SITUATION ANALYSIS OF HIGH-COST DENTAL PROSTHETIC SERVICE PROVISION FOR PATIENTS WITH TOTAL TOOTH LOSS BY COMMUNITY HOSPITALS IN NORTHERN THAILAND IN FISCAL YEAR 2010

Chanapong Rojanaworarit[1], Sathirakorn Pongpanich[1, *], Supawat Rungsuriyawiboon[2], Atthaporn Limpanyalert[3], Bunjong Chumpa[3]

[1]College of Public Health Sciences, Chulalongkorn University, Bangkok 10330, Thailand
[2]Faculty of Economics, Thammasat University, Pathumthani 12121, Thailand
[3]Bureau of Claim Administration, National Health Security Office, Bangkok 10210, Thailand

ABSTRACT: This cross-sectional study was undertaken to determine recent delivery extent and related operating expenditure of high-cost complete denture service at community hospital level in northern Thailand in fiscal year 2010. Labor productivity analysis was also undertaken to provide performance measurement of dentists in delivering this service and to compare such measures across different dental units in this region. Data; including hospital size, number of dentists in each dental unit, and level of ruralness; were obtained from Bureau of Dental Health, Ministry of Public Health. Other data of high-cost complete denture service recipients and value of service reimbursement were acquired from Bureau of Claim Administration, National Health Security Office. Parameters were statistically analyzed with SPSS statistical package. Descriptive statistics were used to generally describe characteristics observed in study variables. Labor productivity ratio was calculated for each dental unit simply by dividing number of high-cost complete denture service recipients with its number of affiliated dentists. The labor productivity analysis was undertaken to determine amount of service output yielded per unit of labor input. To explore whether relationship between labor input and service output conform the economic law of diminishing marginal returns, graphical plot of box-and-whisker diagram and correlation coefficient of these variables were also determined. Statistical significance was considered when P value was less than 0.05. All 92 community hospitals in this region were included in analysis. There were 86 hospitals delivered the service through this program while the other 6 hospitals did not. In total, the program has served up to 2,486 edentulous patients in this region with related service reimbursement of 9,293,072 THBs. Relationship between numbers of dentists and number of service recipients was consistent with economic law of diminishing marginal returns. Correlation between these two variables was indicated by Spearman rank correlation coefficient of 0.512 (p < 0.001). Median labor productivity ratios were found greater among small- and medium-sized hospitals. Hospitals with exceptionally high labor productivity ratios were those small-sized hospitals in urban-like areas. Finding in this situation analysis would be useful for service delivery planning in terms of service burden anticipation and budget estimation. Optimal allocation of dentists would be an issue of consideration to improve service productivity.

Keywords: High-cost dental service, Complete denture, Community hospital, Labor productivity analysis

INTRODUCTION

Tooth loss in Thai populations is a common consequence of progressive dental caries and periodontal diseases [1, 2]. Secular trends of tooth loss in Thai adults (35-44 years old) and elders (60-74 years old) have been improving from 1984 to 2007 as indicated by increasing percentages of individuals with at least 20 functional remaining teeth in both age groups [1, 2]. In spite of the mentioned improving trend, tooth loss has continued to be a major dental public health problem in 82.84% of Thai adults with average loss of 3.92 teeth per person and 94.04% of the elderly with average loss of 13.38 teeth per person, as revealed in the lastly completed national dental

* *Correspondence to: Sathirakorn Pongpanich*
  E-mail: sathirakorn.p@chula.ac.th, gingsath@yahoo.com

survey [2]. Total edentulousness or total loss of teeth could also be found up to 10.47% of the elderly [2]. Among all regions of Thailand, the North was found having the highest percentages of adult populations (35-44 years old) professionally assessed as being in need of mandibular full denture placement (0.2%) and full mouth denture placement (0.2%) [2]. Up to 6.4% and 3.4% of the elderly (60-74 years old) in this region were also required to have mandibular full dentures and complete dentures, respectively [2].

