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ORIGINAL ARTICLE

Association between functional dentition with inadequate calorie intake and underweight in elderly people living in "Pondok" in Kelantan

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Abstract This study was to investigate the association between functional dentition with inadequate calorie intake and underweight in elderly people living in "Pondok" in Kelantan. A cross-sectional study participated by 369 elderly people was carried out. A simple random sampling method was utilized for the selection of the subjects. Subjects were interviewed using a structured form to collect information about subjects' demographic background and self-reported health status. The 24-hour recall method was used to provide information on the subject's exact food intake during the previous 24 hours. Body mass index was calculated from subjects' weight and height, followed by oral assessment. The "Nutrical Software" was used for nutrient calculation, followed by SPSS version 11.5 for data analysis. The response rate was 95.6%. Majority of the respondents were female (92.4%). The percentage of subjects who had inadequate calorie intake and underweight was 71.0% and 25.7% respectively. The percentage of edentulism was 81.0%. The proportion of elderly with compromised functional dentition was 48.2% and majority was edentate elderly without wearing any complete dentures or wearing defective dentures, 23.6% and 56.2% respectively, while 20.2% was dentate elderly. The odds of having inadequate calorie intake and getting underweight among elderly with a compromised functional dentition was 3.7 times and 42.0 times respectively, compared to elderly with a non-compromised functional dentition. There was a significant association between inadequate calorie intake and underweight with functional dentition among elderly living in "Pondok" in Kelantan.

Introduction

The number of functional natural teeth, pairs of occluding teeth, tooth loss, denture status, dental caries and periodontal diseases are among the oral factors that are associated with nutrition intake (Wynne, 1999; Marshal *et al*., 2002; Mojon *et al*., 1999; Shimazaki *et al*., 2001). Decreasing numbers of occlusal units would increase the numbers of chewing strokes needed for swallowing and those with less than 4 occlusal units in symmetrically shortened tooth arches and less than 6 in asymmetrically shortened arches started complaining about their masticatory function (Kayser, 1981). Hence, the position of the remaining teeth seems to be more accurate indicator of chewing ability than merely the total number of teeth presents (Hildebrandt *et al*., 1997).

Loss of teeth resulted in impaired chewing ability (Idowu *et al*., 1986) and avoidance of foods that are difficult to chew such as fruits, vegetables (Brodeur *et al*., 1993; Hildebrandt *et al*., 1997; Chauncey *et al*., 1984) and protein-rich foods such as meat (Zulkowski and Albrecht, 2003) resulting in poor diet quality and poor nutritional status. Changes in eating habits and food selection appear to be reflected in the findings by few researchers in which edentulous individuals consumed more the softer foods such as processed foods and refined carbohydrates which tends to have high content of saturated fats and cholesterol than dentate individuals (Joshipura *et al*., 1996; Greksa *et al*., 1995; Hartsook, 1974).

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This study aims to identify associations between functional dentition with inadequate calorie intake and underweight in elderly population staying in Islamic Religious Community Setup, “Pondok” in Kelantan. “Pondok” refers to a group of houses built around a mosque, and many elderly people live there because they would like to spend their remaining years in a pious manner and to improve their religious knowledge (Abdul Manaf *et al*., 1999). In addition, all elderly people staying in “Pondok” are Malays.

The study was carried out because the relationship between nutritional status and oral health among elderly people has not been explored in Kelantan and previous research on association between dentition status and nutritional status has yielded mixed results. Therefore, this study is important to generate data for the elderly population living in “Pondok” in Kelantan. The one-day 24 hour recall method was used because it is certainly simpler, less demanding, more practical in survey work, and impose little burden to the illiterate respondents compared to the seven-day dietary record (Garn *et al*., 1976). Besides, it has been proved that this method was valid on a group basis with a sufficient sample size (Garn *et al*., 1976).

Materials and methods

This was a cross-sectional study which was conducted from June 2004 to January 2005. The reference and the source population were all the elderly people living in “Pondok” in Kelantan. The sampling frame was determined based on the following criteria: the inclusion criteria were all elderly aged 60 years old and above, while the exclusion criteria were those elderly with mental illness, infectious diseases, bed-ridden, deaf and mute, and those with scoliosis as these might affect the history taking, oral examination, the 24-hour recall nutrition intake and the anthropometric measurement.

