

<Original Article>

Seven-year large cohort study for the association of serum albumin level and aging among community dwelling elderly

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Summary This study was done to clarify the association of serum albumin and aging in community-dwelling independent elderly aged 65 and over. Subjects were 36,674 people who had had a basic health examination at least one time from 2001 to 2007 in Habikino-city, Osaka.

As a cross-sectional study, prevalence of hypoalbuminemia ($\text{Alb} \leq 3.5 \text{g/dl}$) was higher in older age of both men and women. Comparing albumin level by age group, older people showed a higher albumin level. As a longitudinal study, we calculated changes in albumin level for seven years. The results showed that albumin level decreased $4.25 \pm 0.25 \text{ g/dl}$ to $4.21 \pm 0.23 \text{ g/dl}$ for men ($p < .001$), $4.30 \pm 0.23 \text{ g/dl}$ to $4.25 \pm 0.22 \text{ g/dl}$ for women ($p < .001$).

The findings of this study suggested that a decrease in albumin level of both men and women among community-dwelling elderly was significantly associated with aging.

Key words: Albumin, Aging, Community dwelling elderly, Hypoalbuminemia,

1. Introduction

Malnutrition has been widely regarded as a health-care problem among elderly people¹⁾. The serum albumin level is usually used to assess nutritional status, with less than 3.5g/dl of serum albumin concentration defined as "hypoalbuminemia".

Low serum albumin level was related with poor health status among not only institutionalized or hospitalized elderly people²⁻⁴⁾, but also community-dwelling elderly people⁵⁻⁷⁾.

Many studies have shown that even where the

serum albumin level was within normal range, a lower albumin level was a reliable predictor of poor outcomes such as higher mortality⁸⁻¹³⁾, higher risk of cardiovascular disease^{14, 15)} and functional decline¹⁶⁾ in the future.

Moreover, decreasing serum albumin level within normal range was associated with decline in muscle mass^{17, 18)} and muscle strength¹⁹⁾ resulting in impaired mobility and balance among elderly people.

These investigations have suggested that decreasing serum albumin concentration among community dwelling elderly would be a sign of future

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Received for Publication May 28, 2011

Accepted for Publication July 8, 2011

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frailty and may result in the need for future care. Thus prevention of hypoalbuminemia has been a consideration in preventive health service for community dwelling elderly.

In this regard, previous studies have described the effect of ageing on serum albumin level⁽²⁰⁻²⁴⁾.

Several studies have shown that a decline in albumin level with age was an effect of age-related chronic diseases⁽²⁰⁻²²⁾.

Other studies have shown changes of serum albumin level with aging by longitudinal study. Gomi demonstrated that about 60,000 subjects over 65 years old in community dwelling showed decreasing serum albumin level with aging by 4-y longitudinal study⁽²³⁾. Shibata et al. revealed decreasing serum albumin level with aging by a 10-year longitudinal study of 400 subjects⁽²⁴⁾.

Although the information gathered thus far has led to a better understanding of the effect of aging on serum albumin concentration, the question of whether decreasing serum albumin with aging occurs with normative aging or other age-related factors is still unknown.

Even though decline in serum albumin concentration is affected by normative aging or other age-related factors, preventive frailty related with hypoalbuminemia is a significant consideration for independent community-dwelling elderly.

This study conducted to clarify the association of albumin level and aging in cross-sectional and 7-y longitudinal study using large cohort data of health examination participants in community-dwelling elderly aged 65 and older.

2. Materials and Methods

1. Study subjects

The data were collected in Habikino-city, with a population of 118,695, and a 65-year-old and over population of 22,825 in 2005. The sample for this study comprised community dwelling elderly aged 65 and older who had participated in a health examination organized by Habikino-city.

The total number of participants in the health examination for seven years from 2001 to 2007 was

41,367 (14,611 men and 26,756 women). 2,153 men and 2,540 women were excluded by uncertain liver diseases assessed by applicable GOT \geq 36 or GPT \geq 39 values because albumin is protein synthesized in the liver.

The total number of study subjects was 36,674 (12,458 men and 24,216 women); 3,742 persons in 2001, 4,617 persons in 2002, 5,622 persons in 2003, 5,183 persons in 2004, 5,286 persons in 2005, 5,835 persons in 2006 and 6,389 persons in 2007. These subjects included those who had had a health examination more than one time in those seven years.