Without placement of complete denture to restore masticatory function, total edentulousness is more potential to affect change in dietary intake, especially decrease in consumption of vegetables and fiber-rich foods, due to limitation of chewing ability [3]. The adverse alteration in dietary habit can even contribute to development of chronic diseases, such as cardiovascular disease and cancer [3, 4]. Edentulism can also adversely affect facial esthetics, self-confidence, and several aspects of oral health-related quality of life [5-8]. Since total loss of teeth is more likely to be found among individuals with lower socioeconomic status [9], access to high-cost complete denture service is then limited by financial barrier. On account of the mentioned evidences, National Health Security Office (NHSO) has thus provided a channel for individual insured by Universal Healthcare Coverage Scheme (UC) to obtain complete denture free of charge at a registered local public hospital with an aim to provide financial aid and improve access to this high-cost dental intervention [10]. Nevertheless, ceiling or the maximum operating cost for each set of complete denture provided through this program has been estimated by Bureau of Claim Administration to be as high as 4,400 THBs [10], or almost two times higher than UC per capita funding values of 2,401.33 and 2,546.48 THBs in fiscal year 2010 and 2011 respectively [11, 12]. Therefore, unlike other routine dental interventions which are funded by pre-paid contract capitation system, the high-cost complete denture program is financed through fee-for-service reimbursement system with accountancy audit in attempt to primarily control program expenditure [10].

Before fiscal year 2011, budgetary value of high-cost dental prosthetic program was not specifically defined since its spending was inclusively funded through global budgeting system together with other high-cost medical equipment and interventions [10]. Such inclusive funding has raised an issue about how well the global budget has been allocated to this dental prosthetic program

and other medical interventions. Moreover, since definite budget of a certain healthcare service is crucial information for decision making on how much the service should be provided, knowledge about real extent of complete denture service which has be delivered and related expenses could well inform the payer about service demand and related cost burden which would be useful for rational service delivery planning in consecutive fiscal years. However, such information has scarcely been analyzed and documented. In attempt to respond to the mentioned issues and achieve budget control, the National Dental Fund has been established in fiscal year 2011 to undertake one of its tasks to estimate specific budget for high-cost dental prosthetic program [13]. Despite such effort, rational budgeting specifically for high-cost dental prosthetic service is still in an early stage and evidences concerning service extent, service productivity and financial situation are necessarily needed. Moreover, due to a large number of eligible service users and expensive cost of service provision, financial viability risk is still a very important issue to be considered in management of this service. Situation analysis regarding recent extent of complete denture service delivery and related expenditure would thus be useful for better budgeting which practically suits demand for the dental prosthetic service.

This study was undertaken to primarily determine recent delivery extent and related operating expenditure of high-cost complete denture service at community hospital level in northern Thailand. . Labor productivity analysis was also undertaken to provide performance measurement of dentists in delivering this service and to compare such measures across different dental units in this region.

RESEARCH METHODS
Dental service of analysis
This study focused on public provision of high-cost complete dentures (both maxillary and mandibular full dentures) for dental patients with total edentulousness or total loss of teeth. Eligible patients who could utilize this service free of charge were UC beneficiaries. Those UC beneficiaries who received complete denture service through Dental Prosthetic Campaign for the Elderly were not included in this analysis. This exclusion was due to the fact that the high-cost program in this analysis and the Dental Prosthetic Campaign for the Elderly were not the same project and focused on different target groups. Moreover, the Dental Prosthetic Campaign for the elderly had quota setting at provincial level. This feature could consequently

