M – 19

STUDY ON CALCULATION MODEL OF HEALTH INSURANCE PREMIUM FOR POOR FAMILY

Sukono[1*], Sudradjat[2], Riaman[3], Juliarti Donda[4]

[1,2,3,4]*Department of Mathematics, FMIPA, Universitas Padjadjaran*
[1*]Email : fsukono@yahoo.com

Abstract

Health is an important aspect in the life of society, the government should create an adequate health development as an improvement to the poor level of health of poor families over the years. In this paper studied how to calculate the cost of a hospital for the poor by using the actuarial approach. Actuarial approach that will be used is one of life insurance products, namely health insurance. The calculation of the amount of premium to be paid by users of health insurance is done by calculating the annual net premium is updated every year, and annual net premiums that are not updated. The age and gender will affect the value of the annual net premium. In addition, costs are categorized in the cost of health insurance as inpatient, outpatient costs, physician costs will affect the amount of premium to be paid.

Key words: poor families, health insurance, annual net premiums, health insurance costs.

INTRODUCTION

Universal health insurance program was first launched by the Indonesian government in 2004. The program was organized as part of the government's obligation to provide protection to all citizens of various health problems. At first, universal health insurance is organized through poor public health programs (Askeskin) which is managed by PT. Askes. During its development, the program turned into a public health insurance or JAMKESMAS, with targeted as beneficiaries of the program are the poor and near poor. Based on the decision of the minister of health of the operational guidelines of JAMKESMAS, people who are not covered is the responsibility of the local authorities [3]. The problem is how to calculate the budget for financing the program of JAMKESMAS the responsibility of local governments.

To calculate budget of JAMKESMAS financing can be done with the actuarial approach. JAMKESMAS cost calculation can be done by calculating the daily benefit for hospitalized [2], [3]. This cost is a payment of a daily benefit for hospitalized, so as the basis for payment is the fact insured (participants Assurance) hospitalized [5]. In the case of the disease being treated in hospital, illness distinguished by dealing with disaster, probability values differentiated by age, and there are also differentiated by gender (sex) [5]. The costs borne by local government, in the actuarial form of health insurance premiums. According Pradipta [8], the premium paid on health insurance is divided into two types, namely single net premiums, and annual net premiums. Furthermore, according to Futami [5] and Pradipta [8], one of the factors that affect the calculation of the individual health insurance premiums in particular is the interest rate. The use of interest rate is not adjusted can cause harm to either party, well parties insurance company, or the participants of JAMKESMAS [8].

Based on the above description, in this paper conducted preliminary assessment of the health insurance premium calculation models for poor families. The study was conducted with the purpose as the basis for determining the size of the local government budget for the implementation of the program of JAMKESMAS. As the object of study is a health program

that was held at the Regional General Hospital (RSUD) in Ujungberung Bandung. The calculation of net premiums calculated according to gender (sex), as well as using renewable every year approaches, and which are not renewable every year approaches.

RESEARCH METHOD

　　In this section discussed about: the object of study, calculation steps, basic medical insurance premium calculation, the calculation of net premiums are renewed every year, and the calculation of net premiums were not renewed every year, which is described as follows.

　　Object of study. Object of study in this paper is a secondary data obtained from the Regional General Hospital (RSUD) in Ujungberung Bandung. Data objects that are examined include: The cost of hospitalization, drug costs, cost of doctor visits and other medical expenses. The duration of hospitalization, so age poor family of health insurance, and health insurance policy validity period of poor families.

　　Calculation steps. In this paper carried out the calculation of net premiums of health insurance are renewed every year, and net premiums of health insurance is not renewed every year, in hospitals Ujungberung Bandung during December 2014 until January 2015. The steps of calculations performed in this paper are as follows:

- Data of health insurance participants for poor and near-poor families in RSUD Ujungberung Bandung, divided into two groups based on gender (sex).
- Once the data is grouped by gender, data is processed to calculate the amount of net premiums of health insurance is renewed every year by using equation (4), and net premiums of health insurance that is not renewed every year by using equation (5).
- Once the magnitude of net premium is calculated using the two approaches, and then do a comparison between the amount of net premiums are calculated by the which are renewable every year approachs, and which are not renewable every year approaches.This comparison is intended to determine which is better approach applied to health insurance for poor families.

