

The effect of ADL quality on sense of deliciousness and sense of taste in nursing homes in Sri Lanka

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Key Words : Sense of deliciousness, Sense of taste, Activities Daily Living (ADL), General Condition, Multiple Logistic Regression Analysis

Introduction

The Change of disease structure accompanying aging (CDS-AA) in Japan has resulted in the adoption of health, medical and welfare measures such as the Health Promotion Law (2002) along with Healthy Japan 21 Campaign: A New Health Policy for Japan in the 21st Century, as well as the Long-Term Care Insurance System (2000). Furthermore, Health and Medical Service Law for the Elderly will be drastically reformed in the near future. However, according to the WHO's recent report^{Web01)}, the CDS-AA is becoming an urgent problems not only in advanced countries but also in developing countries other than sub-Saharan African countries which suffer socioeconomic and medical difficulties due to epidemics of serious infectious diseases such as HIV/AIDS and malaria. From an international standpoint, there is

a necessity to decrease the burdens caused by CDS-AA.

The campaign to prolong healthy life expectancy proposed by WHO¹⁾ in 2000 is the ultimate purpose of measures to deal with CDS-AA in both developed countries and developing countries. In order to achieve the goals of this campaign, to maintain masticatory & swallowing functions and sense of taste (sense-T) are indispensable elements for the elderly. The function of sense-T as a sensor is linked to sense of deliciousness (sense-D), and it not only contributes to QOL but also various crucial functions in the elderly. Namely, the function of sense-T contributes to the recovery of Activities of Daily Living (ADL), to ensuring food by means of distinguishing decayed food or foreign objects, and to allow perception and avoidance of excessively salty foods which are likely to contribute hypertension²⁾ and stroke³⁾. In other words, sense-T has a very important physiological function as the gatekeeper⁴⁾ of food consumption.

However, there have been few comprehensive studies which have evaluated links between general conditions such as ADL and dental conditions such as present teeth, wearing of denture, and

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sense-T even though decline in sense-T is serious problem for the elderly. One of the reasons for the lack of such studies is the difficulty of synergetic and synthetic research, because this issue is linked to the fields of medicine, dentistry and nutrition. In addition, there may be relatively large differences of sense-D and sense-T caused by diversities in daily habits such as smoking, alcohol drinking, daily food habits, and general health conditions among different countries, regions, or religious groups. To elucidate this question quantitatively is a challenge that must be undertaken in order to develop measures to combat global aging problems and offer technical assistance in the areas of health, medicine, and welfare to other countries.

The aim of this study is to analyze the relationships between ADL and sense-D and sense-T of the elderly at nursing homes in Sri Lanka⁵⁾ while adjusting for background factors such as general and dental conditions.

Methods

1) Background

Sri Lanka is a developing, multiracial country, located in the Indian Ocean near the equator, with a population of approximately 20 million. It has a social democratic parliamentary system of government under which over 80% of hospitals belong to government and medical services are free of charge. Literacy rate^{Web02)} of Sri Lanka (90.4%, ranking 78th in the world) is on par with Republic of China (90.9%) and Mexico (90.3%) and far higher than the neighbouring countries in South Asia such as India (61.0%, ranked 145th), Pakistan(54.2%, ranked 153rd), and Bangladesh (41.1%, ranked 165th).

2) Participants

The participants of this study are 188 elderly people 65+ years old (91 males, 97 females) living in six nursing homes administrated by non-govern-

ment organization (NGO) located in Colombo (population 2.4 million), Kalutara district (1.1 million) in Western Province and Galle district (1.0 million) in Southern Province. These facilities are funded by a combination of governmental subsidy, private donations and pensions. The population of these three districts accounts for about 25 % of country's total population, and capital cities of these districts are the most urbanized areas^{Web03)} in Sri Lanka.

Generally, unlike at their individual homes, similar meals are served to all residents of a nursing home. Therefore, there is less variation in the types of foods, method of preparation, and freshness of food than there would be at individual homes. This was a major reason why these facilities were selected for this study. This restriction of participants is an epidemiological method to control confounding factors. However, because meals are likely to be at the 6 facilities, independent categories for each facility were entered as a variable in the Multiple Logistic Regression Analysis (MLRA) discussed below, in order to look for differences in tendencies at the facilities. This survey was conducted anonymously after obtaining the permission of the administrators and the residents in the nursing homes. Formal ethical approval was not required because this survey consisted of only questionnaire and non-invasive observations such as count of number of teeth or measurements such as weight and height.

3) Dependent variables and independent variables including target variables

Dependent variables Xa and Xb in Table 1 are target indices which are objective variables in the MLRA. Xa is the subjective sense-D (whether the food tastes delicious or not). Xb is subjective sense-T (whether the taste declines or charges). These indices were consolidated into two categories because with three categories, the peripheral fre-

quencies of category “2” were only 1 to 6.

LTCN3 and LTCN2 in Table 1 are target indices which quantify ADL. LTCN6 is abbreviation of “Long-Term Care Need”, which is provisional of six levels of criteria^{Web04} drawn up in 1997 by the Ministry of Health, and Welfare in Japan. The original six levels of LTCN6 were consolidated into three categories as LTCN3 (categorized as 0 : 0, 1 : 1-2, 2 : 2-5) and two categories as LTCN2 (categorized as 0 : 0, 1 : 1-5) respectively. Table 2 shows the classification system as translated from Japanese into English by the authors. These criteria were used in nursing homes in Sri Lanka after being translated into the Sinhalese and Tamil language.