The names of elderly people were obtained by moving from one “Pondok” to another and the assessment of their medical conditions were done by looking at physical conditions and was self-reported. Twenty-three “Pondok” in Kelantan were identified and 1,002 elderly people fulfilled the criteria. The names were arranged according to “Pondok” and were numbered from 1 to 1,002. A simple random sampling method was utilized for the selection of 386 elderly people, the calculated sample size, with a power of 80% (assuming α = 0.05 and 15% non-response rate) (PS Power and sample size calculation version 2.1.15, Vanderbilt University, Nashville, TN) (Dupont and Plummer, 1990). The sample size was based on the prevalence of inadequate calorie intake, 72.0% (Chee *et al*., 1997).

The data collection was conducted in the mosque or in the hall within the vicinity. One examiner was involved throughout the study to reduce inter-variability and no duplicate measurements were made for checking the reliability of measurements. The participants were given briefing about the aims and procedure of the study in detail. After getting the consent, the subjects were interviewed individually using a structured form to collect information about the subjects' demographic background which includes sex, household monthly income, duration of stay in “Pondok”, level of formal education, past employment status, marital status and self-reported health status. Self-reported health status is a subjective integration of individual health or it is a perceived health. It was assessed with the question: “How would you judge your present health in general?” using a two-point scale: healthy or unhealthy. If it is unhealthy, then the subjects need to state any chronic diseases they might have.

We utilized the 24-hour recall form to get information on the respondent’s exact food intake during the previous twenty-four-hour period. It was conducted in four stages, based on the format of the forms. First, a complete list of all foods and beverages consumed during the previous 24 hour were recorded. Second, detailed descriptions of all foods and beverages consumed were recorded (e.g. cooking method). Third, estimates of the amounts of all food and beverages consumed were obtained and finally, the recall was reviewed to ensure all items have been recorded correctly. The household measurements such as bowls, cups, plates, glass and spoons were used to estimate the amount of food consumed and the same household measurements were used for all subjects.

For the body weight measurement, the subjects must wear light garments and bare-footed and was measured using a calibrated portable weighing scale with precision of 0.5 kg (seca 707, Hamburg Germany). For the standing height, the subjects stood bare-footed on a flat horizontal floor with their heels together, against a microtoise fixed to the wall. Then, it was measured with a flat ruler placed on the person's head with the precision of 0.1 cm. Body mass index was then calculated by dividing an individual's weight in kilograms by the square of his or her stature in metres. The unit for BMI is kg/m^2.

Dental Charting form was used to record information on dentition status. Oral examination was done using standard portable dental chair, portable operating light, disposable mouth mirror and dental probe. Oral examination included the assessment of the number of natural teeth including retained roots, number of functional natural teeth, occluding pairs of functional natural teeth, decayed teeth (D), missing teeth (M), filled crown or root surfaces of the teeth (F) and teeth indicated for extraction (X) when caries has destroyed the tooth that it can not be restored or the tooth is so loose that it can not be restored to a functional state.

Functional natural teeth refer to all natural teeth, either sound or filled which are functioning very well, while occluding pairs of functional natural teeth refer to the pairs of maxillary and mandibular functional natural teeth that come into

contact when the subjects close their mouth in the centric occlusion. Coronal caries was recorded as present when there was a cavity, undermined enamel or a detectable softened floor or wall. Root caries was recorded as present when a lesion located on a root surface was felt to be soft with the probe. However, both coronal and root caries were considered under the term "decayed tooth" (DT). In general, oral examination was based on the diagnostic criteria recommended by the World Health Organisation (1997).

In denture wearers, prosthetic status was recorded as either being completely or partially edentulous, and as either wearing denture or not. Denture status was assessed by its stability, retentiveness (McCord and Grant, 2000; Soh *et al*., 1992; Vigild, 1987) and comfort. Dentures which have fulfilled all the criteria that are stable, retentive and did not cause any pain or discomfort on functioning were classified as satisfactory, otherwise unsatisfactory. Subjects were classified into two groups, having a compromised functional dentition or not. Those with at least one of the following criteria were classified as having a compromised functional dentition: dentate elderly with less than 20 functional natural teeth and not wearing any partial denture or with poor dentures (Marshal *et al*., 2002; Mojon *et al*., 1999; Wynne, 1999) or any subject regardless of the number of functional natural teeth present but with decayed teeth or retained roots more than three or with mobile teeth indicated for extraction (Mojon *et al*., 1999) or edentate elderly without full dentures or presenting with defective dentures (Marshal *et al*., 2002; Shimazaki *et al*., 2001; Mojon *et al*., 1999).

