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DETERMINANTS OF ALL CAUSE MORTALITY IN POLAND

UWARUNKOWANIA UMIERALNOŚCI OGÓLNEJ W POLSCE

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ABSTRACT

AIM. The study objective was to evaluate quantitatively the relationship between demographic characteristics, socio-economic status and medical care resources with all cause mortality in Poland.
MATERIALS AND METHOD. Ecological study was performed using data for the population of 66 subregions of Poland, obtained from the Central Statistical Office of Poland. The information on the determinants of health and all cause mortality covered the period from 1st January 2005 to 31st December 2010. Results for the repeated measures were analyzed using Generalized Estimating Equations GEE model. In the model 16 independent variables describing health determinants were used, including 6 demographic variables, 6 socio-economic variables, 4 medical care variables. The dependent variable, was age standardized all cause mortality rate.
RESULTS. There was a large variation in all cause mortality, demographic features, socio-economic characteristics, and medical care resources by subregion. All cause mortality showed weak associations with demographic features, among which only the increased divorce rate was associated with higher mortality rate. Increased education level, salaries, Gross Domestic Product (GDP) per capita, local government expenditures per capita and the number of non-governmental organizations per 10 thousand population was associated with decrease in all cause mortality. The increase of unemployment rate was related with a decrease of all cause mortality. Beneficial relationship between employment of medical staff and mortality was observed.
CONCLUSIONS. Variation in mortality from all causes in Poland was explained partly by variation in socio--economic determinants and health care resources.

KEY WORDS: *health inequalities, mortality, health correlates, subregions of Poland*

STRESZCZENIE

CEL PRACY. Celem pracy była ilościowa ocena związków pomiędzy cechami demograficznymi, pozycją socjo--ekonomiczną oraz zasobami opieki zdrowotnej a umieralnością ogólną w Polsce.
MATERIAŁ I METODA. Wykonano badanie ekologiczne z wykorzystaniem danych dla 66 podregionów Polski, które uzyskano z Głównego Urzędu Statystycznego. Informacje dotyczące uwarunkowań zdrowia oraz umieralności ogólnej populacji uzyskano dla okresu od 1 stycznia 2005 roku do 31 grudnia 2010 roku. Wyniki dla powtarzanych pomiarów poddano analizie z zastosowaniem modelu Generalized Estimating Equations GEE (uogólnione równania estymujące). W modelu użyto 16 zmiennych niezależnych opisujących determinanty stanu zdrowia, w tym: 6 zmiennych demograficznych, 6 zmiennych społeczno – ekonomicznych, 4 zmienne opieki zdrowotnej. Zmienną zależną był standaryzowany na wiek współczynnik umieralności ogólnej.
WYNIKI. Podregiony Polski charakteryzowały się silnym zróżnicowaniem pod względem umieralności ogólnej oraz charakterystyki demograficznej, społeczno – ekonomicznej i pod względem zasobów opieki zdrowotnej. Umieralność ogólna była słabo powiązana z cechami demograficznymi, wśród których tylko zwiększenie współczynnika rozwodów wiązało się ze zwiększeniem umieralności ogólnej. Stwierdzono, że wyższy poziom wykształcenia, wynagrodzeń, PKB na mieszkańca, wydatków samorządu terytorialnego na mieszkańca oraz

liczby organizacji pozarządowych na 10 000 mieszkańców miał związek z mniejszą umieralnością, a wzrost stopy bezrobocia wiązał się ze wzrostem umieralności. Stwierdzono korzystne związki pomiędzy zatrudnieniem kadr medycznych a umieralnością.

WNIOSKI. Zróżnicowanie umieralności ogólnej w Polsce można częściowo wyjaśnić zróżnicowaniem uwarunkowań społeczno – ekonomicznymi i zasobów opieki zdrowotnej.