　　The calculation of basic health insurance premiums. Calculation of annual net premiums of health insurance in RSUD Ujungberung Bandung, performed using the calculation hospital care health insurance. Calculation for health insurance hospital treatment is basically similar to the calculation of life insurance [1], [5]. The difference is, that the health insurance costs of hospital care is used for the calculation of health insurance premiums. So for health insurance, net single premium is calculated using the following equation:

$$P = T^{sh} \sum_{t=0}^{n-1} v^{t+\frac{1}{2}} \, {}_t p_x \, q^{sh}_{x+t} \qquad (1)$$

with: P single premium, T^{sh} the average number of days of hospital care, $v^{t+\frac{1}{2}}$ present value, ${}_t p_x$ probability of life, dan q^{sh}_{x+t} probability of hospitalized [4],[7].

　　As for calculating the amount of premiums regularly performed using the basic formula of insurance as follows:

Premium Value = Benefit Value

$$P\ddot{a} = A . \qquad (2)$$

Furthermore, by substituting equation (1) into equation (2) obtained by the equation to calculate the annual net premiums health insurance hospital as follows [9], [10]:

$$P \cdot \ddot{a}_{\overline{x:n|}} = T^{sh} \sum_{t=0}^{n-1} v^{t+\frac{1}{2}} \, {}_t p_x \, q^{sh}_{x+t}$$

$$P \quad = \frac{T^{sh} \sum_{t=0}^{n-1} v^{t+\frac{1}{2}} \frac{l_{x+t}}{l_x} q_{x+t}^{sh}}{\frac{N_x - N_{x+n}}{D_x}} = \frac{T^{sh} \sum_{t=0}^{n-1} \overline{D}_{x+t} q_{x+t}^{sh}}{N_x - N_{x+n}} \tag{3}$$

with: l_x the number of people who of life in the age of x, $D_x = v^x l_x$, $\overline{D}_x = v^{x+\frac{1}{2}} l_x$, and $N_x = \sum_{i=0}^{n} D_{x+i}$.

Calculation of net premiums renewed every year. Net premiums are renewed each year, is the amount of premium that changes every year depends on participant age insurance. Calculation of net premiums of health insurance is renewed every year [6], [8]:

$$P = T^{sh} \frac{\overline{D}_{x+t} q_{x+t}^{sh}}{N_{x+t} - N_{x+t+1}}, \, t = 0,1,2,\cdots,(n-1). \tag{4}$$

Calculation of net premiums that are not renewed every year. Net premiums were not renewed each year, is the amount of the premium fixed for year *n* which is not influenced by age insurance participants. Calculation of net premiums health insurance is not renewed each year [5], [8]:

$$P = \frac{T^{sh} \sum_{t=0}^{n-1} \overline{D}_{x+t} q_{x+t}^{sh}}{N_x - N_{x+n}}. \tag{5}$$

Furthermore, the methods mentioned above calculation is used to analyze the data in the following section.

RESULT AND DISCUSSION

In this section we describe the results of data processing and discussion, from the health insurance premium calculation for poor families are renewable every year, and wich are not renewable every year, at RSUD Ujungberung Bandung in the period December 2014 until January 2015.

Data were analyzed. Data obtained from RSUD Ujungberung Bandung in the form of hospitalization costs. While the data necessary to calculate the amount of health insurance premiums for poor families is age of health insurance participants, the costs of hospital care, health insurance participants' gender, duration of the health insurance policy. Therefore, the data obtained from RSUD Ujungberung Bandung is incomplete, then the calculation for health insurance premiums for poor families here, incomplete data is obtained by simulation. So that the data needed to calculate the amount of health insurance premiums for poor families can be fulfilled.

The calculation results. In this paper we do two types of calculation of health insurance premiums for poor families. Namely, net premiums of the health insurance for poor families are renewable every year, and net premiums of the health insurance for poor families are not renewable every year, were divided into two groups each based on gender (sex). Based on available data, it is known that the costs of hospital care as given in Table-1.

Table-1: Age of Participants, Cost of Hospitals, Term of Policy, and Gender

No	Age of Health Insurance Participants	Average Cost Hospital for one year	Applicable Period of Policy (T)	Sex (Gender)
1	21	1,414,852.27	18	Male
2	21	1,414,852.27	18	Female

- *Calculation of net premiums are renewed every year*

  For example the *first* calculation, consider the data of the number 1, the health insurance participants is aged 21 years, hospital costs average for one year is IDR 1,414,852.27 with the male gender (sex). Assumed a period of 18 years applies policy. Using equation (4), the results of the calculation are as follows:

- At the year 1st, the age of 21 years:

