

# HEALTH RISK ANALYSIS OF WORKERS INVOLVED IN COAL MINING IN VARIOUS WAYS

Utkir Adilov

*Research Institute of Sanitation, Hygiene and Occupational Diseases of the Ministry of Health of Uzbekistan, Tashkent, Uzbekistan*

**Abstract.** *Occupational risks affect the health of miners and up to 40% of labor losses are caused by diseases directly or indirectly connected with unfavorable working conditions. The research aimed to determine the degree of connection of the disease incidence by temporary loss of working capacity of coal mine workers with working conditions, which was estimated for all classes of diseases and the relative risk (OR) value was 1.69 units, etiological share (EF) - 41% and was estimated as average. These incidence rates for the disease classes were almost complete: Class XIII (OR=5.08 units; EF=80%) and Class XIX (OR=5.03 units; EF=80%), and high for the disease classes: Class XI (OR=2.57 units; EF=61%) and Class X (OR=2.46 units; EF=59%). This relationship by day was almost complete among: Class X (OR=6.18 units; EF=100%), Class XI (OR=7.27 units; EF=100%), Class XIII (OR=7.79 units; EF=100%), and Class XIX (OR=17.87 units; EF=100%). Among workers engaged in underground coal mining, the value of OR=1.4 units, EF=29.3%, was occasionally observed and assessed as small. Relationship of the disease to underground working conditions was assessed as very high by disease classes: Class X (OR=3.6 units; EF=72.1%), Class XI (OR=3.8 units; EF=73.5%) and Class XIII (OR=4.8 units; EF=79.1%). The disease relationship by day was almost complete: in Grade XI (OR=5.3 units; EF=100%) and Grade XIII (OR=8.9 units; EF=100%), and high in Grade X disease (OR=3.0 units; EF=100%). The risk of eating disorders of workers was identified by class XI disease and was assessed as very high in cases (OR=3.8 units; EF=73.8%). A high degree of occupational conditionality was determined for Class XIII disease (OR=2.2 units; EF=55.3%).*

**Keywords:** *morbidity, relative risk, etiological share, working conditions, coal.*

Nowadays, in conditions of industrial advancement in both the developing and developed countries, growth of export potential, increase of efficiency and competitiveness of enterprises based on their modernization, questions of protection and strengthening of health of the working population are one of the most important problems of practical public health services. Prospects for the development of the coal industry, solving the problem of reducing the level of professional and production-related diseases of workers is an urgent and priority task of labor medicine [3].

Scientific works devoted to health protection and provision of safe working conditions for miners are known in the countries of far and near abroad. For the last 30 years in Uzbekistan, researches on the hygienic assessment of working conditions and the study of morbidity among the workers of the coal industry have been carried out in a single case [2].

The purpose of the study was to determine the degree of causal connection of morbidity with a temporary disability (hereinafter - TD) with the working conditions of workers engaged in coal mining by various means.

The object of the study was 6,250 sick leave sheets of TD and working conditions of workers of the Angren coal mine (open-pit mining method) and coal mine No. 9 Angrenskaya (underground mining method).

**Research methods:** The work was performed according to ISO/IEC 31010:2009 international standard "Risk management. Methods of risk assessment" and professional risk assessment in occupational medicine [3,4].

Rates of morbidity from TD among workers engaged in opencast coal mining for the studied three-year period averaged  $128.1 \pm 3.3$  cases and  $963.7 \pm 55.6$  days. In contrast, the average duration of the 1st case was  $7.6 \pm 0.8$  days of disability per 100 workers. According to E.L. Notkin's scale, the morbidity rate in cases is assessed as "high" and in days - as "average." In the general structure of morbidity with TD on cases occupied the first place of disease of the skeletal-muscular system and connective tissue (XIII class). Second place was occupied by diseases of the digestive organs (XI class), injuries, poisoning and some other consequences of external causes (XIX class), third place - diseases of the respiratory organs (class X), fourth place - diseases of the ear and mastoid process (VIII class) and fifth place - diseases of the circulatory system (IX class). In the general structure of morbidity with TD, the share of the above 6th class diseases were 84.1% (Table 1).

Table 1: Disease class ranking among workers of the Angrensky section.

