out may exert greater effects on respiratory function measures, like greater mean values of C-80 in both sexes than those of I-70, with the exception of V50 in men.

On the basis of the above-mentioned findings, the simple and easy-to-manage method to evaluate respiratory function used in this study will be valuable 1) to identify healthy elderly subjects in different environments, even if they were in the same decade and 2) to be applied for more effective, clinical practice for very old subjects. In order to validate these findings more precisely, a larger sample size would be required.

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