SŁOWA KLUCZOWE: *nierówności w zdrowiu, umieralność, korelaty zdrowia, podregiony Polski*

INTRODUCTION

Health status of the population is determined by a number of interrelated factors that may change dynamically. Uneven distribution of social, economic, environmental or even political factors leads to health inequalities. Socio-economic inequalities in health are related to a broad range of differences in both health experience and health status between countries, regions and socio-economic groups (1). Populations vary in the level of education and possibilities of professional development, the labor market, social system and health care, as well as social support. Moreover, substantial differences may be related to lifestyle, health carelessness, ignoring symptoms of diseases, non-compliance with doctor's advice or lack of due care to maintain safety conditions in the workplace (2,3). Large differences in health may also be associated with living in certain environmental conditions and geographic areas (4). Health inequalities are caused by diverse exposure and sensitivity to health determinants. The differences in health resulting from the impact of independent factors can be avoided, since they are due to unequal chances, discrepant access to health services and material resources, as well as choices of lifestyle (2).

In many European countries, almost all major health problems are more common in the lower socio-economic classes, who are more exposed to health risks arising from the physical environment, experience more psycho-social stress and who present harmful health behaviors more frequently. As a result, people from the lower socio-economic classes are more likely to suffer from certain chronic illnesses and disabilities. Socio-economic position is associated with the level of morbidity and mortality due to cardiovascular diseases, cancer, infectious diseases, mental disorders, liver cirrhosis and diabetes (5,6).

There is abundant scientific evidence on disparities in health conditions. One of the first comprehensive publications was *Black's* report prepared in the 1980s by a group of experts of the British government (7), which was followed in the 1990s by the studies of *Acheson* (8). Health inequalities have been the subject of analysis by the World Health Organization, which in 2005 established the Commission of Social Determinants of Health, responsible for observational and field research (9). The European Union accepted scientific evidence on disparities in health between rich countries and low-income countries (10) and defined reduction of them as one of priority objectives in the current EU health strategy (11). The aim to reduce health inequalities was included in the Polish National Health Programme for 2007-2015, which stated its main goal as "Improvement of health and related quality of life of the population and reduction in health inequalities" (12). Tackling health inequalities may bring significant benefits associated with prolonged life expectancy, reduced premature mortality and prolonged period of professional activity, which justifies the need for research in this field.

The study objective was to evaluate quantitatively the relationship between demographic characteristics, socio-economic status and medical care resources with all cause mortality in Poland.

MATERIALS AND METHODS

Ecological study was conducted using data obtained from the Central Statistical Office of Poland (GUS). The units of observation were 66 subregions of Poland, created by Regulation of the Council of Ministers of 13th July 2000 on the implementation of the Nomenclature of Territorial Units for Statistics (NUTS) (13). The rationale for the selection of 66 subregions was the availability of the statistical information on important socio-economic characteristics (higher education, Gross Domestic Product (GDP) per capita), which were not available for smaller administrative units in Poland.

Information on demographic, socio-economic, and health care resources and on all cause mortality for the populations of 66 subregions was collected for the period from 1st January 2005 to 31st December 2010. The information was complete, except for the GDP per capita, which was not available for the year 2010 at sub-regional level.

The distribution of all causes mortality rates, demographic features, socio-economic characteristics and those concerning health care resources in 66 subregions of Poland was described by giving the mean, standard deviation, the minimum and the maximum values. The relationships were tested using Spearman's nonparametric correlation coefficients.The associations of the repeated measures were analyzed using the Generalized

Estimating Equations (GEE) model (14,15). A total of 16 independent variables describing health status determinants were used, including 6 demographic variables, 6 socio-economic variables, 4 medical care variables and 1 dependent variable, namely the standardized mortality rate calculated for the standard Polish population in a respective calendar year.

The GEE model have been applied, because it allows to use data including repeated measurements for the same statistical units. Taking into account correlations between repeated measurements. The model allows for correct estimates of the parameters (compared to simple linear regression model). Ignoring these correlations leads to overestimating of standard errors and inflates Type II error.

In calculations it was assumed, that correlations between measurements from different years were constant, and appropriate (exchangeable) structure of working correlation matrix was chosen.

Each of the created models contained one of the demographic, social, economic or health care-related factors, as well as the percentage of men and percentage of urban population.

In each model, data from six consecutive years were used: 2005, 2006, 2007, 2008, 2009, 2010, where 2005 was the reference point. The result of the analysis was presented as the expected change in the general mortality rate per 100 000 of the population, calculated as a change in the independent variable by one standard deviation, at 95% confidence interval. Statistical analysis was performed using IBM® SPSS® Statistics 20.0.