Food consumption data of each subject (from the 24-hour recall nutrition intake) was converted into daily calorie intake or energy (Kcal) using a computer programme (Nutrical Software version 1.01, Institute of Medical Research, Kuala Lumpur, Malaysia) (Tee *et al*.,1997). Then, the data of daily calorie intake or energy (Kcal) was transferred manually to SPSS version 11.5 statistical software for the calculation of dietary adequacy, based on the Recommended Nutrient Intakes (RNI) for Malaysia 2005 (NCCFN, 2005). The percentage dietary intake was computed for daily calorie (Kcal) intake and two-thirds of the RNI was used as the lower limit for considering sufficient energy intake based on Suriah *et al.* (1996). For the underweight, the value of body mass index of 18.5 kg/m^2 and below was considered (Abdul Manaf *et al*., 1996).

All statistical analyses were performed using SPSS version 11.5. Descriptive statistics such as means and standard deviation (SD) for continuous variables, and frequency and percentages for categorical variables were determined. Normality in distributions of continuous variables was also checked. To determine the association between functional dentition and socio-demographic factors with inadequate calorie (energy) intake and underweight, a simple logistic regression was used followed by multiple logistic regression analysis. The level of significance was set at 0.05. For the independent variables of a categorical in nature, dummy variables were created with a reference category which was set to 0 and for the interpretation of the resulting coefficients for two-category variables, such as sex, is straight forward because it tells the difference between the log odds of a case and a reference category, but for the variables that have more than two categories, the only statement that could be made was by comparing a particular category with the corresponding reference category.

In this analysis, there were two dependent variables (outcome): Inadequate daily calorie or energy (Kcal) intake (Yes or No), and underweight (Yes or No). They were assessed separately. For the outcome of inadequate daily calorie or energy (Kcal) intake, the independent variables were functional dentition and socio-demographic factors while for the outcome of underweight, daily calorie or energy (Kcal) intake was considered as an additional independent variable other than functional dentition and socio-demographic factors. The main independent variable was functional dentition, which was classified into a dichotomous variable: compromised and non-compromised functional dentition. For socio-economic independent variables: sex was categorized as male and female, age of subjects (in years) was categorised into four groups, 60-64, 65-69, 70-74 and 75 years old and above (Oral Health Division, 2004), the level of formal education was categorized as no formal education (0 year), primary and secondary, past employment status as self-employed or being-employed and marital status as married or widowed.

Initially household monthly income and duration of stay in "Pondok" were treated as continuous variables but were found later, they were not linear to the logit, hence were categorized into groups based on their beta coefficient values. Monthly income was categorized as RM 50 or less and more than RM 50 while duration of stay in "Pondok" (months) was categorized as less than 60 months and 60 months or more.

For the multiple logistic *regression analysis, to arrive at the final models, the backward stepwise logistic regression technique based on the likelihood-ratio and Wald chi-square statistics were employed. Backward elimination starts with all chosen variables in the model, then, at each step, variables were evaluated for entry and removal (variables were entered in the model when p-value < 0.05). The final model should contain all variables remaining under the p-value less than 0.05. Crude and adjusted odds ratios (adjusted for confounders) were obtained from simple and multiple logistic regression respectively. Confidence Interval (CI) at 95 % of the odds ratios (OR), likelihood-ratio (LR) chi-square and p-value of the association were obtained in order to make inferences to the study population.

In multiple logistic regression analysis, the two-way interactions between the factor of interest

and other significant independent variables were also checked by LR test. The model was tested for the fitness by using Hosmer-Lemeshow goodness-of-fit test. If the *p*-value approached one, the model was perfectly fit. The Receiver Operating Characteristic (ROC) curve for area under the curve and classification table for sensitivity, specificity and correctly classified were also obtained in order to evaluate the fitness of the model.

Results

The response rate was 95.6% with 369 out of 386 selected elderly people participated and the remaining 17 people were not available at the time of study. Majority of the respondents were female (92.4%) and only 7.6% were male. The mean age of male and female subjects was 77.1 years (SD 7.04) and 73.1 years (SD 7.20) respectively, while the mean age of all subjects was 73.4 years (SD 7.34). The subjects were categorized into four age-groups (Oral Health Division, 2000) and it was found that 12.5% was in the age group of 60-64 years, 20.1% was in the age-group of 65-69 years, 20.8% was in the age-group of 70-74 years, while 46.6% was in the age-group of 75 years and above. About 71.4% of the male subjects were in the oldest age-group (> 75 years old) while for the female subjects, it was 44.6%.