4) Analyses

(1) Basic Statistics of important indices

The distributions of frequency of age and gender, as well as and the correlation coefficients between gender and number of present teeth, and between sense-D and sense-T were calculated.

(2) Trend analyses on simple factors by Cochran-Armitage Trend Test (CAT-test).⁶⁾

Linear trends between LTCN2 and sense-D and sense-T were analyzed by CAT-test.

(3) Trend analyses on multiple factors (MLRA)

The indices used in the analyses shown in Table 1 are composed of six classifications and 21 indices. The classifications are: i) gender, ii) age, iii) present teeth & prosthesis, iv) basic diseases, v) physical conditions, and vi) daily life habits. Tumor, stroke and liver diseases were eliminated from basic diseases because the positive rates were under 5 %. All variables except “age” and “total amount of diseases” are categorical variables.

Backward-MLRA^{7, Web05}, a type of MLRAs using -2 Log Likelihood (-2LL) as a criteria for eliminating insignificant variables one after another up to the optimum goodness-of-fit model were performed. A probability of 0.20 was adopted as the

cut-off point for selecting variables in backward-MRLA using -2LL. The backward procedure was repeated until the difference of before and after nest-mode χ^2 test value reached the probability of the cut-off point. Consequently, a final model with maximum goodness-of-fit was confirmed.

The contract of all categorical items except nursing homes was “simple” and the first categories were used as reference categories. The contract of nursing homes item is “indicator”, and all other unrelated categories were used as reference categories.

In addition, a Kendall's τ correlation coefficient matrix was obtained in order to easily interpret the links between target LTCN2 (or LTCN3) and confounding factors.

Results

1) Basic Statistics of important indices

The Kendall's τ correlation coefficient between sense-D and sense-T was 0.31 ($p < 0.01$), which is equivalent to a 9.6% contribution rate. Figure 1 shows the distribution of participants' ages. Frequencies of age groups by five years shows unimodal distribution, and the mean (SD) ages of males and females were 75.0 years (6.4) and 76.6 years (6.6) respectively. Although the mean age of females was slightly higher, the difference is statistically insignificant according to the Student's t-

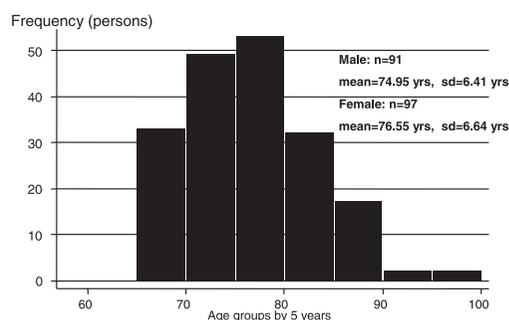


Fig.1 Age Distribution

test. The overall mean age of participants was 75.8 years, 56% were “late elderly”, defined as 75+ years old in Japan. The oldest participants of both genders were 96 years old.

Figure 2 shows the distribution of the level of LTCN6 using the criteria shown in Table 2. The distribution shown in Figure 2 is also unimodal, like the age distribution (Figure 1). Level 1 and Level 2 are approximately 26% each, for a total of around 50%. Level 0 and 5 are 22.3%, 2.7% respectively.

Figure 3 shows the distribution of number of present teeth (PT) in the participants. 40.4% of participants had 0 PT, making this the mode of the PT distribution. Frequencies of participants with PT greater than 0 decreases steadily from 1 PT all the way up to 32 PT. 78.2% of participants had

fewer than 10 PT, and only 6.4% had more than 20 PT. The mean number (SD) of PT was 4.77 (6.76) for males and 5.66 (7.53) for females, and there was no statistically significant difference between genders. The Pearson’s correlation coefficient between age and LTCN6 is small ($r=0.1673$) but significant ($p<0.05$).

Table 3 shows the distribution of sense-D and Sense-T of elderly in nursing homes by LTCN6 and gender.

2) The trend analyses on simple factors

Table 4 shows the trends between LTCN2 and sense-D, Sense-T by CAT-Test[®]. X_T : linear trends of both sense-D and Sense-T are significant ($p<0.05$) and X_Q : Quadratic trends of both senses are insignificant. Therefore, a linear uptrend was confirmed between LTCN2 and sense-D, sense-T as far as the simple factor analyses are concerned, without considering confounding factors mentioned below.

3) The trend analyses on multiple factors

Table 5 shows the results of MLRA using sense-D as the objective variable and the 21 independent variables shown in Table 1 including the target index LTCN3. The final goodness-of-fit model was arrived at through 17 steps of variable reduction using -2LL. The reliabilities of the MLRA model with statistical indices are Nagelkerke $R^2=0.1657$, Omnibus test=0.0157, Hosmer & Lemeshow test $p=0.5940$, and the results fulfill the statistical reliabilities⁷⁾ of the model. The following five variables were selected by MLRA : LTCN, gender, heart disease, hypertension and temporomandibular joints (TMJ) pain. Three of these variables were significant at $p<0.05$: the second category of LTCN3, gender, and hypertension.