RESULTS

There was a large variation in all cause mortality, demographic features, socio-economic characteristics, and medical care resources by subregion. There was 40% difference between the highest and the lowest mortality rate (table I).

Subregions differed slightly in sex distribution. Larger variation was found in the proportion of urban

Table I.   Distribution of the standardized all cause mortality rates in 66 Polish subregions in the years 2005-2010

Tabela I.   Rozkład standaryzowanych współczynników umieralności ogólnej w 66 podregionach Polski w latach 2005-2010

Specification	2005	2006	2007	2008	2009	2010
$\overline{x}$ (SD)	970,7 (72,0)	976,0 (76,9)	1081,0 (82,8)	1081,6 (80,1)	1094,0 (86,5)	1073,6 (85,6)
Min/max	834,9-1126,4	831,0-1173,4	905,2-1269,4	922,1-1256,4	925,2-1257,0	903,4-1235,1

Symbols: $\overline{x}$ - mean value; SD – standard deviation; min – the lowest value; max – the maximum value
Source: Central Statistical Office
Źródło: GUS

population, divorce rate, and in- and out-migration. There were also disparities in the socio-economic development between subregions, including the percentage of the gross enrollment rate and the unemployment rate. There was a 5-fold difference in GDP per capita between the poorest and the richest subregion. The disparities in health care resources tended to increase (table II).

Correlations were found between demographic, socio-economic and health care resources (table III). Marriage and divorce rates were strongly associated with socio-economic features (enrollment rate at tertiary level, salary, GDP and local government expenditures per capita). The inmigration rate was connected only with gross tertiary education enrollment ratio, and the out migration rate with the local government expenditure per capita and the unemployment rate. The existence of non-governmental organizations had no effect on demographic situation.

Health care resources were associated with demographic and socio-economic characteristics. The exception was the rate of midwives which was not associated with the marriage and divorce rates or GDP per capita, as well as the ratio of hospital beds which was not related to the local government expenditures per capita. Mutual reinforcement was noted between all the features within the health care group.

Relationship between all cause mortality and demographic, socio-economic and health care characteristics is presented in table IV. The increase of divorce ratio by 1 standard deviation was related with increase in mortality by 33,18/100 000 population. All socio-economic characteristics were strongly associated with mortality. The strongest negative relationship was found for gross enrollment rate in higher education ratio, for which increase by one standard deviation was associated with decrease in mortality by 64,16/100 000. Strong negative relationships were also found in respect for salaries (-43,37/100 000 per 1 standard deviation) and local government expenditures per capita (-42,71/100 000 per 1 standard deviation). Increase of unemployment rate by one standard deviation was associated with the increase in all cause mortality by 38,64/100 000 per 1 standard deviation. Negative associations were also found for GDP and non-governmental organizations rate

Characteristics of health care were negatively associated with general mortality. The most pronounced relation was found for the number of employed physicians (-64,66/100 000 per 1 standard deviation). Relationship for nurses and midwives rates was less pronounced but significant.

DISCUSSION

Table II. Distribution of demographic, socio-economic and health care resources characteristics in 66 Polish subregions in the years 2005-2010

Tabela II. Rozkład cech demograficznych, socjo–ekonomicznych oraz zasobów opieki zdrowotnej w 66 podregionach Polski w latach 2005-2010