The mean household monthly income and mean duration of stay in "Pondok" was RM 137.4 (SD 67.12) and 81.9 months (SD 68.10) respectively. Regarding the level of formal education, 71.8 % were with no formal education, 28.2% were with primary level of formal education and none of them obtained secondary school or high education. Majority of the participants were previously self-employed (99.2%) and all of the female subjects were widows and living alone while majority of male subjects (96.4 %) were still married. Looking at self-reported health status, more male subjects (78.6%) claimed they were healthy as compared to female subjects (58.4%). Overall, there were about 60% of the subjects considered their general health to be good.

The proportion of elderly with a compromised functional dentition was 48.2% and majority was edentate elderly without wearing any complete dentures or wearing defective dentures, 23.6% and 56.2% respectively as shown in Table 1. Table 2 shows the proportion of inadequate calorie (energy) intake and the prevalence of underweight in elderly people by sex and age-groups. The correlation between calorie intake and body mass index (BMI) is shown in Figure 1. The results of simple logistic regression and multiple logistic regression analysis of the factors associated with inadequate calorie intake were summarized in Table 3 and Table 4 respectively. At multivariable level, functional dentition, duration of stay in "Pondok" and monthly income were significantly associated with inadequate calorie intake.

Table 5 and Table 6 summarize factors associated with underweight at univariable and multivariable level respectively. At multivariable level significant associations were noted between functional dentition, self-reported health status, age of the subjects and energy intake with underweight. For age-group, there was a significant association between older age-group cohorts (70-74 years old and 75 years old and above) with the outcome.

Table 1 Dentition status of elderly subjects by functional oral status

Dentition status	Compromised n (%)	Non-compromised n (%)	Total
Edentate:	142 (47.5) [a]	157 (52.5) [a]	299 (81.0) [e]
Good complete dentures	-	157 (82.2) [d]	157
No complete denture	42 (23.6) [c]	-	42
Defective complete dentures	100 (56.2) [c]	-	100
Dentate:	36 (51.4) [b]	34 (48.6) [b]	70 (19.0) [e]
≥ 20 functional teeth with decayed tooth or root ≤ 3	-	23 (12.0) [d]	23
≥ 20 teeth with decayed tooth or root > 3	4 (2.2) [c]	-	4
< 20 teeth but with good partial denture	-	11 (5.8) [d]	11
< 20 teeth and with poor partial denture	1 (0.6) [c]	-	1
< 20 teeth and without partial denture	31 (17.4) [c]	-	31
Total	178 (48.2) [e]	191 (51.8) [e]	369 (100.0)

[a] denominator is all edentate subjects, n= 299
[b] denominator is all dentate subjects, n= 70
[c] denominator is all subjects with compromised functional dentition, n=178
[d] denominator is all subjects with non-compromised functional dentition, n=191
[e] denominator is all study subjects, n= 369

Table 2 Proportion of inadequate calorie (energy) intake and underweight in subjects

Variables	Adequate intake n (%)	Inadequate intake n (%)	Total n	Underweight (BMI ≤ 18.5 kg/m^2) n (%)	Not underweight (BMI > 18.5 kg/m^2) n (%)
Sex					
Male	3 (10.7)	25 (89.3)	28	2 (7.1)	26 (92.9)
Female	104 (30.5)	237 (69.5)	341	93 (27.3)	248 (72.7)
Total	**107 (29.0)**	**262 (71.0)**	**369**	**95 (25.7)**	**274 (74.3)**
Age group (years)					
60 – 64	18 (39.1)	28 (60.9)	46	4 (8.7)	42 (91.3)
65 – 69	23 (31.1)	51 (68.9)	74	15 (20.3)	59 (79.7)
70 – 74	25 (32.5)	52 (67.5)	77	24 (31.2)	53 (68.8)
≥ 75	41 (23.8)	131 (76.2)	172	52 (30.2)	120 (69.8)
Total	**107 (29.0)**	**262 (71.0)**	**369**	**95 (25.7)**	**274 (74.3)**