Regarding the relationship between LTCN3 and sense-D (Table 5), the second category of

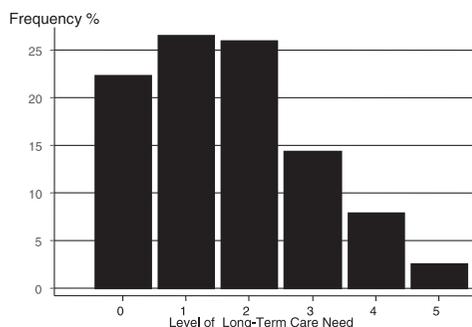


Fig.2 Distribution of Level of Long-Term Care Need (LTCN) - ADL measured by Level of LTCN -

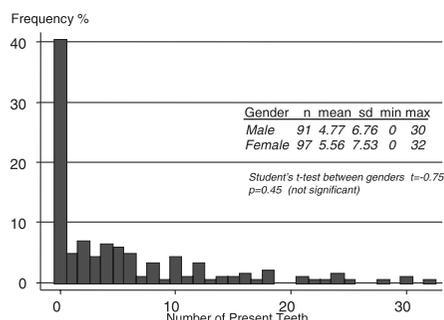


Fig.3 Distribution of the Number of Present Teeth

Table.1 Dependent and Independent Variables for Multiple Logistic Regression Analysis (MLRA)

<u>I. Dependent variables</u>		
Ya) sense deliciousness	0:can enjoy delicious foods	1:cannot enjoy
Yb) sense of taste	0:no problem	1:cannot taste
<u>II. Independent variables</u>		
<u>i) target variables</u>		
Xa. Level of LTCN3 (Long-Term Care Need)	0:0	1:1-2 2:3-5 of LTCN
Xb. Level of LTCN2 (Long-Term Care Need)	0:0	1:1-5 of LTCN
<u>ii) individual physical conditions and daily health habits and customs</u>		
1. Gender	1:male 2:female	
2. Age	65 - 96 years old	
3. Nursing homes	1-6	
4. Heart diseases	0:no 1:yes	
5. Hypertension	0:no 1:yes	
6. Respiratory diseases	0:no 1:yes	
7. Otological diseases	0:no 1:yes	
8. Cataract or Glaucoma	0:no 1:yes	
9. Defective hearing	0:no 1:yes	
10. Neuralgia	0:no 1:yes	
11. Diabetes	0:no 1:yes	
12. Total number of diseases (No. 4-11)	0-8	
13. Number of present teeth	1:0-9 remaining teeth, 2:10-19, 3:20-32	
14. Dentures	0:don't have or don't currently use 1:currently use	
15. Temporomandibular joint pain	0:no 1:yes	
16. Tooth brushing	0:never 1:1 time/day 2:>=2 times/day	
17. Smoking	0:never smoked 1:ex-smoker 2:current smoker	
18. Alcohol drinking	0:never drank 1:ex-drinker (2:current drinker)	
19. Sleeping	0:sound sleeper 1:sometimes cannot sleep soundly 2:seldom sleeps soundly	
20. Bowel movement (BM)	0:no problem 1:often has diarrhea 2:often constipated	

Note: The contrast of all categorical items except nursing homes are "simple" and reference categories are the first categories. The contrast of nursing homes is "indicator" and reference categories are all other unrelated categories.

LTCN3 was much more significant ($p=0.0048$ by MLRA) than the first category. The odds ratio of LTCN3 for category 0 versus category 1 is 5.0 (95%CL: 1.6- 15.3) and for category 0 versus 2 is 3.4 (95%CL: 0.9-12.4). The odds ratio of hypertension for negative versus positive is 3.6 (1.6-8.4). Males showed lower sense-D than females. Hypertension and sense-D by levels of LTCN3 is illustrated in Figure 4. This figure reveals a tendency for hypertension to contribute to a decline of sense-D at each level of LTCN3. The Kendall's τ correlation coefficient between hypertension and LTCN3 is -0.1948 ($p<0.01$).

Table 6 shows the results of MLRA using sense-T as the objective variable and the 21 independent variables in Table 1 including the target

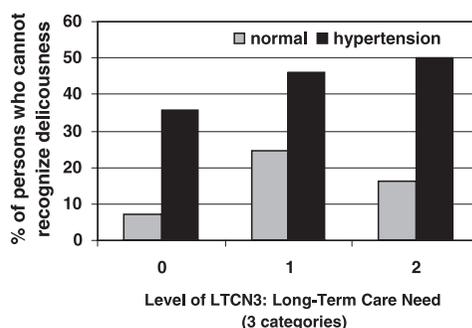


Fig.4 The Effect of Level of LTCN and Hypertension on Sense of Deliciousness

- LTCN3: Levels of LTCN consolidated from 6 categories into 3 categories as 0:0, 1:1-2, and 2:3-5
- The classification of LTCN was developed by Japan's Ministry of Health, Labour and Welfare (MHLW) and provisionally used to improve the certification system for elderly people with LTCN.
- Both LTCN3 and hypertension were confirmed as statistically significant factors affecting sense of taste by backward-MLRA.