  From Indonesian Mortality Table (*RP - 2000 Combined Healthy Male and Female Combined Helathy*), obtained values of commutation: $\overline{D}_{21}$=283,618.33; N_{21}= 444,474; N_{22} = 416,927 and probability q_{21}=0.000357; so the:

  $$P = 1,414,852.27 \times \frac{\overline{D}_{21} \cdot q_{21}}{N_{21} - N_{22}} = 1,414,852.27 \times \frac{283,618.33 \times 0.000357}{444,474 - 416,927}$$

  P = 5,200.43

- At year 2nd, the age 22 years:

  From Indonesian Mortality Table (*RP - 2000 Combined Healthy Male and Female Combined Helathy*), obtained values of commutation: $\overline{D}_{22}$=266,975; N_{22} = 416,927; N_{23} = 390,996 and probability q_{22} =0.000366; so the:

  $$P = 1,414,852.27 \times \frac{\overline{D}_{22} \cdot q_{22}}{N_{22} - N_{23}} = 1,414,852.27 \times \frac{266,975.903 \times 0.000366}{416,927 - 390,996}$$

  P = 5,331.45

- At the 3rd year and so on until the 18th year, in the same way, the results are given in Table-2 column (1).

  For example the *second* calculation, consider the data of the number 2, the health insurance participants is aged 21 years, hospital costs average for one year is IDR 1,414,852.27 with the female gender (sex). Assumed a period of 18 years applies policy. Using equation (4), the results of the calculation are as follows:

- At the year 1st, the age of 21 years:

  From Indonesian Mortality Table (*RP - 2000 Combined Healthy Male and Female Combined Helathy*), obtained values of commutation: $\overline{D}_{21}$=283,618.33; N_{21}= 444,474; N_{22} = 416,927 and probability q_{21}=0.000192; so the:

  $$P = 1,414,852.27 \times \frac{\overline{D}_{21} \cdot q_{21}}{N_{21} - N_{22}} = 1,414,852.27 \times \frac{283,618.33 \times 0.000192}{444,474 - 416,927}$$

  P = 2,796.87

- At year 2nd, the age 22 years:

  From Indonesian Mortality Table (*RP - 2000 Combined Healthy Male and Female Combined Helathy*), obtained values of commutation: $\overline{D}_{22}$=266,975; N_{22} = 416,927; N_{23} = 390,996 and probability q_{22} =0.000194; so the:

  $$P = 1,414,852.27 \times \frac{\overline{D}_{22} \cdot q_{22}}{N_{22} - N_{23}} = 1,414,852.27 \times \frac{266,975.903 \times 0.000194}{416,927 - 390,996}$$

  P = 2,825.96

- At the 3rd year and so on until the 18th year, in the same way, the results are given in Table-2 column (2).

Table-2: Net Premiums are renewed every year

At year	Age (Years)	Sex (Gender) of Male and Female	
		The Amount of Premium of Male (IDR)	The Amount of Premium of Female (IDR)
		(1)	(2)
1	21	5,200.43	2,796.87
2	22	5,331.45	2,825.96
3	23	5,433.39	2,869.65
4	24	5,477.09	2,927.92
5	25	5,477.06	3,015.29
6	26	5,506.34	3,117.35
7	27	5,564.66	3,248.48
8	28	5,724.86	3,423.26
9	29	6,001.65	3,612.65
10	30	6,467.50	3,845.54
11	31	7,268.82	4,472.00
12	32	8,186.55	5,098.39
13	33	9,191.94	5,739.50
14	34	10,225,47	6,336.29
15	35	11,259,75	6,918.99
16	36	12,250,76	7,487.38
17	37	13,168,99	8,070.38
18	38	14,042.34	8,710.91

Can be seen from Table-2, the amount of premium to be renewed each year depends on the age of the insurance participants. Increasing age of the participant's of health insurance, the greater the insurance premiums to be paid annually. In addition, it can be seen that the cost of premium males greater than the cost of the premium female. More detail can be seen from Figure-1.
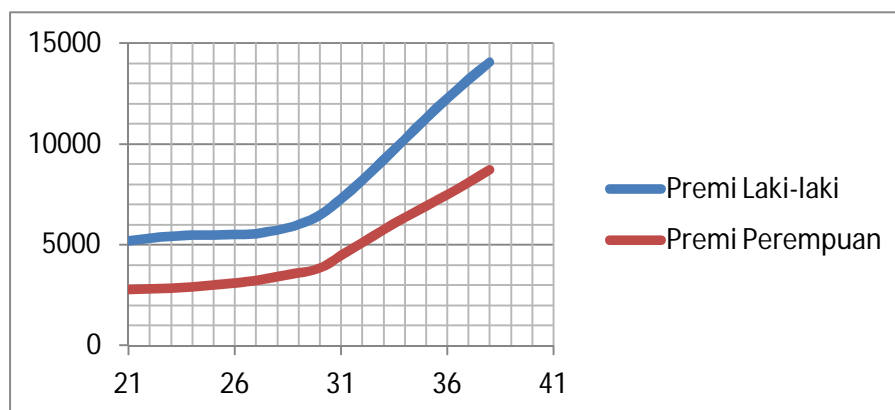