interfere with labor productivity analysis since specified number of service recipients was assigned instead of allowing dentists to freely make their own decision whether to deliver the service. Service providers in this analysis were dental units of all community hospitals in northern Thailand (N = 92). Based on earlier mentioned evidence, the northern region was selected for analysis due to highest professionally-assessed need of complete denture placement in adult populations. This dental program was financed through fee-for-service reimbursement system. Only operating costs; such as costs of materials, costs of denture fabrication in dental laboratory, and others; could be reimbursed. Personnel cost was not included in service reimbursement since dental professionals had already been paid their monthly salaries to provide this service together with other routine dental interventions. There was not any incentive given to dental professionals to positively reinforce delivery of the service. Negative reinforcement by means of punishment in case of no service provision was neither specified. Quota of service delivery extent was neither indicated. Thus, dentists were allowed to make their own judgment on what extent this dental prosthetic service should be delivered. Hospital financial units usually provided prepayment for operating costs of this service by allocation of budget from hospital capitation fund prior to submission of claim documents to Bureau of Claim Administration for service reimbursement. Fiscal year 2010 was selected for analysis due to three features: availability of most recent information, transitional fiscal year prior to attempt of budget estimation specifically for dental prosthetic service by the National Dental Fund, and the first fiscal year when new internet-assisted E-Claim system has completely functioned. Situation analysis in this fiscal year could therefore provide information regarding service delivery extent and related expenditure which was actually not documented by the time of budget estimation for fiscal year 2011. Moreover, this analysis would also provide baseline information both for budgeting of this specific service in later fiscal years and further evaluation of E-Claim system in developing service reimbursement process and service delivery extent.

Study variables
Study variables in this analysis were hospital size, number of dentists in each dental unit, level of ruralness, number of high-cost complete denture service recipients, and value of service reimbursement. Hospital size was categorized by numbers of inpatient bed: 10, 30, 60, 90, and 120.

These sizes of community hospitals were specified by Ministry of Public Health. Greater number of inpatient bed implied larger size of community hospital. The 10- and 30-bed hospitals were regarded as small-sized community hospitals. The 60-bed ones and those with larger numbers of beds were regarded as medium- and large-sized hospitals, respectively. Number of affiliated dentists in dental unit and size of each community hospital were provided by Bureau of Dental Health, Ministry of Public Health. Ruralness of districts where community hospitals were situated was classified into 3 levels: urban-like area, rural area, and very rural area [14, 15]. Parameters regarding number of service recipients and value of service reimbursement were obtained from database of Bureau of Claim Administration, NHSO.

Analytical approaches
Parameters were statistically analyzed with SPSS statistical package (17.0 Version). Either Kolmogorov-Smirnov test was used when appropriate to determine normal distribution of study variables (p > 0.05). Descriptive statistics were used to generally describe characteristics observed in study variables. Labor productivity analysis was undertaken to determine amount of service output yielded per unit of labor input. In this context of analysis, labor input was defined by number of affiliated dentists in each dental unit. Taking only dentist into account and excluding other dental personnel, such as dental auxiliary and dental assistant, was due to the fact that decision whether to provide the complete denture service was necessarily made only by dentist and delivery of complete denture required dentist specific skill. Service output was number of complete denture service recipients. Thus, labor productivity ratio which was a measure of interest could be calculated for each dental unit simply by dividing number of high-cost complete denture service recipients with its number of affiliated dentists.

To further explore whether relationship between labor input and service output in this context tended to conform the economic law of diminishing marginal returns, box-and-whisker diagram was used to graphically display such relationship between numbers of dentists and numbers of service recipients. Correlation of these two production variables was also assessed and identified by correlation coefficient. Statistical significance was considered when P value was less than 0.05. Additionally, relationships between labor productivity ratio and two variables–hospital size and level of ruralness–were also explored by means

Table 1 Community hospitals in northern Thailand and features concerning provision of high-cost complete denture service under UC in fiscal year 2010