The protocol of this study was approved by the Institutional Review Board of Osaka Prefecture University. All the data were compiled by the health center of Habikino-city, which allowed Osaka Prefecture University to use these data for analysis in this study.

2. Albumin

Blood samples were collected by medical practitioners in Habikino-city. Each medical doctor sent the samples to the laboratory to analyze blood count and biochemical parameters. Albumin concentrations were determined by the Bromocresol Green (BCG) procedure at the medical laboratory.

3. Statistical analysis

In view of differences between men and women, all values were stratified by sex. Data analysis was performed using the statistical package SPSS 13.0J for Windows.

4. Cross-sectional study

First of all, all subjects were divided by sex and six age groups: ages 65-69y, 70-74y, 75-79y, 80-84y, 85-90y, and \geq 90y, and calculated percent distribution of hypoalbuminemia ($\text{Alb} \leq 3.5$ g/dl).

Second, subjects who were participants in the health examination in 2001 were divided into six age groups. The difference in albumin level by age groups was calculated and tested along with the relationship between age and albumin level by one-way analysis of variance.

Table 1 Prevalence of hypoalbuminemia ($\text{Alb} \leq 3.5 \text{g/dl}$) by sex and age groups among community-dwelling elderly aged 65 and older in each year from 2001 to 2007

Year	Men				Women			
	n (young-old/old-old)	Incidence of hypoalbuminemia (%)			n (young-old/old-old)	Incidence of hypoalbuminemia (%)		
		65-74y	75y and older	Total		65-74y	75y and older	Total
2001	1,223 (847/376)	1.30	7.45	3.19	2,519 (1,682/837)	0.54	5.38	2.14
2002	1,544 (1,076/468)	0.84	5.34	2.46	3,073 (2,052/1,021)	0.39	3.62	1.46
2003	1,952 (1,292/660)	0.31	9.85	2.10	3,670 (2,377/1,293)	0.17	4.33	1.63
2004	1,757 (1,170/587)	0.57	3.07	1.59	3,426 (2,236/1,190)	0.27	2.69	1.11
2005	1,748 (1,190/558)	0.86	1.25	1.49	3,538 (2,332/1,206)	1.03	0.66	1.27
2006	1,977 (1,332/645)	0.30	1.71	0.86	3,858 (2,466/1,392)	0.08	1.51	0.60
2007	2,257 (1,497/760)	0.40	0.79	0.84	4,132 (2,619/1,513)	0.73	0.93	0.90

Table 2 Comparison of albumin value (g/dl) by age groups among elderly aged 65 and older who participated in health examination in 2001

	Age	n	Albumin value (g/dl)		Correlation coefficient
			mean	S.D.	
Men	65-69	494	4.30	± 0.28	***
	70-79	561	4.23	± 0.32	
	80-89	148	4.03	± 0.47	
	≥90	20	3.76	± 0.33	
	Total	1,223	4.22	± 0.34	r = -.271
Women	65-69	1,052	4.32	± 0.27	***
	70-79	1,065	4.25	± 0.28	
	80-89	347	4.10	± 0.36	
	≥90	55	3.83	± 0.47	
	Total	2,519	4.25	± 0.31	r = -.292

*** : $p < 0.001$

5. Longitudinal study

To test the changes of albumin level for seven years, we followed those who had participated in a health examination in 2001 as the first year to 2007 as the last year of the survey.

Differences of albumin level between 2001 and 2007 were calculated by age and sex, and tested by paired t-test. The percentage reduction of decreasing albumin value for seven years was calculated.

Changes of albumin level in each year for seven years were examined by ANOVA and linear least-square methods.

3. Results

1. Prevalence of hypoalbuminemia ($\text{Alb} \leq 3.5 \text{g/dl}$) by age and sex

Prevalence of hypoalbuminemia among community-dwelling elderly was calculated by sex and age groups.

As shown in Table 1, all participants were divided into two age groups: young-old of 65-74y and old-old of age ≥ 75 y. Prevalence of hypoalbuminemia showed higher value in the old-old group of both men and women than in the young-old age group.