Table.2 Criteria for Certification of Long-Term Care Need (LTCN)for the Elderly by MHLW, Japan (1998)

Classification	Description of condition and required care
Simple support for improving ADL (Activities of Daily Living) required Classification 0	The basic abilities of ADL are sustained. However, some instability is observed when he/she stands on one or both feet for a long time. Nursing care is required several times a week, although not every day, for cleaning belongings, cleaning himself/herself, bathing, putting on or taking off clothes, etc.
Nursing care required Classification 1	Some decline in activity is observed when taking a bath. Instability is sometimes observed when he/she stands up or stands on one or both feet for a long time or walks. Nursing care is required at least once a day for cleaning belongings, cleaning himself/herself, putting on or taking off clothes, cleaning his/her living room, taking medicine, supervising his/her money, etc.
Nursing care required Classification 2	Direct nursing care is required for bathing, or indirect nursing care is required for cleaning up after excretions, more than for a Classification 1 person. Instability is observed when maintaining a sitting position, and the action of getting up by himself/herself is quite difficult. Assistance is often required when taking medicine or controlling money for social life. Nursing care is required at least once a day, in two or more activities (or actions) below: -cleaning belongings, cleaning himself/herself, eating, putting on or taking off clothes, excretions, bathing, etc.
Nursing care required Classification 3	There is an increase (more than for Classification 2) in situations which require partial or total direct nursing care for bathing, excretions, putting on or taking off clothes, cleaning belongings, or cleaning himself/herself. Instability is observed when sitting, and the action of getting up by himself/herself or turning from side to side in bed are impossible. Assistance is required, more often than for Classification 2, when taking medicine or controlling money for social life. Some problems may be observed, such as violence, violent language, resistance to nursing care, or night and day reversal. Nursing care is required at least twice a day, in three or more activities (or actions) below: -cleaning belongings, cleaning himself/herself, eating, putting on or taking off clothes, excretions, bathing, etc.
Nursing care required Classification 4	Partial or total direct nursing care is required for all daily activities, such as bathing, excretions, putting on or taking off clothes, eating, cleaning belongings, and cleaning himself/herself. This classification is sometimes applied to persons in a vegetative state who cannot use any type of communication. It is difficult or impossible to sit up or stand up, more than for Classification 3. Nursing care is required at least 3-4 times a day, in two or more activities (or actions) below: -cleaning belongings, cleaning himself/herself, eating, putting on or taking off clothes, excretions, bathing, turning from side to side in bed, sitting up, standing up, etc.
Nursing care required Classification 5	Partial or total direct nursing care is required for all daily activities. In the case of swallowing disability, independent intake of foods becomes difficult, and specific nursing care associated with that will become necessary. Almost all persons in this classification cannot turn from side to side in bed or maintain a sitting position. Nursing care is required at least 5 times a day, in two or more activities (or actions) below: -cleaning belongings, cleaning himself/herself, eating, putting on or taking off clothes, excretions, bathing, turning from side to side in bed, sitting up, standing up, maintaining a standing position, walking, etc.

Table.3 Distribution of sense of deliciousness and sense of taste by LTCN and Gender

Levels of LTCN ^{a)}	sum	Sense of Deliciousness ^{b)}			Sense of Taste ^{c)}			
		0	1	2	0	1	2	
Male	0	27	23	4	0	23	4	0
	1	21	15	4	2	16	4	1
	2	21	13	7	1	11	8	2
	3	13	9	3	1	10	3	0
	4	6	3	2	1	5	1	0
	5	3	3	0	0	2	1	0
sum	91	66	20	5	67	21	3	
Female	0	15	14	1	0	12	2	1
	1	29	22	6	1	16	11	2
	2	28	19	9	0	12	14	2
	3	14	13	1	0	9	4	1
	4	9	8	1	0	9	0	0
	5	2	2	0	0	2	0	0
sum	97	78	18	1	60	31	6	

a) LTCN: Long-Term Care Need (Table 2)

b) Sense of deliciousness: 0: can enjoy delicious food 1: cannot recognize the deliciousness of food so much 2: cannot feel the deliciousness of foods completely

c) Sense of taste: 0: no problem 1: cannot taste well 2: can hardly taste at all

Table.4 Trend Analyses on Sense of Deliciousness and Sense of Taste with level of LTCN¹⁾

		<u>Sense of deliciousness</u>			<u>Sense of taste</u>		
		0	1	2	0	1	2
LTCN ¹⁾	1-5	107	33	6	92	46	8
	0	37	5	0	35	6	1
LTCN(+)		0.74	0.87	1.00	0.72	0.88	0.89
<u>Cochran-Armitage</u>		χ^2 : linear			$p^{2)}$ = 0.0338		
<u>Trend Test</u>		χ^2 : quadratic			0.0198		
					0.3977		

1) LTCN: Long-Term Care Need (Table 2)

2) p: Asymptotic p-value with two-tailed test

Table.5 The relationship between physical condition & lifestyle and sense of deliciousness