Disease class	Morbidity with TD					
	Total cases		Total days		the average duration of the 1st case, days	%
	on average over 3 years	per 100 employees	on average over 3 years	per 100 employees		
VIII	112	9,36	346	29	3,08	7,3
IX	93	7,78	290	24	3,11	6,1
X	194	16,17	1968	164	10,14	12,6
XI	274	22,87	2540	212	9,26	17,9
XIII	346	28,81	1732	144	5,01	22,5
XIX	272	22,64	3273	273	12,05	17,7
Total						84,1

In the period under study, the incidence rate of TD for workers engaged in underground coal mining was  $161.5 \pm 7.6$  cases of disability and  $3649.5 \pm 436.2$  days of work loss, while the average duration of the first case was  $22.6 \pm 2.7$  days per 100 workers. When comparing the data obtained with E.L. Notkin's scale, the morbidity rate for cases and days of disability can be estimated as "very high." The analysis of morbidity according to the materials of TD has shown that the workers of the 2nd main group of mine 19 "Angrenskaya" had the leading places in 6 classes of diseases, the share of which in the general structure of morbidity was 88,2%.

It should be noted that indicators of morbidity from TD in cases of disability, injury, poisoning and some other consequences of external causes (XIX class) took the first rank; respiratory diseases (class X) took the second place; digestive diseases (XI class) took the third place.

The fourth, fifth and sixth rank places were consistently occupied by diseases of the musculoskeletal system and connective tissue (class XIII), diseases of the circulatory system (class IX) and diseases of the eye and its appendage (class VII) (Table 2).

Table 2.: Disease class ranking among workers of Angrenskaya mine No. 9

Disease class	Morbidity with TD					
	Total cases		Total days		the average duration of the 1st case, days	%
	on average over 3 years	per 100 employees	on average over 3 years	per 100 employees		
VII	19,0	6,8	404	33,7	10,4	4,2
IX	24,0	8,6	290	24,2	3,1	5,3
X	95,0	33,9	1968	164,0	10,1	21,0
XI	80,3	28,7	2540	211,7	9,3	17,8
XIII	80,0	28,6	1732	144,3	5,0	17,7
XIX	100,7	36,0	3273	272,8	12,0	22,3
Total						88,2

Thus, employees with the underground method of coal mining have higher morbidity rates than employees with open coal mining: 1.3 times - for the number of disability cases, 3.8 times - for the number of days of work loss and 3 times - for the average duration of the 1st case.

Consequently, working conditions in underground coal mining have a more significant impact on morbidity rates than those of the aboveground group of workers.

Comparative assessment of disease classes by their specific weight showed that the main disease classes of coal industry workers are XIII, X, XI and XIX classes of diseases, which in the

general structure of morbidity, regardless of the method of coal mining, take the leading places. However, reliable differences in the specific weight of disease classes of workers of the main groups of the Angrensky mine and mine #9 "Angrenskaya" were revealed in the diseases of the ear and mastoid process ( $P<0,001$ ), respiratory organs ( $P<0,001$ ) and musculoskeletal system and connective tissue ( $P<0,01$ ). The share of respiratory diseases (X class) is higher among workers of underground coal mining, while ear and mastoid diseases (VIII class), diseases of musculoskeletal system and connective tissue (XIII class) prevail among workers engaged in open coal mining. A comparative analysis of the proportion of morbidity with TD by disease classes among workers of the 1st experimental group (Angrensky surface mine) and the 2nd experimental group (Angrenskaya mine #9) is presented in Table 3.

Table 3.:The proportion of disease classes among workers of the Angrensky open-pit and mine #9 Angrenskaya

Disease class	"Angrenskiy" section.		Mine #9 "Angrenskaya"		P
	M	±m	M	±m	
VII	2,5	0,5	4,2	5,5	-
VIII	7,3	0,7	1,3	0,6	***
IX	6,1	2,6	5,3	1,2	-
X	12,6	0,7	21,0	2,2	***
XI	17,9	1,1	17,8	2,3	-
XIII	22,5	1,1	17,7	1,2	**
XIX	17,7	0,9	22,3	2,4	-

Note: \*\* -  $P<0,01$ ; \*\*\* -  $P<0,001$

We have studied the degree of causal connection of morbidity with TD and working conditions of workers engaged in opencast and underground coal mining. To assess the degree of production conditionality, we used relative risk indicators (OR, i.e.) and the etiological share of risk factors (EF, %) in working conditions in the development of morbidity [5,6].