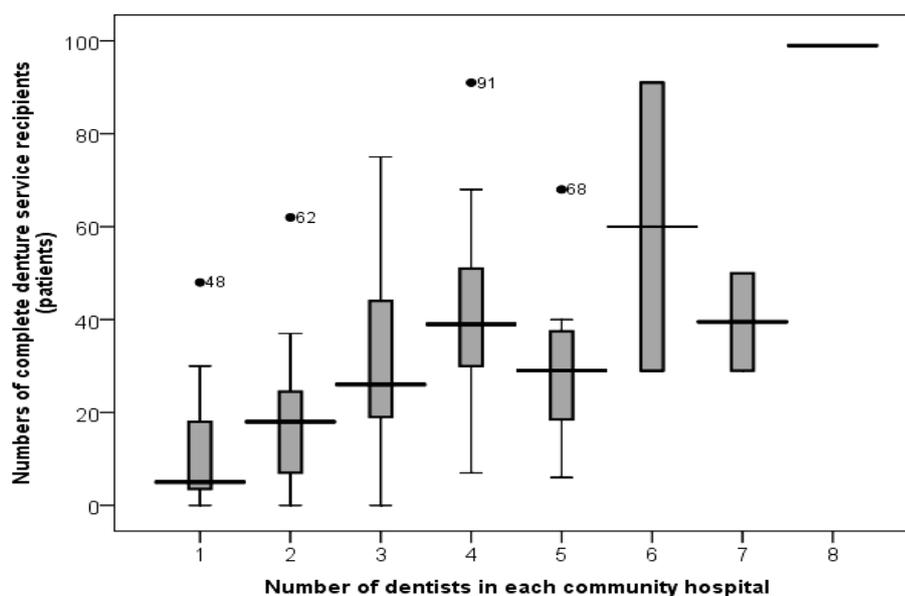| Categories	Community hospitals			Complete denture service recipients (N = 2,486)	Reimbursed expenses (Total = 9,293,072 THBs)
	Without service provision through the program (N = 6)	With service provision through the program (N = 86)	Total (N = 92)		
Hospital sizes (beds)					
10	0	9	9	182 (7.3%)[†]	685,098 (7.4%)[†]
30	5	57	62	1,578 (63.5%)[†]	5,903,032 (63.5%)[†]
60	1	10	11	369 (14.8%)[†]	1,383,236 (14.9%)[†]
90	0	7	7	174 (7.0%)[†]	659,454 (7.1%)[†]
120	0	3	3	183 (7.4%)[†]	662,252 (7.1%)[†]
Dentists in each dental unit (persons)					
1	2	13	15	181 (7.3%)[†]	658,750 (7.1%)[†]
2	2	21	23	414 (16.7%)[†]	1,564,701 (16.8%)[†]
3	2	27	29	852 (34.2%)[†]	3,216,499 (34.6%)[†]
4	0	12	12	497 (20.0%)[†]	1,841,663 (19.8%)[†]
5	0	8	8	244 (9.8%)[†]	891,237 (9.6%)[†]
6	0	2	2	120 (4.8%)[†]	452,206 (4.9%)[†]
7	0	2	2	79 (3.2%)[†]	313,632 (3.4%)[†]
8	0	1	1	99 (4.0%)[†]	354,384 (3.8%)[†]
Level of ruralness					
Urban-like	2	57	59	2,037 (81.9%)[†]	7,616,866 (82.0%)[†]
Rural	1	15	16	293 (11.8%)[†]	1,095,833 (11.8%)[†]
Very rural	3	14	17	156 (6.3%)[†]	580,373 (6.2%)[†]

[†]Percentage by column

of box-and-whisker diagram.

RESULTS

Characteristics of high-cost complete denture service provided by community hospitals in northern Thailand in fiscal year 2010 are summarized in Table 1. Among 92 community hospitals in this region, 86 hospitals delivered the service through this program while the other 6 hospitals did not provide evidence of service delivery nor claim for reimbursement. These hospitals without service provision through the program were mostly of small size (30-bed hospital) with limited numbers of dentists and more likely to be in very rural areas. In total, the program has served up to 2,486 edentulous patients in this region with related service reimbursement of 9,293,072 THBs. The average cost per care for complete denture service in this region was approximately 3,738.16 THBs. This average cost per care in real practice was noticeably lower than the maximum ceiling cost of 4,400 THBs which was estimated and set as highest reimbursement value allowed by Bureau of Claim Administration, NHSO. Kolmogorov-Smirnov test revealed that neither distribution of service recipients nor that of reimbursed expenses was normal (p < 0.01). Median and Interquartile range (IQR) of service

Remark: Outliers (●) are labeled with numbers of service recipients (patients).

Figure 1 Numbers of complete denture service recipients served by 92 community hospitals with various numbers of dentists in northern Thailand in fiscal year 2010

recipients served in this year by all hospitals were 24 and 30 cases, respectively. Maximum number of service recipients was 99 and this number was delivered by a 120-bed hospital with 8 dentists in an urban-like district. Median and IQR of reimbursed expenses of all hospitals were 89,100 and 115,652.25 THBs, respectively. Maximum reimbursement was 354,384 THBs and this was claimed by the same hospital which served the largest number of edentulous patients through this program. However, the largest portion of total service delivery extent in this region was shared by a great number of small, 30-bed hospitals.