Variable	B: Coefficient	S.E.	Wald	df	Sig.	odds ratio	
						Exp (B)	95.0% C.I. for EXP(B) Lower Upper
<u>Xa. LTCN3</u>			8.0882	2	0.0175		
<u>LTCN3(1)</u>	1.6104	0.5711	7.9519	1	0.0048	5.0047	1.6341 15.3277
<u>LTCN3(2)</u>	1.2179	0.6651	3.3527	1	0.0671	3.3799	0.9178 12.4468
1. Gender (1)	-0.7629	0.3788	4.0552	1	0.0440	0.4663	0.2219 0.9798
4. Heart (1)	-1.1244	0.8326	1.8235	1	0.1769	0.3249	0.0635 1.6613
5. Hypertension(1)	1.2889	0.4254	9.1792	1	0.0024	3.6287	1.5763 8.3533
15. TMJ pain	0.8452	0.6794	1.5477	1	0.2135	2.3285	0.6148 8.8181
Constant	-2.0281	0.5283	4.7396	1	0.0001	0.1316	

1. LTCN3: Long-Term Care Need consolidated from 6 categories (LTCN defined by Ministry of Health, Labour & Welfare, Japan, 1998)) into 3 categories.

2. TMJ pain: Temporomandibular joint pain

3. Method of Analysis:

i) Multiple Logistic Regression Analysis (MLRA)

ii) Backward method with -2 log likelihood

iii) All reference categories of each categorical variable in Table 5 are the first category.

iv) Fin p=0.20 Fout p=0.21

v) Final step of backward MLRA is 17

vi) Dependent variables: Table 1

vii) Independent variables: Table 1

4. Reliability of the MLRA model

Nagelkerke R²=0.1657, Omnibus test=0.0157, Hosmer & Lemeshow test p=0.5940

index LTCN3. The final goodness-of-fit model was arrived at through 17 steps of variable reduction using -2LL. The reliabilities of the MLRA model with statistical indices are Nagelkerke R²=0.1883, Omnibus test=0.0001, Hosmer & Lemeshow test p=0.3442, and the results fulfill the statistical reliabilities of the model. The following five variables

were selected by MLRA : LTCN3, heart disease, hypertension, alcohol drinking, and bowel movement (BM). Two of these variables are significant : the second category of LTCN3 (p=0.0042) and third category of BM (constipation, p=0.0343).

Regarding the relationship between LTCN3 and sense-T (Table 6), the second category of LTCN3

was much more significant than the first category. The odds ratio of LTCN3 for category 0 versus category 1 is 4.0 (1.5- 10.3) and for category 0 versus 2 is 1.4 (0.5- 4.5). The Kendall's τ correlation coefficient between hypertension and LTCN3 is 0.1472 ($p < 0.05$). Odds ratio of constipation for negative versus positive is 2.1 (1.1- 4.3). Constipation and sense-T by levels of LTCN3 is illustrated in Figure 5. This figure reveals a tendency for constipation to contribute to a decline of sense-T at each level of LTCN3.

In the MLRA variable selection process, when assessing the effect of different nursing homes on sense-D and sense-T, sense-T was remained up to 8th step, but sense-D was remained up to 16th step.

Of the four dental related indices (PT, denture, Tooth brushing habit, and TMJ-pain), only TMJ-pain remained in the final model. PT (3 categories)

remained up to 14th step in the case of sense-D, but up to 6th step in the case of sense-T. Defective hearing remained up to 8th step in the case of sense-D but 16th step in the case of sense-T.

As shown in these results, a relationship between LTCN and sense-D and sense-T was confirmed by MLRA with adjustment for confounding factors such as general conditions, dental conditions, and health related habits. To facilitate interpretation of these factors, a Kendall's τ matrix and an illustration are shown in Table 7 and Figure 6, respectively. The significant simple correlations which are important for interpreting these MLRAs are as follows: sense-D vs. sense T=0.31 ($p < 0.01$), LTCN2 vs. sense-T=0.18 ($p < 0.01$), age vs. LTCN3 or LTCN2=0.13, 0.16 ($p < 0.05, 0.01$), hypertension vs. sense-D=0.20 ($p < 0.01$), and BM vs. LTCN3=0.18 ($p < 0.05$).

Table.6 The relationship between physical condition & lifestyle and sense of taste

Variable	B: Coefficient	S.E.	Wald	df	Sig.	odds ratio		
						Exp (B)	95.0% Lower	C.I. for EXP(B) Upper
Xa. LTCN3			11.7572	2	0.0028			
LTCN3(1)	1.3826	0.4824	8.2129	1	0.0042	3.9852	1.5481	10.2592
LTCN3(2)	0.3599	0.5861	0.3771	1	0.5391	1.4332	0.4544	4.5202
4. Heart (1)	-0.8967	0.7133	1.5803	1	0.2087	0.4079	0.1008	1.6510
5. Hypertension(1)	0.6556	0.3987	2.7045	1	0.1001	1.9263	0.8818	4.2079
18. Drinking(1)	-0.6873	0.3932	3.0546	1	0.0805	0.5030	0.2327	1.0870
20. BM			5.4900	2	0.0642			
BM(1)	-0.1885	0.6603	0.0815	1	0.7753	0.8282	0.2270	3.0214
BM(2)	0.7598	0.3589	4.4814	1	0.0343	2.1378	1.0580	4.3198
Constant	-1.5862	0.4335	13.3894	1	0.0003	0.2047		

1. LTCN3: Long-Term Care Need consolidated from 6 categories (LTCN defined by Ministry of Health, Labour & Welfare, Japan, 1998) into 3 categories.