Figure-1: Graph of Net Premiums For Gender (Sex) of Male and Female

For the calculation of other data, the authors use the help of Microsoft Excel and Borland C ++. Based on the calculation results can be seen that the greater the age of the health insurance participants for poor families, the greater the premium to be paid. It can also be compared to the amount of premiums based on sex (gender), that the amount of the premium for participant male sex is greater, than the amount of the premium for the female sex (gender).

- *Calculation of net premiums were not renewed every year*

In health insurance net premiums not renewed every year, the calculation is done by using equation (5).

As an example of the ***third*** calculation, consider the data of the number 1, the health insurance participants is aged 21 years, hospital costs average for one year is IDR 1,414,852.27 with the male gender (sex). Assumed a period of 18 years applies policy. Using equation (4), the results of the calculation are as follows:

From Indonesian Mortality Table (*RP - 2000 Combined Healthy Male and Female Combined Helathy*), obtained values of commutation: $\overline{D}_{21}$ = 283,618.3314;…; $\overline{D}_{38}$ = 101,755.4512; N_{21} = 444,474; N_{38} = 142,750.50 and probability q_{21} = 0.000357; …; q_{38} = 0.00964 so the:

$$P = \frac{1,414,852.27}{44,474 - 142,750.5} \times \left[(283,618.3314 \times 0.000357) + (266,975.903 \times 0.000366) + \right.$$
$$\left. \cdots + (101,755.4512 \times 0.00964) \right]$$
$$= 1,414,852.27 \times \frac{(101.2517 + 97.7132 + \cdots + 98.0923)}{44,474 - 142,750,5} = \text{Rp } 7,092.27$$

with the total health insurance premiums to be paid is: $\text{IDR } 7,092.27 \times 18 \text{ years} = \text{IDR } 127,661.00$.

For example, the ***fourth*** calculation, consider the data of the number 2, the health insurance participants is aged 21 years, hospital costs average for one year is IDR 1,414,852.27 with the female gender (sex). Assumed a period of 18 years applies policy. Using equation (4), the results of the calculation are as follows:

From Indonesian Mortality Table (*RP - 2000 Combined Healthy Male and Female Combined Helathy*), obtained values of commutation: $\overline{D}_{21}$ = 283,618.3314;…; $\overline{D}_{38}$ = 101,755.4512; N_{21} = 444,474; N_{38} = 142,750.5 and probability q_{21} = 0.000192; …; q_{38} = 0.00598 so the:

$$P = \frac{1,414,852.27}{44,474 - 142,750.5} \times \left[(28,361.3314 \times 0.000192) + (26,6975.903 \times 0.000194) + \right.$$
$$\left. \cdots (101,755.4512 \times 0.000598) \right]$$
$$= 1,414,852.27 \times \frac{(54.4547 + 51.7933 + \cdots + 60.8498)}{282,469 - 66,694.6} = \text{IDR } 4,157.80$$

with the total health insurance premiums to be paid is: $\text{IDR } 4,157.80 \times 18 \text{ years} = \text{IDR } 74,840.40$

So for example the calculation of the third the amount of health insurance premiums to be paid each year is IDR 7,092.27, with the total premium for 18 years is IDR 127,661.00. Whereas for fourth calculation example, the amount of the health insurance premiums to be paid each year is IDR 4,157.80, with the total premium for 18 years is IDR 74,840.40.

Discussion. Based on the calculations have been done, can be compared by gender (sex) is a premium on males gender (sex) were higher than the premium female. The premium on males gender is greater because chances pain in males larger than females. The amount of pain opportunities (q_{sh}) can be seen in the table *RP - 2000 Combined Healthy Male and Female Combined Healthy*. In addition to gender, the amount of the premium can also be compared based on the types of premium, that is the net premiums of the health insurance for poor families are renewable every year, its value is greater than the net premiums are not renewable every year. More detail can be seen from Table-3.