As also shown in Table 1, most of the dental units in this region had around 1-3 affiliated dentists and 61 hospitals of this kind, excluding 6 hospitals without service provision, has served around 58.2% of the service recipients. All 25 hospitals with 4-8 affiliated dentists provided the service and served up to 41.8% of the cases. Figure 1 further illustrates numbers of the complete denture cases served by all hospitals with different numbers of dentists. Three highest numbers of service recipients were served by hospitals with 8, 6, and 4 dentists; respectively. Nevertheless, some hospitals with 1-3 dentists also served exceptionally high numbers of recipients compared to their peer groups. The box-and-whisker diagram also depicts changing trend of service output (patient) by increasing numbers of labor input (dentist). Initial increasing trend in numbers of complete denture patients could be observed when input numbers of dentists increase

from 1 to 4. Later on, fluctuation trend existed as firstly marked by sharp decrease in output when number of labor input changed from 4 to 5.

Kolmogorov-Smirnov test indicated that distribution of dentists among different dental units in this region was not normal (p < 0.001). Numbers of service recipients were neither normally distributed, as earlier mentioned. However, monotonicity relationship between these two variables seemed to exist as shown in Figure 1 that number of service recipients tended to increase when number of dentists increased. Thus, Spearman's correlation was adopted as method of correlation analysis. Spearman rank correlation coefficient between these two variables was 0.512 (p < 0.001).

Figure 2 illustrates labor productivity ratios which varied across different sizes of community hospitals in this region. Although, in general, the labor productivity ratios did not vary considerably across different sizes of the hospitals, median ratios of the small- and medium-sized hospitals appeared to be greater than those of the larger hospitals. Much greater difference was noticeable when maximal labor productivity ratios were compared. Small-sized hospitals with exceptionally high labor productivity ratios as indicated by outliers and an extreme outlier in this figure should also be remarked.

Figure 3 illustrates labor productivity ratios when variation in level of ruralness was considered. Median labor productivity ratios showed a decreasing trend when level of ruralness changed
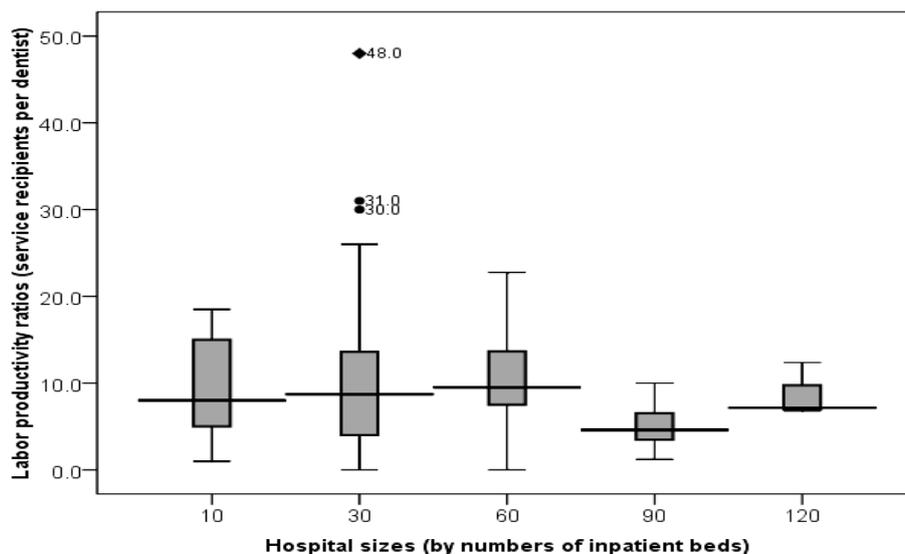
Remark: Outliers (●) and extreme outliers (♦) are labeled with labor productivity ratios.