2. Method of Analysis:

i) Multiple Logistic Regression Analysis (MLRA)

ii) Backward method with -2 log likelihood

iii) All reference categories of each categorical variable in Table 5 are the first category.

iv) Fin $p=0.20$ Fout $p=0.21$

v) Final step of backward MLRA is 17

vi) Dependent variables: Table 1

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3. Reliability of the MLRA model

Nagelkerke $R^2=0.1883$, Omnibus test= 0.0001 , Hosmer & Lemeshow test $p=0.3443$

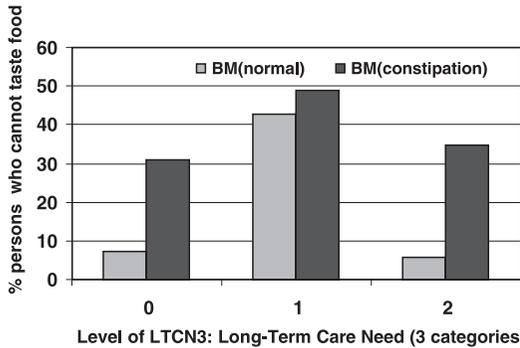


Fig.5 The Effect of Level of LTCN and Constipation on Sense of Taste

- LTCN3: Levels of LTCN consolidated from 6 categories into 3 categories as 0:0, 1:1-2, and 2:3-5
- Item BM(bowel movement) is composed of three categories: 0:normal, 1:often diarrhea, and 2:often constipation.
- Category 1(often diarrhea) was omitted in Figure 5 due to the small number of subjects.
- Both LTCN3 and BM(constipation) were confirmed as statistically significant factors affecting sense of taste by backward-MLRA.

Discussion

1) Special characteristics of the sample and variables

It is not clear whether participants and private nursing homes in this study are representative samples or not. The average household incomes of target areas^{Web(03)} of this study are 1st, 3rd and 4th out of 25 districts in the country. Therefore, the participants and facilities of this sample belong to relatively wealthy social circumstances compared to the general population.

Regarding distributions of frequency of basic variables, both genders and early elderly and late elderly groups are unbiased. Therefore, this sample seems to be appropriate to evaluate most of the variables. However, distribution of PT is biased because 80% of the participants have fewer than 10 PT, which is not adequate for evaluating

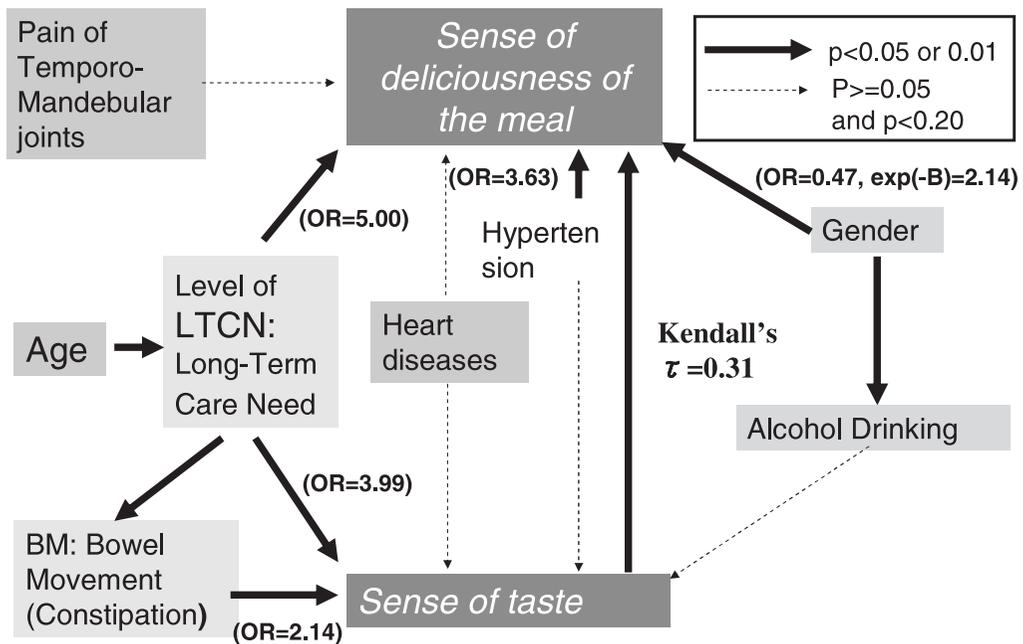


Fig.6 Correlation between dependent or independent factors on the sense of taste and sense of deliciousness of the meal

Table.7 Correlation Coefficients (*Kendall's* τ) between dependent variables and factors (independent variables)

	Ya.Sense of deliciousness	Yb.Sense of taste	Xa.LTCN3	1. Gender	2.Age(65-)	4.Heart disease	5.Hypertension	15. Pain of TMJs	18.Alcohol drinking	20.BM
a)Sense of deliciousness	1	0.31**	0.05	-0.09	0.03	-0.07	0.20**	0.09	0.11	0.10
b)Sense of taste		1	0.02	0.13	0.02	-0.08	0.13	-0.05	-0.12	0.18*
Xa) LTCN3			1	0.11	0.13*	0.07	-0.19	0.01	-0.04	0.15*
1. Gender				1	0.09	-0.03	0.03	0.03	-0.62**	-0.12
2. Age (65-)					1	-0.06	0.05	-0.06	-0.04	0.04
4. Heart diseases						1	0.07	-0.07	-0.02	-0.06
5.Hypertension							1	0.02	-0.02	0.03
15.Pain of TMJs								1	0.06	-0.12
18. Alcohol drinking									1	0.03
20.Bowel Movement (BM)										1

*:p<0.05 **:p<0.001 ***:p<0.001

LTCN3: Integrated LTCN: Long-Term Care Need into 3 categories as / 0/0/ 1:1 or 2/ 2:3 or 4 or 5/

TMJs: Temporo-Mandibular Joints

the number of PT on sense-D and sense-T.