Table-3: Comparison of Health Insurance Premiums for Poor Families

Sex (Gender)	Premiums are renewed every year	Premiums are not renewed every year
Male	IDR 141,779.00	IDR 127,661.00
Female	IDR 84,516.80	IDR 74,840.40

Based on the results of the calculation are given in Table-3, it appears that the relief to the poor family health insurance, for sex male and female, when applied to net premiums which are not renewed every year.

CONCLUSION AND SUGGESTION

Conclusion. This paper has examined the calculation model of health insurance premiums for poor families. Calculation net premiums of the health insurance for poor families, can be done by using a clean approach to health insurance premiums which are renewable every year, and health insurance premiums are not renewable every year. The amount of net premiums of health insurance which are renewable every year greater value. While net premiums of health insurance that are not renewable every year is fixed value. Gender (sex) health insurance, is one of the factors that affect the amount of health insurance premiums. Age is also a factor that affects the amount of health insurance premiums. The increasing age of the participant's health insurance, the greater the premium to be paid by health insurance.

Suggestion. Recording the data required to calculate the amount of health insurance premiums poor families should be done with detail, so expect obtained results more accurate calculations and appropriate. Calculation of the poor family health insurance premiums, should consider other factors that affect the poor family health insurance premiums, for example, the status of the work.

ACKNOWLEDGEMENTS

REFERENCES

[1] Cichon, M., Newbrander, W., Yamabana, H., Weber, A., Normand, C., • Dror, D. and Preker, A. (1999). *Modelling in health care finance. A compendium of quantitative techniquesfor health carefinancing.* Quantitative Method in Social Protection Series. International Labour Office, Geneva.

[2] Cavagnero, E., Carrin, G. and Torres, R. (2010). A National Social Health Insurance Plan for Argentina: Simulating Its Financial Feasibility. *Discussion Paper.* World Health Organization.

[3] Dwicaksono, A., Nurman, A. dan Prasetya, P.Y. (2012). *JAMKESMAS dan Program Jaminan Kesehatan Daerah* (JAMKESMAS *and Regional Health Insurance Program).* Laporan Pengkajian di 8 Kabupaten/Kota dan 2 Provinsi. Bandung: Perkumpulan INISIATIF. ISBN: 978-979-25-2109-2.

[4] Futami, T. (1993). *Matematika Asuransi Jiwa, Bagian 1* (*Life Insurance Mathematics, Part 1).* Tokyo: Incorporated Foundation Oriental Life Insurance Cultural Development Center.

[5] Futami, T. (1994). *Matematika Asuransi Jiwa, Bagian 2* (*Life Insurance Mathematics, Part 2).* Tokyo: Incorporated Foundation Oriental Life Insurance Cultural Development Center.

[6] Karnon, J., Mackay, M. and Mills, T.M. (2009). Mathematical Modelling in Health Care. *Working Paper.* 18th World IMACS / MODSIM Congress, Cairns, Australia 13-17 July 2009. http://mssanz.org.au/modsim09.

[7]   Mesike, G.C., Adeleke, I.A. and Ibiwoye, A. (2012). Predictive Actuarial Modeling of Health Insurance Claim Costs. *International Journal of Mathematics and Computation,* ISSN 0974-570X (Online), ISSN 0974-5718 (Print), Vol. 14, Issue No. 1, Year 2012. Copyright @ 2011-12 by CESER Publucations.

[8]   Pradipta, Y., Widana, I.N. dan Sugiarto, Y.B. (2013). Pengaruh Perubahan Suku Bunga Terhadap Perhitungan Premi Neto Tahunan Asuransi Kesehatan Individu (*Effect of Interest Rate Changes To The Net Premium Calculation of Annual Individual Health Insurance*). *E-Jurnal Matematika* Vol. 2, No.3, Agustus 2013, 17-22, ISSN: 2303-1751.

[9]   Lahallo, A.P.T.P., Widana, I.N. dan Nilakusumawati, D.P.E. (2013). Perumusan Premi Bulanan Asuransi Kesehatan individu Perawatan Rumah Sakit (Anuitas Hidup Pembayaran Bulanan) (*Formulation of individual Health Insurance Premiums Monthly Care Hospital (Life Annuity Payments Monthly)*). *E-Jurnal Matematika* Vol. 2, No.4, Nopember 2013, 40-45, ISSN: 2303-1751.

[10]   Squires, H. and Tappenden, P. (2011). *Mathematical Modelling and Its Application to Social Care*. NIHR School for Social Care Research, London School of Economics and Political Science, ISBN 978-0-85328-452-9.