The degree of correlation between the incidence of diseases at the Angren coal mine and working conditions was assessed for all classes of diseases with an average relative risk of 1.69 i.e., the etiological share of 41% and was assessed as average. The degree of connection of morbidity with working conditions of workers engaged in surface coal mining was almost completely high for diseases of digestive organs (OR=2.57 units; EF=61%) and respiratory organs (OR=2.46 units; EF=59%). An almost complete correlation was observed for diseases of the musculoskeletal system and connective tissue (OR=5.08 units; EF=80%), as well as for poisoning injuries (OR=5.03 units; EF=80%).

The analysis of morbidity data from the Angren section workers' TD with the calculation of relative risk by days of disability allowed to establish the degree of connection by the high classes of diseases as almost complete.

The data presented in Tab. 1. indicate that the highest risk of health disorders among workers in the Angrensky transect is registered by diseases of the musculoskeletal system (class XIII) and injury (class XIX).

This situation can be explained by the fact that the working conditions of the workers of the Angrensky incision are characterized by the combined effect of a complex of harmful and dangerous factors and the general classes of working conditions established by the 3rd complex method corresponded to the 4th class of the 3rd class and 4th class (combined effect of general and local vibration, work in adverse microclimatic conditions in a warm period of the year, increased dustiness, pollution with harmful chemicals, labor severity and intensity of the work process).

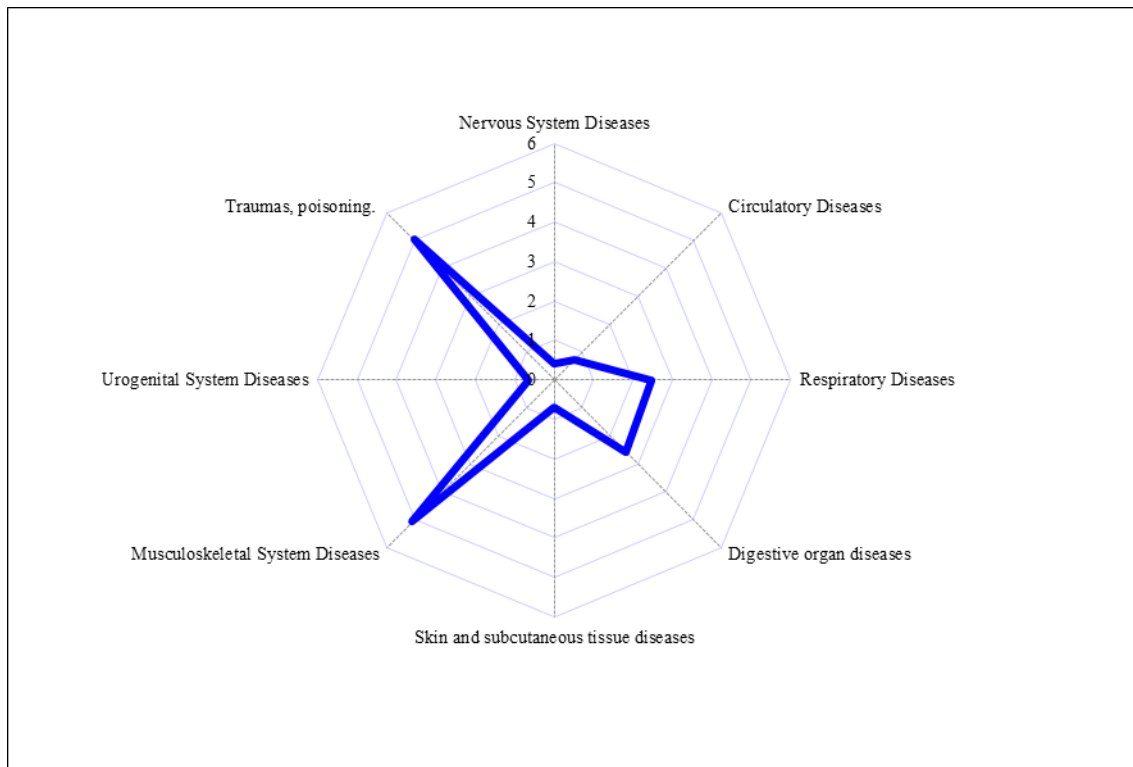


Figure 1: Relative risk of morbidity from TDD by the number of cases of Angrensky transect workers, depending on working conditions, i.e. the number of cases in the Angrensky transect.