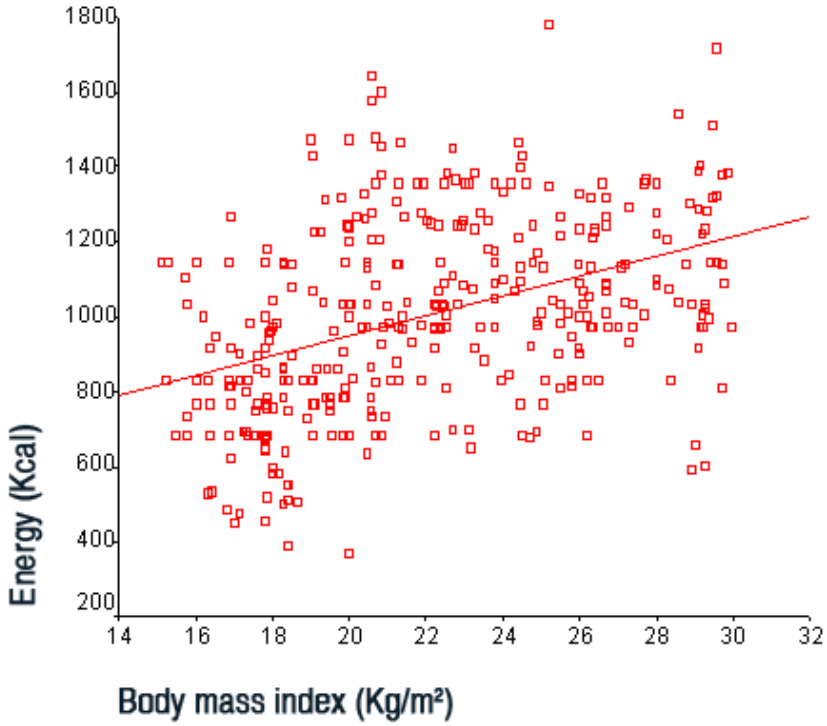

Figure 1 The correlation between energy intake (Kcal) and body mass index (kg/m^2)

Discussion

The response rate of this study was 95.6% and it represented 36.9% of the total eligible residents identified at all 23 "Pondok". The females contributed to the largest proportion of the elderly subjects studied and all of them lived alone and widowed, whereas majority of male elders were still married. This high proportion of widowed female elderly agrees to the findings by Avlund *et al.* (2003) which indicates that more elderly men than women were still married. Nevertheless, women tend to live longer than men and the disproportion between males and females increases with age (Mafauzy, 2000).

Teeth serves as the primary means of mastication and it is a very important function of the oral cavity. Thereby, the loss of teeth reduces an older adult's ability to chew food (Wayler and Chauncey, 1983) which may lead to poor diet quality and poor nutritional status (Sahyoun *et al.* 2003). This study has indicated higher proportion of elderly subjects with a compromised functional dentition compared to Mojon *et al.* (1999). Better findings by Mojon *et al.* (1999) could be due to the fact that most residents (69 %) had their dental treatment covered by a government plan unlike the residents in "Pondok".

Table 3 Association between functional dentition and socio-demographic factors with inadequate calorie intake by simple logistic regression analysis [a]

Variables	Total calorie intake		Crude OR		LR χ^2 (df)	*P* value[a]
	Inadequate n (%)	Adequate n (%)	OR	95 % CI of OR		
Sex	-	-	-	-	5.85 (1)	0.016[a]
Female (0)	237 (69.5)	104 (30.5)	1.0	-		
Male (1)	25 (89.3)	3 (10.7)	3.7	1.08 , 12.38		
Age of patients (years)	-	-	-	-	5.07 (3)	0.167
60 – 64 (0)	28 (60.9)	18 (39.1)	1.0	-		
65 – 69 (1)	51 (68.9)	23 (31.1)	1.4	0.66 , 3.08		
70 – 74 (2)	52 (67.5)	25 (32.5)	1.3	0.63 , 2.86		
≥ 75 (3)	131 (76.2)	41 (23.8)	2.1	1.03 , 4.09		
Level of formal education	-	-	-	-	1.52 (1)	0.218
Primary(0)	69 (66.3)	35 (33.7)	1.0	-		
No formal education(1)	193 (72.8)	72 (27.2)	1.4	0.83 , 2.22		
Monthly income (RM)	-	-	-	-	3.52 (1)	0.060
> 50(0)	109 (66.1)	56 (33.9)	1.0	-		
≤ 50(1)	153 (75.0)	51 (25.0)	1.5	0.98 , 2.42		
Duration of stay in “Pondok”	-	-	-	-	12.59 (1)	< 0.001[a]
≤ 60 months(0)	115 (62.5)	69 (37.5)	1.0	-		
> 60 months(1)	147 (79.5)	38 (20.5)	2.3	1.46 , 3.70		
Living status	-	-	-	-	5.36 (1)	0.021[a]
Widowed (0)	238 (69.6)	104 (30.4)	1.0	-		
Married (1)	24 (88.9)	3 (11.1)	1.3	1.03 , 11.87		
Self-reported health status	-	-	-	-	0.52 (1)	0.471
Healthy (0)	160 (72.4)	61 (27.6)	1.0	-		
Unhealthy (1)	102 (68.9)	46 (31.1)	1.2	0.75 , 1.88		
Functional dentition	-	-	-	-	30.40 (1)	< 0.001
Non-compromised (0)	112 (58.6)	79 (41.4)	1.0	-		
Compromised (1)	150 (84.3)	28 (15.7)	3.8	2.30 , 6.20		

