

ANALYSIS STUDY ON THE COST-EFFECTIVENESS OF COMMUNITY NURSING SERVICES IN ASSISTED COMMUNITIES FOR THE YEAR 2010 IN SIBIU COUNTY

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I. INTRODUCTION

The burden of disease can be reduced by different interventions. In order to determine the optimal intervention from a series of alternatives, certain factors must be considered, such as the cost-effectiveness of the intervention.

In order to cope with the burden of disease and risk factors, most necessary funds required to finance a adequate health system depend on large array of variables. There is no direct relationship between conventional indicators of the burden of disease and the need for resources: some diseases can be treated in a simple fashion with low costs, whereas others require a very expensive treatment and care. The profile of expenses varies according to the age of the beneficiary and on-coming death [1].

II. PRESENTATION OF THE STUDY

1. Cost-effectiveness analysis is an economic evaluation that compares costs and consequences of two or more alternatives, from which one of the results is expressed in natural units. The index used is the proportion between total actualized costs and effects obtained (C/E) [2].

2. Type of study: Applied scientific research (intervention)

3. Background: Verifying the hypothesis according to which in the year 2010 in Sibiu county community nursing specific interventions were cost-effective, bringing advantages to the economy by the gain in health due to years of life lived extra by the population from towns that benefited from these services (study sample), compared with the population from the other towns (witness study).

4. Object of the study: The cost-effectiveness analysis, considering the health benefit due to community nursing specific interventions, by comparing the burden of disease from

The burden of disease can be reduced by different interventions. In order to determine the optimal intervention from a series of alternatives, certain factors must be considered, such as the cost-effectiveness of the intervention.

OBJECT OF THE STUDY: *The cost-effectiveness analysis, considering the health benefit due to community nursing specific interventions, by comparing the burden of disease from assisted communities (study sample) with the levels of the burden of disease from unassisted communities (witness sample).*

SCOPE OF THE STUDY: *Adapting community nursing services to specific health problems identified in each zone and community, on the criteria of cost-effectiveness.*

METHOD OF RESEARCH: *Method for estimating the years of life lost by premature death, (from the Cost-Effectiveness Analyze model proposed by W.H.O.) on the assisted population. (study sample) and on unassisted population (witness sample) by community personnel in the year 2010, comparing the results obtained on the two strands (survival curve), and estimating the health benefit obtained by community nursing: number of extra years lived, the effectiveness of interventions, (back-adjusting method), costs.*

RESULTS AND DISCUSSIONS: *In the year 2010 in Sibiu county, community nursing specific interventions were cost-effective, bringing economical advantages by the health gain due to the years of life gained by the population of the community that benefited from this type of services (study sample), compared to the population of the other communities (witness sample).*

CONCLUSIONS: *Community nursing specific interventions are cost-effective. These interventions can be generalized and can be sustained on the long term with minimum costs, generating important benefits for the entire population. Community nursing specific interventions need to be permanently adapted to the ever changing populations needs by public health management.*

Keywords: *community nursing, burden of disease, cost-effectiveness of services.*

assisted communities (study sample) with the levels of the burden of disease from unassisted communities (witness sample).

5. Scope of the study: Adapting community nursing services to specific health problems identified in each zone and community, on the criteria of cost-effectiveness.

6. Methods of research:

For this study were used few methods like:

- method for estimating the years of life lost by premature death, (from the *Cost-Effectiveness Analyze model proposed by W.H.O.*) on the assisted population (study sample) and on unassisted population (witness sample) by community personnel in the year 2010 [2];
- comparing the results obtained on the two strands (survival curve) [2];

- estimating the health benefit obtained by community nursing: number of extra years lived;
- calculating the effectiveness of interventions, (adapting *back-adjusting method*) [2];
- calculating the cost-effectiveness of community nursing interventions ratio.