Hypoalbuminemia appeared in ranges 0.30-1.30% in the age 65-74 years, to 0.79-9.85% at age 75 and over for men, and range 0.08-0.73% to 0.93-5.38% at

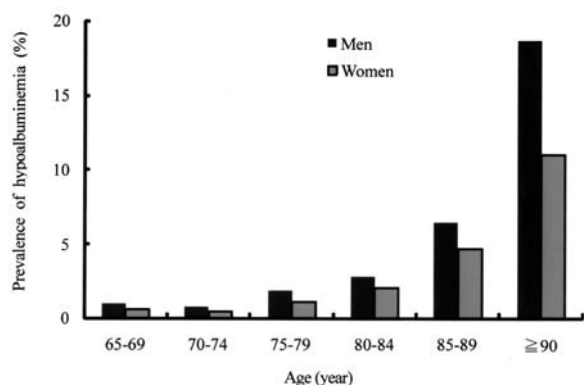


Fig. 1 Prevalence of hypoalbuminemia by age groups and sex. This figure shows percent distribution of hypoalbuminemia ($Alb \leq 3.5$ g/dl) differed from sex and six age groups. Total number of subjects was 12,458 of men and 24,216 of women, who participated in a health examination from 2001 to 2007.

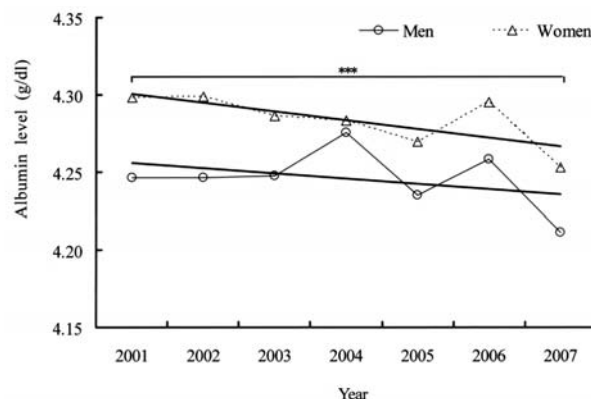


Fig. 2 Changes of albumin level for seven years. Subjects were participants of a health examination every year from 2001 to 2007 (296 of men, 712 of women). The dotted line shows changes of mean albumin level in each year for seven year. The solid line shows approximate line of decreasing albumin level for seven year. R^2 was 0.522 of women and 0.134 of men by linear least-square method. $***P < 0.001$

Table 3 Changes in albumin value over 7 years among aged 65 and older who participated in health examination in both 2001 and 2007

	number of subjects	albumin value (g/dl)			% change in 7 years
		2001	2007		
Men	628	4.25 ± 0.25	4.21 ± 0.23	***	-0.95%
Women	1,404	4.30 ± 0.23	4.25 ± 0.22	***	-1.20%

Value are expressed as mean ± SD.

***: $p < 0.001$ compared with serum albumin level in 2001 and 2007.

the same age for women.

In addition, subjects were divided by sex and six age groups: ages 65-69, 70-74, 75-79, 80-84, 85-89 and 90 and over.

Figure 1 showed that hypoalbuminemia appeared more likely among the older and men, values for men ranged from 0.7% in the 65-69 group to 21.0% in ages 90 and over, and 0.2% to 14.1 % in women of the same age.

2. Comparing albumin level by sex and age

The relationship of albumin level to age was calculated by sex and age groups.

A total of 3,742 subjects who participated in a health examination in 2001 were divided into four age groups: 65-69, 70-79, 80-89 and 90 and over.

Table 2 shows that albumin level ranged from 4.30 ± 0.28 g/dl at ages 65-69 years to 3.76 ± 0.33 g/dl at age 90 and over in men, and 4.32 ± 0.27 g/dl to 3.83 ± 0.47 g/dl in women of the same age.

A one-way analysis of variance was conducted to test the relationship between albumin level and age. There were a significant difference in albumin level in both of men ($p < .000$) and women ($p < .000$).

3. A longitudinal study: Changes of albumin level for seven years

The albumin level of subjects who had a health examination in both 2001 and 2007 was followed. Table 3 shows the comparison of albumin level by sex in 2001 and 2007.

A decline in albumin level was more likely in

women than men. The albumin level of men decreased from 4.25 ± 0.25 g/dl in 2001 to 4.21 ± 0.23 g/dl in 2007 ($p < 0.001$) and -0.95% reduction for seven year. The albumin level of women decreased from 4.30 ± 0.23 g/dl in 2001 to 4.25 ± 0.22 g/dl of women in 2007 ($p < 0.001$), and -1.2% reduction for seven years.