[a] significant at *p-value* < 0.05

Table 4 Association between inadequate calorie intake and functional dentition

Variables	Crude OR	Adjusted[a] Odd Ratio	95 % CI (Adjusted OR)	LR stat [c] (df)	*P* value
Functional dentition					
Non-compromised (0)	1.0	1.0	-		
Compromised (1)	3.8	3.7	2.20 , 6.07	26.99 [c] (1)	< 0.001[c]
Monthly income (RM) [b]					
> 50.00 (0)	1.0	1.0	-		
≤ 50.00 (1)	1.5	1.7	1.03 , 2.70	3.79 [c] (1)	0.051[c]
Duration of stay in “Pondok” (months) [b]					
< 60 (0)					
≥ 60 (1)	1.0	1.0	-		
	2.3	2.00	1.22 , 3.26	10.01[c] (1)	0.002 [c]

[a] The multiple logistic regression model is reasonably fit with Hosmer-Lemeshow goodness-of-fit: Chi square = 3.147, df = 6, *p-value* = 0.790; percentage of correct classification = 71.8 with sensitivity of 91.6 % and specificity of 23.4 %; area under ROC = 0.718

[b] There is no significant interaction between functional dentition and other significant variables (Controlled variables)

[c] Likelihood ratio statistics

Table 5 Association between functional dentition and socio-demographic factors with underweight by simple logistic regression analysis

Variables	Body-mass index		Crude OR		LR χ^2 (df)	*P* value[a]
	Underweight n (%)	Not Underweight n(%)	OR	95 % CI of OR		
Sex	-	-	-	-	4.53 (1)	0.033[a]
Male (0)	2 (7.1)	26 (92.9)	1.0	-		
Female (1)	93 (27.3)	248 (72.7)	4.9	1.13 , 20.95		
Age of subjects (years)	-	-	-	-	12.79(3)	0.005[a]
60 – 64 (0)	4 (8.7)	42 (91.3)	1.0	-		
65 – 69 (1)	15 (20.3)	59 (79.7)	2.7	0.83 , 8.62		
70 – 74 (2)	24 (31.2)	53 (68.8)	4.8	1.53 , 14.77		
≥ 75 (3)	52 (30.2)	120 (69.8)	4.6	1.55 , 13.34		
Level of formal education	-	-	-	-	7.83 (1)	0.005[a]
Primary (0)	16 (15.4)	88 (84.6)	1.0	-		
No schooling (1)	79 (29.8)	186 (70.2)	2.3	1.29 , 4.23		
Monthly Income (RM)	-	-	-	-	0.13 (1)	0.716
≤ 50(0)	51 (25.0)	153 (75.0)	1.0	-		
> 50(1)	44 (26.7)	121 (73.3)	1.1	0.68 , 1.74		
Duration of stay in "Pondok"	-	-	-	-	3.94 (1)	0.047[a]
≤ 60 months(0)	39 (21.2)	145 (78.8)	1.0	-		
> 60 months(1)	56 (30.3)	129 (69.7)	1.6	1.01 , 2.59		
Living status	-	-	-	-	4.28 (1)	0.039[a]
Married (0)	2 (7.4)	25 (92.6)	1.0	-		
Widowed (1)	93 (27.2)	249 (72.8)	4.7	1.08 , 20.10		
Self-reported health status	-	-	-	-	20.03(1)	< 0.001[a]
Unhealthy (0)	19 (12.8)	129 (87.2)	1.0	-		
Healthy (1)	76 (34.4)	145 (65.6)	3.6	2.04 , 6.20		
Functional dentition	-	-	-	-		
Non-compromised(0)	4 (2.1)	187 (97.9)	1.0	-	54.46(1)	< 0.001[a]
Compromised (1)	91 (51.1)	87 (48.9)	48.9	17.40 , 137.40		
Daily calorie intake	-	-	-	-	16.86(1)	< 0.001[a]
Adequate (0)	11 (10.3)	96 (89.7)	1.0	-		
Inadequate (1)	84 (32.1)	178 (67.9)	4.1	2.10 , 8.10		