III. RESEARCH STAGES

Stage A. Comparative analysis of years of life gained by the population that benefited from community nursing (survival curve)

A.1. Calculating the life tables [3] for the two populations (assisted and unassisted) and respective to gender the following variables [4]:

- x – exact age
- n – the size of range between ages
- ${}_n P_x$ – population on January 1th 2008 on years of age
- ${}_n D_x$ – number of deaths at age x , in 2008 within population P_x
- ${}_n M_x$ – specific mortality at age x for P_x
- a – constant
- ${}_n q_x$ – probability of death at age x for P_x
- ${}_n p_x$ – probability of survival to age $x + 1$ for P_x
- l_x – cohort set arbitrarily (value 100000)
- ${}_n d_x$ – number of deaths at age x in the cohort l_x for the probability of death q_x
- ${}_n L_x$ – number of years lived by survivors from l_x between ages x and $x + 1$
- T_x – total number of years lived by the generation studied from l_x
- e_x – life expectancy at age x

A.2. In order to prove that there are no statistically significant differences between the two populations (assisted and unassisted), namely in the structure of the sex and the 18 age groups, were proceeded to a **dispersion analysis** by applying the **R. Fisher** formula [5]:

$$F = \frac{S_1}{S_2} = \frac{\frac{1}{n_1 - 1} \sum_1^{n_1} (X_i - \bar{X}_{n_1})^2}{\frac{1}{n_2 - 1} \sum_1^{n_2} (Y_i - \bar{Y}_{n_2})^2}$$

Hypothesis:

$$H_0 : F_{\text{calculated}} = \frac{S_1}{S_2} \leq F_{\text{table}}$$

$$H_a : F_{\text{calculated}} = \frac{S_1}{S_2} > F_{\text{table}}$$

Was accepted the null hypothesis H_0 demonstrating that, in terms of structure by sex and age groups, they are part of

the population of Sibiu county, the affirmation stands at a probability of 95% and a risk α of 0.05. If there are significant differences in health status between the two populations, they are due to the action of favorable external factors, in this case community nursing.

A.3. Information processing

- Calculating the difference between the life expectancy of men and women in the assisted communities and unassisted communities;
- Calculating the percent of survivors from ${}_n L_x$ of the exact x and $x+1$ age, for the two samples;
- Calculating the difference between the total number of years lived by the assisted cohort and by the unassisted cohort, T_x assisted - T_x unassisted, respectively.

Data source: The statistical data necessary for the study were taken and centralized from the existing statistical posts from the Sibiu County Statistics Center and The Informatics and Statistics Compartment from Health Department of Sibiu County.

A.4. Comparing results

Placing the data into tables and graphically representing the results: life expectancy and survival curve.

Stage B. Calculating the cost-effectiveness of community nursing services

B.1. Adapting the back-adjusting formula [2]:

Notations:

$$\lambda_N = \frac{\lambda_c}{1 - (c \times e)} \quad \text{therefore} \quad e = \frac{\lambda_N - \lambda_c}{\lambda_N \times c}$$

λ_N = DALY rate for the unassisted for the null situation (*witness sample*);

λ_c = DALY rate for the assisted communities for the present situation (*study sample*);

c = percent of the population covered by community nursing in the year 2008.

e = effectiveness of community nursing services

Data source: DALY (Disability Adjusted Life Year) rates, representing years of life lost (YLLs) + years of life lived with disability [6], I have obtained from **Study concerning the county and local burden of disease for Sibiu county, (cross-sectional study)** and comparative analysis of health issues according to their “burden” on the population from communities that benefit from community nursing and unassisted

communities – Dr. Doina Merla, Doctoral Thesis “*Reducing the burden of disease by developing of community nursing*”, “Lucian Blaga” University of Sibiu, 2010 [7].

The number of healthy years of life lost by premature death and disability (DALYs) for the two samples of population was:

Study sample **42050 DALYs** per total population (**270795 persons**), a rate of **155.3⁰/₀₀**, namely:

- **23501 DALYs men** with a rate of **180.2⁰/₀₀**
- **18548 DALYs women** with a rate of **132.1⁰/₀₀**
- Witness sample **26938 DALYs** per total population (**154064 persons**), a rate of **174.8⁰/₀₀**, namely:
- **15569 DALYs men** with a rate of **204.9⁰/₀₀**
- **11369 DALYs women** with a rate of **145.6⁰/₀₀**

B2. Calculating the cost-effectiveness ratio (RCA)

The general formula used to calculate the cost-effectiveness ratio (CER) is [2]:

$$\text{CER} = \frac{\text{Sum of Costs}}{\text{Sum of Benefic Effects}}$$

The cost-effectiveness of the services was determined based on the data resulted from stages **A** and **B**.