New research in these areas using participants that are unbiased regarding PT will be necessary because Kanda's study⁹⁾ for example, shows that the threshold becomes higher as missing teeth increase in the case of female.

2) The link between sense-T and sense-D

The differences and similarities between sense-T and sense-D are as follows:

- Generally, sense-T is the physiological function to perceiving the five taste elements (sweetness, saltiness, sourness, bitterness and umami) with the taste buds located at the sides of the tongue and the other oral mucosa.^{Web06)}
- However, sense-T has been sometimes expressed using more words⁹⁾ (e.g. pungent, harsh, insipid, metallic).
- On the other hand, sense-D is comprehensive evaluation of deliciousness that takes into account various factors such as how food is prepared, freshness, presentation of food, texture when chewed, flavor, physiological or psychological condition⁹⁾.
- The difference between "umami", derived

from Japanese⁹⁾, and "flavor" has often been disputed because of its ambiguous definition. Actually, "umami" is translated into many English words as deliciousness, heartiness, savoriness, or fullness of the mouth^{Web06)}.

- Differences in the five taste elements, as well as thermal characteristics influence the sensory and motor aspects of swallowing^{Web07)}.

As described above, sense-D and sense-T are neither perfectly independent nor dependent. The fact that "nursing homes" remained up to 16th step, just one step before the final step of the MLRA for sense-D, indicates that differences in sense-D among facilities were greater than those of sense-T. The differences of sense-D seem to be caused by not only by the taste elements of sense-T, but also by the types of foods used, method of preparation, and storage methods. Therefore the definition of sense-D is ambiguous and more difficult to measure than sense-T. However, sense-D such as "flavor" as well as masticatory & swallowing function seems to be a very important index to evaluate and improve the daily eating (nursing care food¹⁰⁾) of nursing home residents.

3) Significant Background factors

According to a review on the elderly's sense-T by Narazaki et al.¹¹⁾, aging contributes to an increasing threshold of sense-T, however previous studies are not in agreement as to the causes of this threshold increase. One strong reason for this confusion seems to be diversity of physiological, pathological, psychological and environmental conditions of the elderly. However, this study focuses on elucidating only the relationship between ADL and sense-D, and sense-T. From this point of view, adjustment of confounding factors using MLRA might be the only one way to avoid confusion in the evaluation of the causes.

Concerning the process of the backward-MLRA, dental-related indices other than TMJ-pain should be re-examined using samples that are unbiased in terms of number of PT. Otological diseases such as damage to the middle ear are likely to contribute to disorder of sense-T because the anterior two-thirds of the tongue is controlled by chorda tympani nerve, branch of the facial nerve^{Web08)}. In this study, variable "defective hearing" remained up to 2nd step in sense-D, but 16th step just one before the final model. in sense-T. This result indicates that defective hearing is likely to contribute to a decline in sense-T as is the noted in previously published classification tables^{11, 12)} of leading causes of deficiency of sense-T.

Regarding hypertension, a report by the U.S. National Institutes of Health on the prevention, detection, evaluation, and treatment of Hypertension^{13, Web09)} recommends a habitual daily brisk walk for preventing hypertension. Since elderly people with low levels of ADL are likely get less exercise, high blood pressure is inevitable unless effective daily rehabilitation programs are introduced. However, there is a mild negative correlation between LTCN3 and hypertension, and hypertension acts as a confounding factor in the

relation between LTCN and sense-D.

The relationship between salt intake and hypertension is an established theory, but according to Yakura⁹⁾, the level of sensitivity to salty taste in elderly people with hypertension is still uncertain because the results of studies have been highly variable. However, in this study a hypothesis which could explain rationally the phenomenon that hypertension causes a decline in sense-D could not be obtained, because sensitivity to salty was not separately evaluated.

Sakagami¹²⁾ classified the causes of taste disorders into four groups: (1) communicative disorders of taste substances, (2) disorders of taste bud cells, (3) disorders of taste nerve, and (4) central nerve system disorders. These disorders are related to aging, drugs, saliva secretion disorders, zinc deficiency, damage to middle ear, etc. According to the Aiba's report¹⁴⁾, taste disorders are classified into ten groups: zinc deficiency, Idiopathic, drug-induced, general diseases, oral diseases, disorders of taste nerves, simultaneous disorders of smell and taste, flavor disorders, psychogenic, and others. According to the web-site of the University of Wisconsin Hospitals^{Web10)}, the causes are follows: aging (due to the number of taste buds decrease with age), Bell's palsy, oral or nasal infection, heavy smoking, mouth dryness (including Sjögren syndrome), side effects of medicines, vitamin B12 or zinc deficiency and others.