Figure 2 Labor productivity ratios (service recipients per dentist) of community hospitals with different sizes in northern Thailand in fiscal year 2010
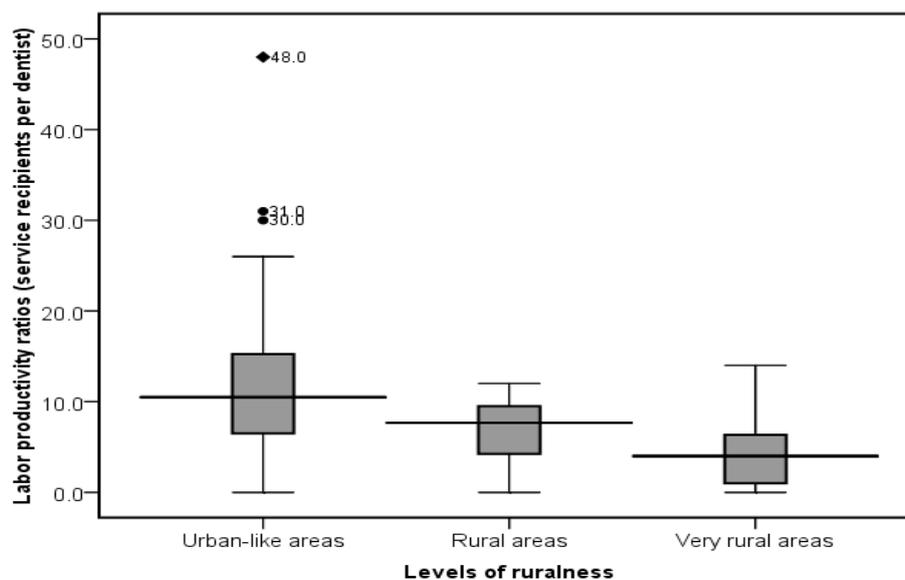
Remark: Outliers (●) and extreme outliers (♦) are labeled with labor productivity ratios.

Figure 3 Labor productivity ratios (service recipients per dentist) of community hospitals in different levels of ruralness in northern Thailand in fiscal year 2010

from urban-like level to rural and very rural levels. Those hospitals with the remarkably high labor productivity ratios were all found situated in urban-like areas.

DISCUSSION

Based on finding of hospitals without evidence of high-cost complete denture service provision, underlying reason of service unavailability should be investigated to address local condition hindering such provision and to appropriately support these dental units. Attention should be greatly paid for this issue since these community hospitals were the most significant dental providers in the districts where local residents were more dependent on public dental service provision as private dental care was of limited availability [16]. Information regarding total number of service recipients and value of reimbursement would be very useful for the National Dental Fund to rationally anticipate

service burden, better estimate the specific budget for this service, and to monitor implementation of the program over the years in this region. Additionally, such information would also be beneficial for payer of this program, NHSO's Bureau of Claim Administration, in rational allocation of financial resource for this service and other high-cost healthcare interventions which were all inclusively funded through global budgeting system.

Adding more dentists to a certain dental unit might not necessarily improve service delivery extent. This key message was well illustrated by the trend found in Figure 1. The relationship between number of dentists and number of service recipients was consistent with the economic law of diminishing marginal return which states that when a production input is additionally given more and more to a production process and other production inputs are kept constant, at some stage the marginal product would be lowered [17, 18]. The correlation between these two variables was neither strong as indicated by the value of Spearman rank correlation coefficient of 0.512, although the positive correlation suggested tendency of increase in number of service recipients when more number of dentists was added. Based on these evidences, issue in allocation of dental workforce should also be considered. Putting optimal number of dentists to suit real service burden would be a key strategy in improving service productivity. Nevertheless, consideration of only this service would not be sufficient to assign number of dentists to a certain dental unit, information concerning service burden of all other dental interventions provided at each community hospital is necessarily required.

Result of labor productivity ratios should be carefully interpreted. In general, the ratio implies amount of production output yielded by a unit of labor input. The greater ratio would imply greater productivity or better ability of labor to produce more production output. In this sense, dental units with greater labor productivity ratios would have more number of service recipients served per dentist. However, greater labor productivity ratios in this context of analysis would also imply greater workload of this service responsible by each dentist. Thus, attention should be paid to the dental units with high ratios, especially those small-sized hospitals with exceptionally high ratios, whether excessive workload regarding this service was faced by dentists working there. Low labor productivity ratios would neither imply that the dental units or dentists working there were inefficient since the analysis focused only on one dental intervention.