Specification		2005	2006	2007	2008	2009	2010
% men	$\overline{x}$ (SD)	48,5 (0,8)	48,5 (0,8)	48,4 (0,8)	48,4 (0,8)	48,4 (0,8)	48,4 (0,8)
	min/max	45,6-49,6	45,5-49,6	45,5-49,5	45,5-49,5	45,4-49,5	45,4-49,6
% urban population	$\overline{x}$ (SD)	59,2 (20,5)	59,1 (20,5)	59,1 (20,5)	59,0 (20,5)	58,9 (20,4)	58,9 (20,4)
	min/max	23,0-100,0	22,9-100,0	22,8-100,0	22,7-100,0	22,7-100,0	22,6-100,0
Marriages per 1 000 of the population	$\overline{x}$ (SD)	5,4 (0,4)	6,0 (0,4)	6,6 (0,5)	6,8 (0,5)	6,6 (0,4)	6,0 (0,4)
	min/max	4,5-6,1	5,0-6,7	5,3-7,7	5,6-7,8	5,5-7,4	5,1-6,9
Divorces per 1 000 of the population	$\overline{x}$ (SD)	1,8 (0,5)	1,9 (0,7)	1,7 (0,5)	1,7 (0,5)	1,7 (0,5)	1,6 (0,4)
	min/max	0,6-3,0	0,5-3,7	0,7-2,9	0,7-2,8	0,6-3,2	0,8-2,6
In-migration per 1 000 of the population	$\overline{x}$ (SD)	11,9 (2,0)	13,9 (2,3)	14,6 (2,2)	11,7 (2,0)	11,3 (1,8)	11,7 (1,8)
	min/max	7,1-15,9	8,1-18,3	8,8-18,3	7,2-15,3	6,9-14,7	7,7-15,2
Out-migration per 1 000 of the population	$\overline{x}$ (SD)	11,3 (3,1)	12,7 (3,8)	13,9 (4,3)	11,1 (3,4)	11,1 (3,3)	11,5 (3,5)
	min/max	5,3-23,7	5,7-26,1	6,1-29,6	5,0-23,4	5,0-23,0	5,5-22,9
% gross enrollment rate – higher education	$\overline{x}$ (SD)	4,5 (5,7)	4,5 (5,8)	4,5 (5,9)	4,5 (6,1)	4,4 (6,0)	4,0 (5,8)
	min/max	0,00-23,4	0,00-24,0	0,02-25,2	0,01-25,4	0,01-24,8	0,0-24,5
Salary in PLN	$\overline{x}$ (SD)	2256,8 (326,3)	2370,9 (343,1)	2581,0 (368,6)	2841,5 (405,6)	2978,0 (413,8)	3090,4 (415,4)
	min/max	1864,1-3613,4	1971,4-3789,9	2154,6-4099,7	2401,1-4504,9	2490,1-4603,3	2603,7-4694,5
Gross Domestic Product per 1 inhabitant	$\overline{x}$ (SD)	24390 (9917,9)	26267 (10898,1)	29180 (12199,7)	31656 (12788,7)	33260 (13832,6)	n/a
	min/max	14834-77001	15859-83933	17438-94185	19338-98854	19306-105340	n/a
Local government expenditure per 1 inhabitant	$\overline{x}$ (SD)	2550,9 (313,6)	2921,9 (335,2)	3110,8 (420,6)	3483,1 (505,7)	3903,3 (545,4)	4326,7 (515,3)
	min/max	2114,5-4410,5	2305,4-4755,0	2492,4-5336,9	2915,8-6160,7	3071,4-6630,7	3438,1-7048,2
Unemployment rate	$\overline{x}$ (SD)	18,9 (6,2)	16,0 (5,6)	12,3 (4,9)	10,4 (4,6)	13,2 (5,0)	13,6 (4,9)
	min/max	5,6-33,2	4,6-28,9	2,9-23,6	1,8-21,4	2,8-24,9	3,5-24,5
Non-governmental organizations per 10 000 of the population	$\overline{x}$ (SD)	20,3 (5,1)	21,6 (5,3)	23,1 (5,6)	24,2 (5,9)	25,4 (6,2)	26,4 (6,6)
	min/max	11,6-43,8	12,6-45,6	13,3-48,9	14,0-51,0	14,6-53,7	15,4-56,5
All physicians per 10 000 of the population	$\overline{x}$ (SD)	18,8 (8,1)	19,1 (8,7)	19,3 (9,0)	19,3 (9,1)	19,5 (9,4)	19,5 (9,6)
	min/max	9,1-43,1	9,2-47,2	8,8-46,3	7,5-45,2	6,5-45,7	6,0-47,6
All nurses per 10 000 of the population	$\overline{x}$ (SD)	45,4 (12,3)	45,5 (12,3)	46,4 (13,0)	46,6 (13,0)	47,3 (13,4)	46,9 (13,5)
	min/max	22,6-77,4	22,1-77,1	21,0-78,6	20,6-79,5	18,3-83,1	18,8-84,5
All midwives per 10 000 of the population	$\overline{x}$ (SD)	5,37 (1,66)	5,40 (1,69)	5,53 (1,80)	5,61 (1,88)	5,67 (1,81)	5,71 (2,13)
	min/max	2,18-11,48	1,97-11,43	2,16-12,50	2,27-13,28	2,28-12,49	2,33-16,42
All hospital beds per 10 000 of the population	$\overline{x}$ (SD)	46,0 (15,2)	45,4 (14,8)	45,1 (14,8)	47,3 (15,2)	47,2 (15,2)	46,6 (14,9)
	min/max	21,7-96,6	21,1-91,6	20,1-97,5	22,1-103,3	21,8-104,2	21,5-103,0