[a] Significant at *p-value* < 0.05

Table 6 Association between underweight and functional dentition

Variables	Crude OR	Adjusted[a] Odd Ratio	95 % CI (Adjusted OR)	LR stat [c] (df)	*P* value
Functional dentition:				103.89 (1) [c]	< 0.001[c]
Non-compromised (0)	1.0	1.0	-		
Compromised (1)	48.9	42.3	14.68 , 121.88		
Self-reported Health status [b]				7.31 (1) [c]	0.007 [c]
Unhealthy (0)	1.0	1.0	-		
Healthy (1)	3.6	2.6	1.28 , 5.13		
Age of subjects (years) [b]				10.26 (1) [c]	0.016 [c]
60 – 64 (0)	1.0	1.0	-	-	-
65 – 69 (1)	2.7	2.8	0.74 , 10.65	2.32 (1) [d]	0.138 [d]
70 – 74 (2)	4.8	4.9	1.33 , 18.10	5.71 (1) [d]	0.017[d]
≥75 (3)	4.6	5.6	1.63 , 19.03	7.48 (1) [d]	0.004[d]
Calorie intake [b]				4.72 (1) [c]	0.030 [c]
Adequate (0)	1.0	1.0	-		
Inadequate (1)	4.1	2.5	1.07 , 5.79		

[a] The multiple logistic regression model is reasonably fit with Hosmer-Lemeshow goodness-of-fit: Chi square = 2.669, d*f* = 8, *p-value* = 0.953; percentage of correct classification = 83.7 with sensitivity of 89.1 % and specificity of 68.4 %; area under ROC = 0.893

[b] There is no significant interaction between functional oral status and other significant variables (Controlled variables)

[c] Likelihood ratio statistics

[d] Wald test/ statistics

There was 71.0% of elderly people with inadequate calorie intake and 25.7% were underweight. The higher proportion of elderly in the age-group of 75 years and above had inadequate calorie compared to the younger age-group is consistent with a local study among free living elderly in southern Peninsular Malaysia (Suriah *et al.,* 1996). Regarding the prevalence of underweight, it was found to be similar with the observation by Juguan *et al.* (1999). However, it was better than findings among elderly in the rural, agro-based communities in Kelantan and in institution, Rumah Sri Kenangan, Kemumim, Kelantan, respectively (Abdul Manaf *et al.,* 1997; Abdul Manaf *et al.,* 1996).

Our results also demonstrated that elderly subjects with compromised functional dentition have inadequate calorie intake. As stated earlier, one of the criteria under compromised functional oral status was the presence of functional natural teeth less than 20 without good partial dentures or with poor partial dentures. This result seems to be consistent with Joshipura *et al.* (1996) that there is a linear decreasing trend of nutrient intakes as the total number of teeth decreases. It was documented that maintaining about 20 natural teeth may contribute to general health, and frequently, individuals with poor dentition consume soft, easily chewed food that are low in fibre, energy and nutrient density (Suzana *et al.,* 1999; Appollonio *et al.,* 1997). Hence, a minimum of 20 functional natural teeth (for adults 35 years old and above) has been regarded as favourable for optimal nutritional status because with 6 aesthetic units and 4 premolars occlusal units is necessary for moderate functioning and better mastication (Wynne, 1999; Shimazaki *et al.,* 2001; Budtz-Jorgensen *et al.,* 2000).

The present study also showed that elderly subjects with good dentures (non-compromised functional dentition) seemed to have a better chance of having adequate calorie intake as compared to those without dentures or with defective dentures (compromised functional dentition). Therefore, our results support observations of other researchers that edentulousness or ill-fitting dentures reduce dietary quality and nutrient intake (Marshall *et al.,* 2002). In addition, Lamster (2004) and Walton (2001) supported the fact that defective and ill-fitting dentures adversely affect chewing efficiency. Hence adequacy of dental prostheses in edentulous person is important for an optimal nutritional status (Brodeur *et al.,* 1993). Nonetheless, findings by Appollonio *et al.* (1997) the association was only true for micronutrients (vitamins and minerals) but not for calorie intake.