Statistical collectivity (statistical population) representing the object of the statistical analysis:

- **study sample** – the population of Sibiu county that benefited from community nursing = 270795 persons, of which 82791 assisted persons;
- **witness sample** – the population from Sibiu county that did not benefit from community nursing = 154064 persons.

Variables analyzed:

- **independent variables: gender, age group, number of population for the two samples, number of deaths, DALY rates, coverage percent, budget for 2008;**
- **continuous quantitative dependent variables:** life expectancy, survivors, differences in years of life lived, cost-effectiveness of services.

Statistical series

- bivariate: the string of values corresponding to the difference between the two populations;

Instruments used:

- Microsoft Office Excel for the registering, complex **grouping and data processing. Simple statistic tables, grouping tables and correlation tables were obtained, and formulae mathematical and statistical functions were applied for the calculus of analytical and synthetic statistic indicators;**
- **Exercise for applying the calculation method for the adjusted table of mortality Brass Growth Balance, and Excel template with illustrations of the application;**

- **Standard set of values L_x for the life table;**
- **Microsoft Office Word for the editing of the study, presenting information and results, graphical representation of the material** resulted from the research, analysis and synthesis;

IV. RESULTS

In the year 2010, a number of **82791** persons from Sibiu county (studied sample) benefited from community nursing, representing **19.54%** of the total population of Sibiu county and **30.57%** of the total population from assisted communities; considering these conditions, the standard was of **2500** persons/community nurse and **500-750** persons of roma ethnicity/sanitary mediator.

Supplying criteria for economical evaluation of community nursing and verifying the hypothesis according to which, in Sibiu county, community nursing specific interventions were cost-effective, bringing economical advantages by the health gain due to the years of life gained by the population of the community that benefited from this type of services (study sample), compared to the population of the other communities (witness sample), conducted to the following results:

- The difference between the life expectancies at birth for the two samples is obviously favorable to the male population from the studied sample, the largest difference being for these groups of age: 15-19 years = **1.98** years, 10-14 years = **1.93** years and 20-24 years = **1.83** years.
- The difference between total number of years lived by the assisted male cohort and the unassisted male cohort: assisted Tx - unassisted Tx, namely 7147635-6995885=**151750 years of life gained** by male population from the researched sample. (*Table no 1, Graph no 1*)
- Also, the difference between the life expectancies at birth for the two samples is favorable to the female population from the studied sample, the largest difference being for these groups of age: 35-39 years = **1.06** years, 15-19 years = **1.03** years and 45-49 years = **1.00** years.
- The difference between the total number of years lived by the assisted women cohort and the unassisted women cohort – assisted Tx – unassisted Tx, namely 7825011-7758635=**66376 years of life gained** by the female population of the researched sample. (*Table no 2, Graph no 2*)
- A gain of **218126 years of life gained** by the assisted population compared to the unassisted population was recorded, more of the gained years being lived by men (**151750**) compared to the number of years gained by women (**66376**).
- The allocated budget from the Ministry of Health to Sibiu county for the VI National Program – Community Nursing and Actions for Health was of **1049000** lei;

Table 1 - Life table for men, with and without community nursing, Sibiu county for the year 2008