Symbols: $\overline{x}$ – mean value; SD – standard deviation; min – the lowest value; max – the maximum value
Source: Central Statistical Office
Źródło: GUS

Variation in mortality from all causes in 66 subregions found indicated large health inequalities in Poland. Higher socio-economic status and greater health care resources (strongly interrelated) were associated with lower mortality rates. While interpreting these findings it should be noted that they have been obtained through ecological research and thus the correlations found at the population level cannot be always related to the level of individuals (16). Although some confounding factors (urbanization and sex distribution) were included in the statistical models, it cannot be assumed that the effect of confounding was completely eliminated. An essential limitation in interpreting the results is that the current research did not include lifestyle factors, as the data concerning lifestyle are not collected at the subregional level in the system of public statistics.

The study confirmed a number of relationships that have been observed in the other countries. Striking is the relationship between general mortality and higher education found in international (17,18) and Polish studies (19). As indicated by numerous studies, weaker economic condition is a threat to the health of the population, especially in less affluent areas. This is supported by the results of the meta-analysis of 155 studies by *Wilkinson* and *Pickett* (20). In this study, strong inverse correlations of total mortality with salary and the

Table III. The matrix of correlations between independent variables (averaged data for the years 2005-2010)
Tabela III. Macierz korelacji pomiędzy zmiennymi niezależnymi (uśrednione dane dla lat 2005–2010)

	Marriages	Divorces	In-migration	Out-migration	Higher education	Wages	GDP	LGE	Unemployment rate	NGO	Physicians	Nurses	Midwives
Divorces	-,55**												
In-migration	,04	,17											
Out-migration	,17	,20	,56**										
Higher education	-,34**	,37**	-,36**	-,23									
Salary	,46**	,46**	,03	-,10	,45**								
GDP	,66**	,66**	,16	-,06	,48**	,80*							
LGE	,48**	,48**	,22	,32**	,42**	,44**	,47**						
Unemployment rate	-,09	-,09	,08	,40**	-,30*	-,58**	-,58**	-,02					
NGO	,14	,14	-,06	-,04	,61**	,01	,08	,26*	-,14				
Physicians	,34**	,34**	-,43**	-,38**	,79**	,48**	,49**	,31*	-,38**	,42**			
Nurses	,28*	,28*	-,53**	-,30*	,77**	,44**	,36**	,33**	-,32*	,47**	,88*		
Midwives	,17	,17	-,47**	-,30*	,74**	,28*	,24	,30*	-,25*	,51**	,81*	,81**	
Hospital beds	,34**	,34**	-,40**	-,28*	,61**	,38**	,40**	,24	-,35**	,36**	,82*	,82**	,71**

* $p \leq 0,001$; ** $p \leq 0,050$; Symbols: GDP - Gross Domestic Product; LGE - local government expenditure; NGO – non-governmental organizations

level of GDP per capita were also observed as shown by *Mackenbach* et al. (21) material factors, especially low income, pose restrictions on access to products and services related to health promotion (diet, sport). Due to difficult economic situation, payable health services or prophylactic examinations can be inaccessible. Financial difficulties may induce psychosocial stress, which leads to the deterioration of the health status in both biological (impairment of the immune system, chronic diseases, depression) and behavioral (unhealthy behaviors) aspects. Many studies suggest that the lower socio-economic position, the higher the likelihood of multiple risk factors, including poor education, unemployment, social isolation and irrational health behaviors (22,5). These factors are correlated and exert a cumulative effect on health status. The present study found a significant relation between the level of local government expenditure and mortality. It seems reasonable that good financial condition of public institutions enabling greater public spending not only on health but also other targets, contributes to health improvement. Health-promoting conditions in the local community are ensured due to investments in education, environmental protection, maintaining cleanliness, transport, social welfare, culture or housing, and not only in the field of health services, prevention and health promotion (23).