Previous studies of the association between oral status and body weight have yielded mixed results. In our study it showed that elderly with a compromised functional oral status tend to be underweight because of a decrease in calorie intake. It is in agreement to the findings by other researchers (Srisilapanan *et al.,* 2002; Mojon *et al.,* 1999; Blaum *et al.,* 1995). However, the present finding is in contrast to Sahyoun *et al.* (2003) in which edentulous elderly subjects had elevated body mass index because edentulism reduce chewing ability so, they tend to eat foods high in caloric density which consequently lead to increase in weight. This fact is in accordance to the findings by Johansson *et al.* (1994) that edentulous men and women were more obese and tended to have higher BMI because they ate more sweet snacks but less fruits, vegetables and fibres.

This study also noted that monthly income and duration of stay in "Pondok" were significantly associated with inadequate calorie intake, while self-reported health status, age, and calorie intake were significantly associated with underweight. Low income or poverty plays the most important environmental determinant of inadequate nutrition among elderly because it affects person's ability to obtain adequate and more diverse diet (Clarke *et al.,* 1998). It has been documented that consumption of more diverse diet was associated with higher calorie intake, while a narrow range of food choices may lead to dietary inadequacies (Bernstein, 2002). Knapp (1989) cites a study by Guthrie *et al.* and United States Department of Health, Education and Welfare that there was a relationship between income and nutritional adequacy. The same fact was also reported by Suzana *et al.* (1999) in their local study among rural elderly Malays in Mersing District, on the East coast of Malaysia, that elderly people who did not have a pension or salary as their main source of income were more likely to be undernourished. Moreover, other factors that can affect nutritional intake are also influenced by income, such as transportation (inability to use public transport to go to towns to get good foods), housing and facilities for food storage and preparation (Knapp, 1989).

The duration of stay in "Pondok" was also significantly associated with inadequate calorie intake. As indicated earlier, majority of the elderly subjects in the present study were alone in their "Pondok". The longer the duration of stay in the "Pondok", means the longer they were alone. Living alone is a psychosocial issue and reflects loneliness. Loneliness results in a lack of interest towards food and can undermine the desire to prepare and eat food which ultimately affects the nutrition intake (Walker and Beauchene, 1991). This fact was supported by Abdul Manaf *et al.* (1999) in their "Community Kitchen" study that there was an improvement in nutritional status of elderly after four months of the Community Kitchen programme. Possible reasons could be because in the Community Kitchen programme, the elderly ate the warm meal together which might improve their appetite thus increased food intake and consequently increase the mean intake of calorie.

Self-reported health status was found to be significantly associated with underweight. In this

study, those elderly subjects who claimed that their health status is excellent (healthy and no known disease) was found to be significantly associated with underweight where the odds of getting underweight was 2.6 times more compared to those who claimed unhealthy. The reason is probably because chronic diseases are associated with obesity or over nutrition and it agrees to the results by Suzana *et al.* (1999) in their nutrition study among rural elderly in Malaysia, where elderly without such diseases were found to be undernourished.

Age was also associated with underweight, in which the odds of being underweight was increased by five and six times among elderly in age-groups of 70-74 years and 75 years and above respectively as compared to the younger age-groups. This finding is consistent with Srisilapanan *et al.* (2002) in their study among Thai people aged 70-74 years. With ageing there is a decrease in peristalsis and hydrochloric acid secretion, resulting in gastrointestinal disturbances which may interfere with nutrient absorption and utilization (Ferry, 2005). On the other hand, a decrease in the number of taste buds on the tongue and nerve ending response to taste and smell may reduce dietary intake because taste is the strongest determinant of food choices, and the sense of smell is a major determinant of appetite (Krall and Henshaw, 2003). Hence, inability to perceive the aromas of food can diminish an external cue for eating. However, there are few researchers who did not support this fact. It was suggested that ageing process per se is not a cause of malnutrition in a healthy elderly population but it is more likely to occur among elderly with poor socio-economic status, the homebound (particularly those living alone), the bereaved, those with physical disability and those with depression or mental disorders (Buchowski and Sun, 1996). In addition, Abdul Manaf *et al.,* (1997) have also suggested low BMI was not influenced by age. Calorie intake was also significantly associated with underweight while controlling other factors. This finding would be explained by a positive correlation between calorie intake and body mass index (BMI).

In general, we can conclude that inadequate calorie intake and underweight were highly significantly associated with functional dentition status. Hence, it is timely that oral health services to restore masticatory function are looked into. Improved masticatory function consequently will improve their feeling of well-being, self-image, ability to communicate and to socialize, improve nutrition and ultimately the quality of life. Health professionals, nutritionist and dietitions should play an important role in educating the elderly people to improve their dietary intake in order to have a better quality of life. Apart from that, it is in the hand of government to improve the economy of the poor elderly since poverty is known to play the most important environmental determinant.

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