Age group x	Men from the researched sample				Men from the witness sample			
	l_x	${}_n d_x$	T_x	e_x	l_x	${}_n d_x$	T_x	e_x
0-1	100000	891	7147635	71.48	100000	924	6995885	69.96
1-4	99109	341	7048436	71.12	99076	0	6896716	69.61
5-9	98768	283	6652819	67.36	99076	0	6500411	65.61
10-14	98485	73	6159688	62.54	99076	0	6005028	60.61
15-19	98412	169	5667446	57.59	99076	445	5509646	55.61
20-24	98243	466	5175809	52.68	98631	530	5015378	50.85
25-29	97777	202	4685758	47.92	98101	393	4523547	46.11
30-34	97575	492	4197377	43.02	97708	438	4034024	41.29
35-39	97083	874	3710732	38.22	97270	1338	3546579	36.46
40-44	96209	1544	3227501	33.55	95932	2014	3063573	31.93
45-49	94665	2975	2750315	29.05	93918	3895	2588946	27.57
50-54	91690	4964	2284428	24.91	90024	5095	2129091	23.65
55-59	86726	6135	1838388	21.20	84929	7614	1691709	19.92
60-64	80591	6858	1420094	17.62	77315	8147	1286098	16.63
65-69	73733	13486	1034282	14.03	69168	12405	919891	13.30
70-74	60247	14304	699330	11.61	56763	14042	605064	10.66
75-79	45944	15529	433852	9.44	42721	15431	356354	8.34
80-84	30414	12499	242958	7.99	27290	15280	181328	6.64
85+	17915	17915	122134	6.82	12009	12009	83080	6.92

Notations:

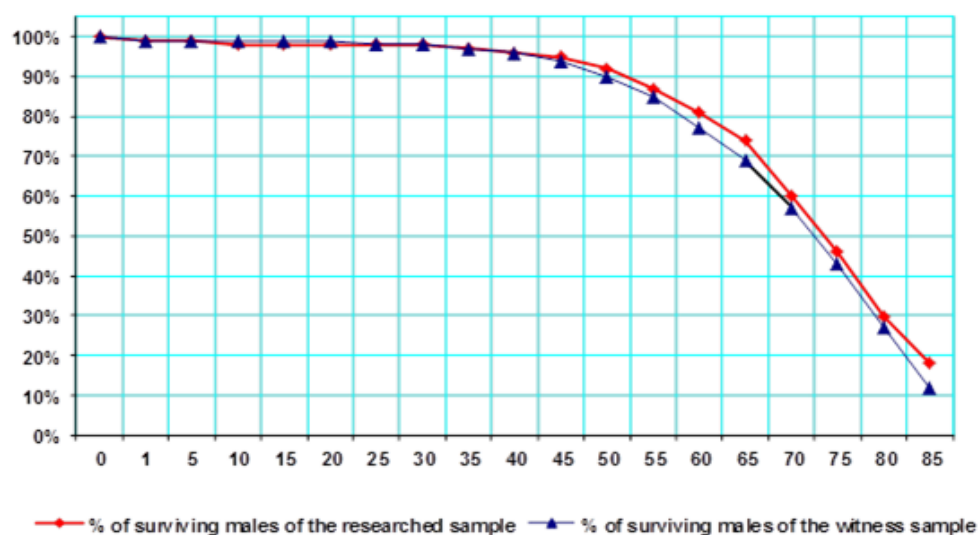
x – the exact age of the men in the two cohorts

l_x – cohort arbitrarily set (value 100000)

${}_n d_x$ – număr number of man deaths at age x in the cohort l_x for the probability of death q_x

T_x – total number of years lived by the generation studied from l_x

Graph 1 - Percent of surviving males from l_x between the exact age of x and $x+1$ for the two samples (survival curve), Sibiu county



- The cost-effectiveness ratio was:

$$RCE = \frac{\text{The cost per 1 year of life gained}}{\text{The effectiveness of community nursing interventions}} \Rightarrow \frac{4,81}{0,3631} = 132,47$$

- The effectiveness of community nursing for Sibiu county was of **0.3631**, or **36.31%** for a population coverage percent of **30.57%**.

- The average cost/assisted person/the year 2008 was of **12.67 lei**.
- The cost per 1 year of life gained was of **4.81 lei**.

V. CONCLUSIONS

Community nursing specific interventions are cost-effective.