For other classes of diseases, identified in the analysis of morbidity materials from the TDD, no causal relationship of morbidity with working conditions of Angrensky transect workers was revealed.

In terms of total employee morbidity in mine #9 "Angrenskaya" revealed a small degree of occupational conditionality with working conditions. At the same time, very high indicators of relative risk and etiological share were found for diseases of the musculoskeletal system and connective tissue (OR=4.8 units; EF=79.1%), which corresponds to a strong connection of diseases of this class with working conditions. A very high degree of occupational conditionality is also established for diseases of the digestive system (OR=3.8 units; EF=73.5%) and respiratory system (OR=3.6 units; EF=72.1%).

The values of the relative risk of injuries and poisonings were 1.6 units and the etiological share was 37.9%, the values of which correspond to the average degree of occupational conditionality.

On the days of total disability from TD of workers in mine #9 "Angrenskaya," the value of relative risk was 1.8 units, which corresponded to the value of etiological proportion - 100%, i.e. the degree of occupational conditionality for all identified diseases with working conditions was estimated as average.

At the same time, the greatest risk of health disorders in workers of Mine #9 "Angrenskaya" on days of disability was revealed in connection with diseases of the musculoskeletal system (OR=8.9 units; EF=100%), digestive organs (OR=5.3 units; EF=100%) and respiratory organs (OR=3.0 units; EF=100%). At the same time, the degree of connection with working conditions was assessed as almost complete and high.

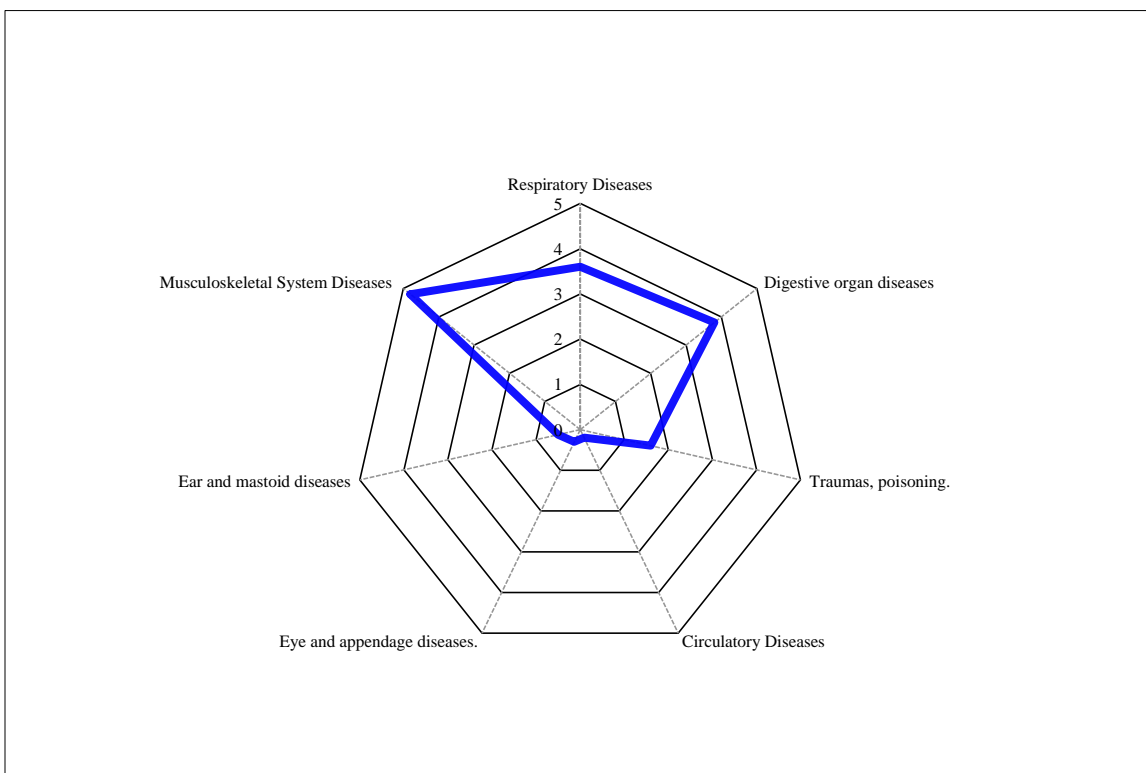


Figure 2: Relative risk of morbidity from HTP by the number of cases at Angrenskaya mine workers, depending on working conditions, i.e. the number of cases at Angrenskaya mine.