The albumin level of subjects who had a health examination every year from 2001 to 2007 was followed.

Figure 2 shows the changes of albumin level for seven years among men and women.

Differences in albumin level were tested by Turkey's test. There were significantly lower levels in 2007 than in 2001 (men: $p < .001$, women: $p < .001$) among both men and women.

4. Discussion

The findings of this study provide information about the relationship between albumin level and aging. The results support previous study which demonstrated that albumin level decreases with age.

As to the association of albumin level and age, first of all, the results showed that an increase in hypoalbuminemia was more likely among "old-old" elderly aged 75 and older, and at ages 80s and 90s for both men and women. This result supports previous study²¹⁻²³). The prevalence of hypoalbuminemia showed higher in men than women.

Both men and women aged 90 and over showed a remarkable increase in low albumin level ($\text{Alb} \leq 3.5$ g/dl). In the future, our society will see greater longevity and an increasingly older population. Thus the result of this study provides valuable information about albumin level at age 90 and over in men and women for future study.

Second, serum albumin level differed with age groups and showed decrease with age. These results showed similar results to previous study which reported 4.29 g/dl for those in their 60s, 4.25 g/dl for those in their 70s, and 4.13 g/dl for those in their 80s²⁰).

As to longitudinal study, changes in albumin level for 7-y among community dwelling elderly showed that serum albumin level decreased in men and

women. Percent reduction in serum albumin level for 7y showed -0.95% in men and -1.2% in women.

Previous studies showed the percent reduction in serum albumin level for 5y was -1.9% among men and -1.5% among women²³). Findings in this study suggest that albumin level gradually declines with aging and the rate of decrease in albumin level of men was less than women. The percent reduction of albumin level with age and sex requires more study in the future.

The strength of the present study was that it was a large cohort study. Previous study analyzed data from community-dwelling elderly, but the total number of subjects was small²¹⁻²³). This study, however, was conducted using a large number of typical community dwellers who participated in a health examination at least one time in seven years, which was the half of the older population living in the city.

The subjects in this study were self-supporting elderly people living in community. Elderly people in an institution or hospital have a managed living environment, and their nutrition is especially managed through the provided meal services. On the other hand, community-dwelling elderly live independently and differ in nutrition status by lifestyle. Differences in nutrition status are common among community-dwelling elderly, so subjects in this study were the elderly in general.

Two limitations of the study are as follows. First, the relationship between albumin concentration, nutrition status, and physical activity was not analyzed in this study, because lifestyle among community dwelling elderly differs by individual.

Second, data in this study was compiled from Japanese elderly living in Habikino city, which is a suburb of Osaka. Data for a future study could be compiled from different areas, such as a city or rural area. Lifestyle, especially nutrition status or eating habits, can be differentiated by generation, culture, and ethnicity.

In conclusion, this study demonstrates that decreasing albumin level was significantly associated with aging among community dwelling older aged 65 and over. Thus, observing albumin level with aging becomes an important method would for promoting health among elderly people.

Acknowledgements

This study was supported by Habikino-city. We are grateful to Mrs.Tsujinishi.