The results of the present study confirm the relationship between unemployment and all cause mortality, which is consistent with the results obtained in the Danish population by *Osler* et al. (24) and in the American population by *Davila* et al. (25). It should be emphasized

that the health effects of long-term unemployment are associated with stress, which leads to depression and general deterioration of the physical condition. Stress in the unemployed frequently contributes to adverse changes in health behaviors, such as diet, excessive consumption of alcohol, smoking, i.e. risk factors of many civilization diseases (26). Moreover, poor financial situation of the unemployed poses restrictions on access to medical services and medicines, which often leads to aggravation of the existing diseases. Also the shortcomings of health education, the ineffectiveness of prevention (e.g. tuberculosis, hepatitis) and unequal access to medical care can be enhanced by unemployment (27). Unemployment is a serious menace to health through the accumulation of a multitude of negative factors which may lead to shortening of life span.

The relationship between mortality and the divorce rate was found in a prospective study by *Ikeda* et al. conducted among the Japanese population (28). Similar results were obtained in a study on the American population, performed by *Patterson* and *Veenstra*, who stated that being lonely increases the risk of general mortality (29).

The present study showed a strong inverse relationship between the existence of non-governmental organizations and general mortality, which can be attributed to the positive impact of social ties on the population health (30-32). Based on the review of 148 studies *Holt-Lundstad* et al. indicated that the probability of survival was 50% higher among those with stronger social ties compared to those with weaker social ties.

Table IV. Expected change in all cause mortality rate by change of 1 standard deviation in demographic, socio-economic and health-care characteristics adjusted for the percent of men and percent of urban population

Tabela IV. Oczekiwana zmiana współczynników umieralności ogólnej w zależności zmiany cech demograficznych, społeczno – ekonomicznych i opieki zdrowotnej (o 1 odchylenie standardowe) po uwzględnieniu wpływu odsetka mężczyzn i odsetka ludności miejskiej

Specification	Unit change of independent variable (1SD)	Expected change in general mortality rate	95% CI	
Demographic features				
Marriages	20,32	14,16	-17,16	45,48
Divorces	0,65	33,18*	13,09	53,26
In-migration	0,54	-3,58	-19,61	12,60
Out-migration	3,73	16,76	-7,19	40,72
Socio-economic features				
Higher education	5,85	-64,16*	-87,90	-40,42
Salary	489,31	-43,37**	-76,33	-10,41
GDP	12357,70	-37,85*	-60,36	-15,33
Local government expenditure	764,87	-42,71*	-67,25	-18,16
Unemployment rate	5,88	38,64*	20,16	57,12
Non-governmental organization	6,15	-35,93*	-56,63	-15,23
Health care features				
All physicians	8,94	-64,66*	-94,00	-35,32
All nurses	12,87	-28,60**	-56,85	-0,36
All midwives	1,83	-25,37**	-42,72	-7,03
All hospital beds	14,96	-8,78	-33,10	15,54

* p≤0,001; ** p≤0,050; Symbols: SD – standard deviation; CI – confidence interval

This relationship was the strongest in complex social relations, and the weakest among loners (33).

The relationship between the ratio of employed physicians, nurses and midwives with mortality has also been reported by other authors (34-36). This relationship is not surprising and confirms the importance of medical care in ensuring health safety of the population. However, there was a very strong correlation between the resources of health care and socio-economic position, as well as substantial correlations between the features of health care resources (table III). We found no correlation of the rate of hospital beds with mortality.

The description of health inequalities in 66 subregions of Poland confirms the observations reported by other authors (35,37,38). In many countries, attempts are made to improve the health status and reduce health disparities by reforming health sector, strategies and health promoting programs that ignore this important aspect of public health determinants. It is noteworthy that social factors that cause significant health effects are considered in the documents issued by international organizations involved in health policy, thus implying the need for effective actions. The issues of health inequalities determined by socio-economic factors and the necessity to counteract their effects have been undertaken by the WHO Commission of Social Determinants of Health which has formulated recommendations in this field. So far, attempts to shape social relations in order to improve the population health are scarce (39).

CONCLUSIONS

Variation in mortality from all causes in Poland was explained partly by variation in socio-economic determinants and health care resources.

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