The development of these diseases is associated with adverse factors of working conditions, such as general and local vibration, increased dustiness, noise, labor severity and labor process tension. The data presented in Figure 2. shows that the highest risk of health disorders among the workers of Mine #9 "Angrenskaya," as well as the Angrensky section, is registered by diseases of the musculoskeletal system (XIII class).

The results of the calculation of OR and EF morbidity rates from TD depending on working and nutrition conditions for workers of Angrensky and Angrenskaya mine #9 are presented in tables 4, 5.

The highest risk of health disorders among workers of the Angrensky transect and mine #9 "Angrenskaya," associated with eating disorders, was identified by diseases of the digestive organs and, in cases, was assessed as very high (OR=3.8 units; EF=73.8%). A high degree of professional conditioning was determined by diseases of the musculoskeletal system and connective tissue (OR=2.2 units; EF=55.3%) (Fig.3).

The analysis of the obtained materials indicates that for the rest of the studied disease classes, no connection with food behavior disorders was revealed.

Table 4: Assessment of the causality degree of morbidity of workers involved in surface and underground coal mining

Disease classes	Indicator of bonding assessment					
	By cases			By days		
	OR, unit.	EF, %	hazard tolerance	OR, unit.	EF, %	hazard tolerance
"Angrensky" section						
Nervous System Diseases	0,43	-132	null	0,41	99	null
Circulatory Diseases	0,73	-38	null	0,77	100	null
Respiratory Diseases	2,46	59	high	6,18	100	almost complete
Digestive organ diseases	2,57	61	high	7,27	100	almost complete
Skin and subcutaneous tissue diseases	0,69	-44	null	1,07	100	small
Musculoskeletal diseases	5,08	80	almost complete	7,79	100	almost complete
Urogenital System Diseases	0,64	-56	null	0,66	99	null
Traumas, poisoning.	5,03	80	almost complete	17,87	100	almost complete
Total.	1,69	41	average	3,02	100	high
"Angrenskaya" mine #9						
Traumas, poisoning.	1,6	37,9	average	0,6	99	null
Respiratory Diseases	3,6	72,1	very high	3,0	100	high
Digestive organ diseases	3,8	73,5	very high	5,3	100	almost complete
Musculoskeletal System Diseases	4,8	79,1	very high	8,9	100	almost complete
Circulatory Diseases	0,2	-307,5	null	0,2	97	null
Eye Diseases	0,3	-264,0	null	0,5	99	null
Ear and mastoid diseases	0,5	-86,7	null	0,5	99	null
Total.	1,4	29,3	small	1,8	100	average



Table 5: Assessment of the causality degree of morbidity of workers with food behavior involved in surface and underground coal mining

Disease classes	Indicator of bonding assessment					
	By cases			By days		
	OR, unit.	EF, %	hazard tolerance	OR, unit.	EF, %	hazard tolerance
“Angrensky” section, “Angrenskaya” mine #9						
Respiratory Diseases	0,5	-83,3	null	0,5	99	null
Digestive organ diseases	3,8	73,8	very high	5,3	100	almost complete
Skin and subcutaneous tissue diseases	0,4	-158,6	null	0,5	99	null
Musculoskeletal and connective tissue diseases	2,2	55,3	high	3,0	100	high
Injuries, poisoning and some other effects of external causes	0,6	-56,6	null	0,5	99	null
Other diseases	0,3	-293,0	null	0,5	99	null