References

- 1) Chen, CC-H: A concept analysis of malnutrition in the elderly. *J Adv Nurs*, 36: 131-142, 2001.
- 2) Greenblatt DJ: Reduced albumin concentration in the elderly: a report from the Boston collaborative Drug surveillance program. *J Am Geriatr Soc*, 27: 20-22, 1979.
- 3) Covinsky KE, Covinsky MH, Palmer RM, Sehgal AR: Albumin concentration and clinical assessments of nutritional status in hospitalized older people: Different sides of different coins? *J Am Geriatr Soc*, 50: 631-637, 2002.
- 4) Sahyoun NR, Jacques PF, Dallal G, Russell RM: Use of albumin as a predictor of mortality in community-dwelling and institutionalized elderly populations. *J Clin Epidemiol*, 49: 981-988, 1996.
- 5) Margetts BM, Thompson RL, Elia M, Jackson AA: Prevalence of risk of undernutrition is associated with poor health status in older people in the UK. *Eur J Clin Nutr*, 57: 69-74, 2003.
- 6) Reuben DB, Moore AA, Domesyn M, Keeker E, Harrison GG, Greendale GA: Correlates of hypoalbuminemia in community-dwelling older persons. *Am J Clin Nutr*, 66: 38-45, 1997.
- 7) Okamura T, Hayakawa T, Hozawa A, Kadowaki T, Murakami Y, Kita Y, et al: Lower levels of albumin and total cholesterol associated with decline in activities of daily living and excess mortality in a 12-year cohort study of elderly Japanese. *J Am Geriatr Soc*, 56: 529-535, 2008.
- 8) Fried LP, Kronmal RA, Newman AB, Bild DE, Mittelman MB, Polak JF et al: Risk factors for 5-year mortality in older adults. *JAMA*, 279: 585-592, 1998.
- 9) Klonoff-Cohen H, Barrett-Connor EL, Edelstein S: Albumin levels as a predictor of mortality in the healthy elderly. *J Clin Epidemiol*, 45: 207-212, 1992.
- 10) Hasuo Y, Ueda K, Fujii I, Yanai T et al: Changes in blood chemical constituents and death in the aged population. The Hisayama study[Jpn]. *Jpn J Geriatr*, 23: 65-72, 1986.
- 11) Nagai H, Shichita K, Haga H, Suyama Y et al: Relationship of albumin concentration to aging and survivorship in the community volunteers aged 70[Jpn]. *Jpn J Geriatr*, 21: 588-592, 1984.
- 12) Goldwasser P, Feldman J: Association of albumin and mortality risk. *J Clin Epidemiol*, 50: 693-703, 1997.
- 13) Corti, Maria-Chiara, Guralnik JM, Salive ME, Sorkin JD: Albumin level and physical disability as predictors of mortality in older persons. *JAMA*, 272: 1036-1042, 1994.
- 14) Corti, Maria-Chiara, Salive ME, Guralnik JM: Albumin and physical function as predictor of coronary heart disease mortality and incidence in older persons. *J Clin Epidemiol*, 49: 519-526, 1996.
- 15) Schalk BWM, Visser M, Bremmer MA, Penninx BWJH, Bouter LM, Deeg DJH: Change of albumin and risk of cardiovascular disease and all-cause mortality: Longitudinal aging study Amsterdam. *Am J Epidemiol*, 164: 969-977, 2006.
- 16) Schalk BWM, Visser M, Deeg DJH, Bouter LM: Lower levels of albumin and total cholesterol and future decline in functional performance in older persons: The Longitudinal aging study Amsterdam. *Age Ageing*, 33: 266-272, 2004.
- 17) Visser M, Krtchevsky SB, Newman AB, Goodpaster BH, Tyllavsky FA, Nevitt MC, Harris TB: Lower albumin concentration and change in muscle mass: the health, aging and body composition study. *Am J Clin Nutr*, 82: 531-537, 2005.
- 18) Baumgartner RN, Koehler KM, Romeo L, Garry PJ: Albumin is associated with skeletal muscle in elderly men and women. *Am J Clin Nutr*, 64: 552-558, 1996.
- 19) Schalk, BWM, Deeg DJH, Penninx BWJH, Bouter LM, Visser M: Albumin and muscle strength: A longitudinal study in older men and women. *J Am Geriatr Soc*, 53: 1331-1338, 2005.
- 20) Cooper JK, Gardner C: Effect of Aging on albumin. *J Am Geriatr Soc*, 37: 1039-1042, 1989.
- 21) Champion EW, DeLabry LO, Glynn RJ: The effect of Age on Albumin in Healthy males: Report from the normative Aging study. *J Gerontol*, 43: M18-20, 1988.
- 22) Salive ME, Cornoni-Huntley J, Phillips CL, Guralnik JM, Cohen HJ, Ostfeld AM, Wallace RB: Albumin in older persons: relationship with age and health status. *J Clin Epidemiol*, 45: 213-221, 1992.
- 23) Gomi I, Fukushima H, Shiraki M, Miwa Y, Ando T, Takai K, Morikawa H: Relationship between albumin level and aging in community-dwelling self-supported elderly population. *J Nutr Sci Vitaminol*, 53: 37-42, 2007.
- 24) Shibata H, Haga H, Ueno M, Nagai H, Yasumura S, Koyano W: Longitudinal changes of albumin in elderly people living in the community. *Age Ageing*, 20: 417-420, 1991.