The interventions of community nursing are supplied on the basic level of the health system and their main objective is promoting health (education for health, prevention and maintaining health) offering considerable economical advantages by health gain, reducing inequalities and costs for secondary healthcare level (hospitalization). These interventions can be generalized and can be sustained on the long term with minimum costs, generating important benefits for the entire population.

Community nursing specific interventions need to be permanently adapted to the ever changing populations needs by public health management. → **24**

Table 2 - Life table for women with and without community nursing services, Sibiu county

Age group x	Women from the researched sample				Women from the witness sample			
	l_x	ndx	T_x	ex	l_x	ndx	T_x	ex
0-1	100000	929	7825011	78.25	100000	876	7758635	77.59
1-4	99071	142	7725847	77.98	99124	0	7659423	77.27
5-9	98929	224	7329905	74.09	99124	117	7262926	73.27
10-14	98705	307	6835820	69.26	99007	114	6767597	68.35
15-19	98398	57	6343063	64.46	98893	188	6272846	63.43
20-24	98341	125	5851216	59.50	98705	239	5778851	58.55
25-29	98216	164	5359824	54.57	98466	89	5285924	53.68
30-34	98052	263	4869152	49.66	98377	0	4793818	48.73
35-39	97790	237	4379548	44.79	98377	715	4301934	43.73
40-44	97552	820	3891193	39.89	97662	464	3811838	39.03
45-49	96732	1321	3405482	35.21	97198	1913	3324688	34.21
50-54	95411	1270	2925125	30.66	95285	1651	2843480	29.84
55-59	94141	3208	2451244	26.04	93635	2359	2371180	25.32
60-64	90933	3528	1988557	21.87	91276	3796	1908903	20.91
65-69	87405	5881	1542712	17.65	87480	8517	1462013	16.71
70-74	81524	10559	1120390	13.74	78964	11042	1045904	13.25
75-79	70965	15457	739167	10.42	67921	16710	678692	9.99
80-84	55508	21044	422983	7.62	51211	21638	380861	7.44
85+	34465	34465	198050	5.75	29572	29572	178903	6.05

Notations:

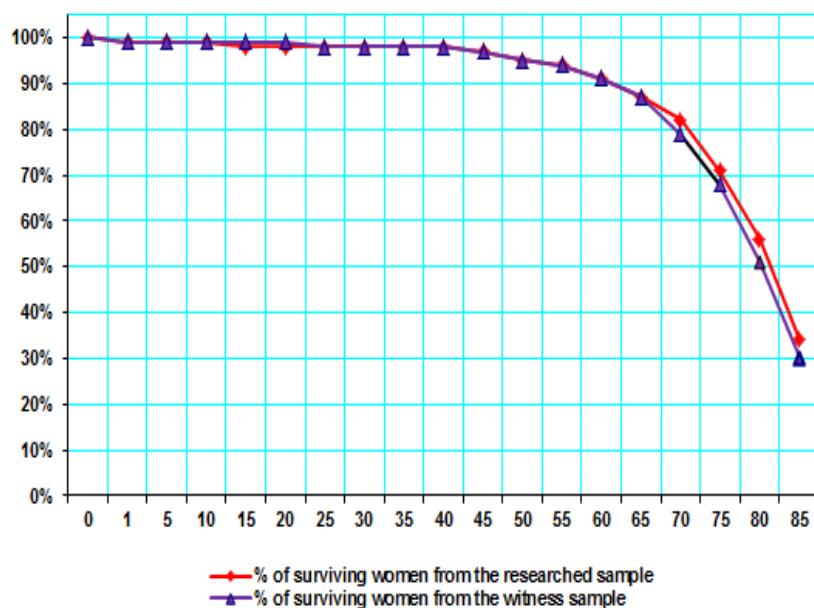
x – the exact age of the women in the two cohorts

l_x – cohort arbitrarily set (value 100000)

ndx – number of women deaths at age x in the cohort l_x for the probability of death q_x

T_x – total number of years lived by the generation studied from l_x

Graph 2 - Percent of surviving women from l_x between the exact age of x and $x+1$ according to the two samples (survival curve), Sibiu county



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