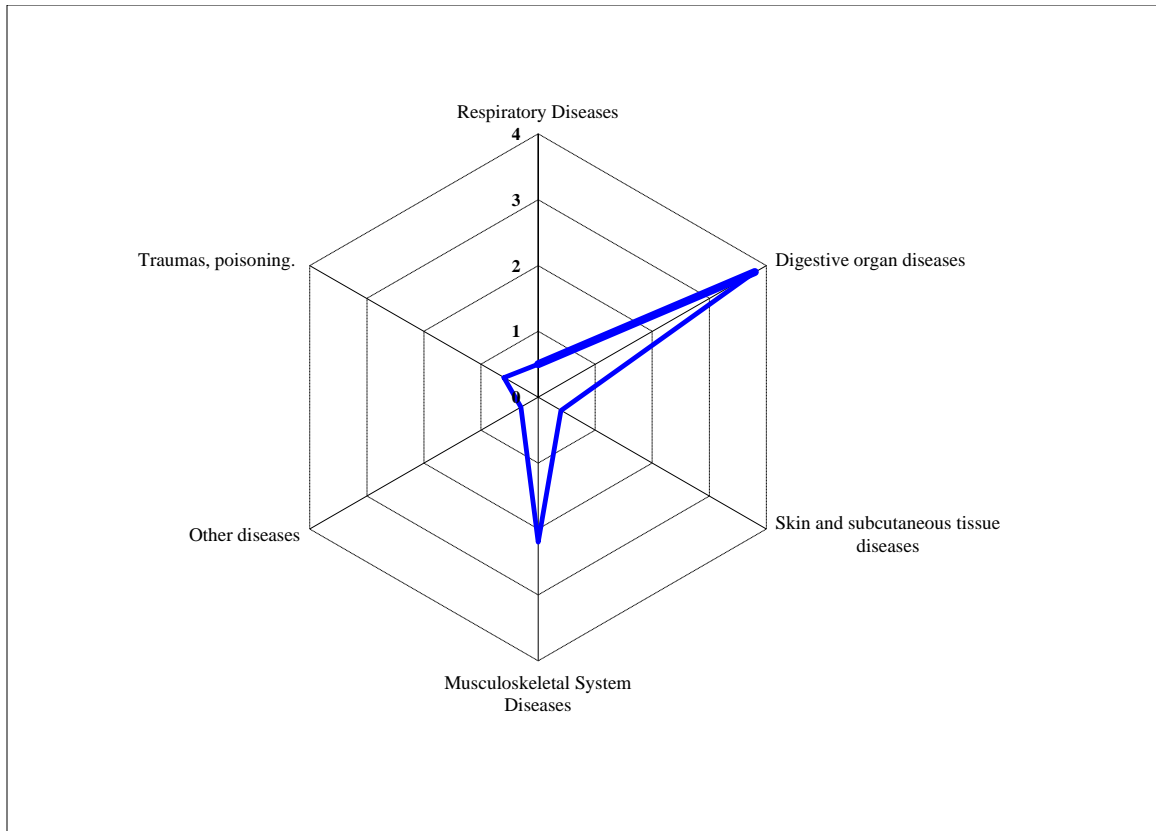


Figure 3. The relative risk of morbidity from TD by the number of cases among workers of Angrensky and Angrenskaya mine operations, depending on food behavior, units.

## CONCLUSIONS

1. The values of relative risk and the etiological share of morbidity with temporary disability among workers of coal mining enterprises were the basis for the assessment of occupational risks associated with working conditions and affecting their health, with a very high, high and almost complete degree of conditionality.
2. Establishment of a very high degree of connection of morbidity with working conditions by diseases of the musculoskeletal system, digestive and respiratory organs among workers of the underground mine #9 "Angrenskaya" (OR = 3.6-4.8 units; EF = 72.1-79.1%), an almost complete and high degree of connection among workers of the Angrensky open-pit mine (OR = 2.5-5.1 units). Besides, the very high and high degree of dependence on diseases of the musculoskeletal system and digestive organs on food behavior (OR = 2.2-3.8 units.; EF = 55.3-73.8%), indicates the professional condition of these diseases on working conditions and nutrition.
3. The complex influence of dust, general and local vibration, noise, labor severity and labor process tension has a significant impact on the organism of coal industry workers; the revealed connection of morbidity with working conditions of very high, high and almost full degree of professional conditionality among workers engaged in open and underground coal mining proves the connection of morbidity with harmful and dangerous working conditions.

4. Significant professional risks for diseases of musculoskeletal system, digestion and respiratory organs, as well as the identified connection of these diseases with working conditions and nutrition, indicates the need to take timely additional therapeutic and preventive measures concerning workers with production-related pathology.

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