Of these causes, zinc deficiency is one of the most important common clinical causes. Lack of zinc prolongs the turnover time of taste bud cells, and this causes a decline in sense-T. However, there seem to be no previous studies which refer to links between BW (constipation) and sense-T.

According to Aiba¹⁴⁾, there are over a hundred drugs which cause taste disorders, and about 40% of cases involve low zinc levels in the blood. In particular, diuretics, antihypertensives, antibiotics,

drugs for diabetes, and other drugs which act as zinc chelating agents are likely to lower zinc levels in the blood. Basic diseases such as diabetes, hypothyroidism, or cerebral-vascular diseases cause chronic constipation¹⁵⁾, and long-term bed rest and lack of exercise cause lack of bowel movement, which also contributes to chronic constipation^{15,16)}. This seems to be the key to explaining these phenomena. Hence, there is possibility that special dosages of drugs to treat elderly people with constipation or the basic diseases mentioned above contribute to taste disorders because of the zinc-chelating characteristic of the drugs. On the other hand, the case-control study by S.M. Green, et al.¹⁷⁾ shows that the pressure ulcers of long-term bedridden elderly have been accompanied significantly by both malnutrition and taste disorders, and are likely to be healed by courteous nursing. This result implies that looking at related aspects such as nutrition and quality of nursing may be essential for the prevention of disorders of sense-D and sense-T.

On the other hand, some researchers and clinical doctors consider dry mouth to be the most significant factor of taste disorders. According to these opinions^{web11,12)}, "the most common cause of taste problems, especially in the elderly, is problems in the mouth - with teeth or saliva. Any condition which results in a dry mouth can cause problems because saliva is essential for taste. Chemicals in food or drink dissolve in saliva and this bathes the taste buds. In a dry mouth, the chemicals never reach the taste buds".

4) Links between ADL and sense-D and sense-T, adjusting for confounding factors

As seen in the results of the trend analyses (Table 4) by both CAT-test and MLRAs, it was confirmed that both sense-D and sense-T significantly increase linearly with the decline of ADL.

There seem to be no previous systematic studies which deal with ADL as an apparent direct cause of the decline of sense-D or Sense-T. At least, ADL is not referred as a genuine cause in the classification tables or reviews^{11,12,13, Web10)}.

Conclusion

According to the results of this study, the links between the decline of ADL of the elderly and the decline of sense-D and sense-T were statistically significant after adjusting for confounding factors using MLRA. In addition, a unique relationship between blood pressure and BM (constipation) and sense-D and sense-T was indicated. It should be confirmed whether these significant relationships also hold true in Japan and other countries. Problems to consider when new studies are planned include: objective tests (e.g. sense of taste, saliva secretion), drugs history, and large number of participants. In addition, since this issue involves the fields of medicine, dentistry and nutrition, it will be essential for experts in these three fields to cooperate with each other on this type of research. In the light of goals of sustaining QOL, preventive nursing cares for the elderly and preventive management of general conditions such as hypertension, strokes, and pressure ulcers, further studies on the links between deterioration of ADL and decline of sense-D and sense-T will be beneficial for rapidly aging societies.

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スリランカの要介護施設入所高齢者の全身状態、歯科状態を調整した日常生活動作能力と美味感覚と味覚との関係分析

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キーワード：食事の美味感覚、味覚、日常生活動作能力、全身状態、多重ロジスティック回帰分析

目的：味覚は食事の美味感覚に繋がって高齢者のQOLの維持のみならず塩分、糖分等過剰摂取を防ぐ等、健康寿命の延伸にも関係する必須の機能である。そこで本研究の目的は日常生活動作能力（ADL）と美味感覚および味覚の関連を交絡因子である全身状態等の背景要因を調整して解析することである。

対象および方法：スリランカ国の6つの民間高齢者介護施設の65歳以上の高齢者188名を対象に問診した。目的変数は美味感覚（食事の美味しさ）と味覚の2指標説明変数としてADL、全身の状態、歯科的状态および生活習慣等21指標を独立変数として変数減少法の多重ロジスティック回帰分析（MLRA）を行った。

結果および考察：高齢者のADL低下と美味感覚および味覚との関連がMLRAで交絡因子を調整しても有意であった。歯科関連指標に関しては顎関節痛と美味感覚の関連が示唆された。背景因子である血圧と美味感覚、便秘（便秘）と味覚とに関して報告例の無い特異な関係が有意であった。ADLと美味感覚とのオッズ比は5.0（95%CL: 1.6-15.3）、高血圧の有無と美味感覚は3.6（1.6-3.4）、ADLと味覚は4.0（1.5-10.3）、便秘の有無と味覚は2.1（1.1-4.3）であった。今後の調査において味覚異常を引き起こす可能性が高い幾つかの重要な要因、すなわち入所者の運動、便秘、薬剤服用歴（亜鉛キレート剤等）、また口腔乾燥を引き起こす唾液の分泌低下の有無等を押さえる必要がある。この種の研究が高齢者のQOLの維持と介護予防の観点から、要介護状態の悪化と美味感覚と味覚の減退の関連について各国における今後の研究が超高齢社会対応策に繋がると考察された。

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