More advanced techniques of efficiency analysis, such as data envelopment analysis, and consideration of all dental care interventions provided by the community hospital would be necessary for comprehensive assessment of public dental care provision at this hospital level.

ACKNOWLEDGEMENT

REFERENCES

1. Ministry of Public Health, Division of Dental Public Health. The 5th Thailand National Oral Health Survey 2000-2001. Nonthaburi: Ministry of Public Health; 2002.

2. Ministry of Public Health, Division of Dental Public Health. The 6th Thailand National Oral Health Survey 2006-2007. Nonthaburi: Ministry of Public Health; 2008.

3. Joshipura KJ, Willett WC, Douglass CW. The impact of edentulousness on food and nutrient intake. J Am Dent Assoc. 1996 Apr; 127(4): 459-67.

4. Hung HC, Willett W, Ascherio A, Rosner BA, Rimm E, Joshipura KJ. Tooth loss and dietary intake. J Am Dent Assoc. 2003 Sep; 134(9): 1185-92.

5. Fiske J, Davis DM, Frances C, Gelbier S. The emotional effects of tooth loss in edentulous people. Br Dent J. 1998 Jan 24; 184(2): 90-3; discussion 79.

6. Davis DM, Fiske J, Scott B, Radford DR. The emotional effects of tooth loss - a preliminary quantitative study. Br Dent J. 2000 May 13; 188(9): 503-6.

7. Sowmya MK, Vinaya B, Krishna Prasad D. Review article: psychological impact of edentulousness. J Indian Acad Dent Spec. 2011; 2(1): 34-36.

8. Gerritsen AE, Allen PF, Witter DJ, Bronkhorst EM, Creuger NH. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. Health Qual Life Outcomes 2010; 8:126 [cited 2012 Dec 7]. Available from: http://www.hqlo.com/content/8/1/126

9. Esan TA, Olusile AO, Akeredolu PA, Esan AO. Socio-demographic factors and edentulism: the Nigerian experience. BMC Oral Health 2004; 4:3 [cited 2012 Dec 7]. Available from:http://www.biomedcentral.com/1472-6831/4/3

10. Bureau of Claim Administration. Manual of claim for health service expenses. Nonthaburi: National Health Security Office, Thailand; 2010.

11. National Health Security Office. Manual for national health security fund administration: fiscal year 2010. Nonthaburi: National Health Security Office, Thailand; 2010.

12. National Health Security Office. Manual for national

health security fund administration: fiscal year 2011. Nonthaburi: National Health Security Office, Thailand; 2011.

13. Eungpoonsawat W, Weerasrethakul K, Siriwattanapisan S, Limpanyalert A, Lamduan W. National Dental Fund: a changing point for solving dental public health problems [monograph on the internet]. Bangkok: Thai Dental Council; 2011 [cited 2012 Dec 7]. Available from: http://www.dentalcouncil.or.th/content/journal/detail.php?type=7&id=456

14. Ministry of Public Health. Official correspondence: list of district hospitals in rural areas with shortage of health professionals in fiscal years 2009-2010. Nonthaburi: Ministry of Public Health, Thailand; 2009.

15. Chiangchaisakulthai K, Sirikanokvilai N, Jongudomsuk P, Chunharas S, Fahamnuaypol P. Hardship area: criteria and classification. Journal of Health System Research. 2011 Jul-Sep; 5(3): 355-62.

16. Jirapongsa W, Prasertsom P, Wongkhongkhathep S. Oral health care system in Thailand. Nonthaburi: Ministry of Public Health; 2004.

17. Samuelson PA, Nordhaus WD. Microeconomics. 17th ed. Boston: McGraw-Hill; 2001.

18. Coelli TJ, Rao DSP, O'Donnell CJ, Battese GE. An introduction to efficiency and productivity Analysis. 2nd ed. New York: Springer; 2005.