URBAN AND RURAL MORTALITY IN HUNGARY PARALLEL TO DIURNAL WEATHER (1971-2005)

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RESUMEN
Los posibles efectos de las anomalías del tiempo sobre la mortalidad por enfermedad cardiovascular y pulmonar son investigado en Hungría. Alrededor 2.8 millones de decesos (para el periodo 1971-2005) han sido analizados. Los datos de mortalidad son contrapuestos a siete datos meteorológicos diarios. Por ejemplo, temperatura mínima, media y máxima, nubosidad, velocidad del viento, humedad relativa y presión reducida al nivel del mar. Ya que la conexión estadística entre la frecuencia de la mortalidad y los datos meteorológicos es no lineal en algunos casos, empleamos cuatro cuadros macrosinópticos. Todos los análisis son realizados para Budapest (la capital de Hungría con dos milliones de habitantes) y para el área rural (que representa más de 8 milliones de residentes). Nuestros resultados preliminares acompañan los efectos decrecientes (en invierno) y efectos crecientes (en verano) de la temperatura ante la mortalidad por enfermedad cardiovascular en área rural, mientras que estos effectos no son evidentes en Budapest. La temperatura superior en invierno coincide con un número menor de deceso por enfermedad pulmonar en la ambas comunidades. La conexión con los cuadros macrosinópticos es menos consensual, pero la proporción de efectos significativos es dos o tres veces más que una ocurrencia casual.

Palabras clave: mortalidad, enfermedad cardiovascular y pulmonar, efecto del tiempo, cuadros macrosinópticos del tiempo, Hungría

ABSTRACT
Possible effects of weather anomalies on mortality in cardiovascular and respiratory illnesses are investigated in Hungary. Long-term (1971-2005) archives of ca. 2.8 million fatalities are analyzed. The mortality data are compared to seven diurnal meteorological parameters, i.e. the mean, maxima and minima of temperature, cloudiness, wind speed, relative humidity and sea-level pressure. Since the statistical connections between the mortality frequencies and the latter variables are non-linear in some cases, we also applied four different circulation types. All investigations are performed for Budapest, with its ca. 2 million urban dwellers, and for the remainder of the countryside (the 'rural'), representing over 8 million inhabitants. Our preliminary results support the well known decreasing (in winter) and increasing (in summer) effect of temperature on cardiovascular mortality in the rural environment, whereas this effect is not so evident in Budapest. Higher temperature in winter statistically coincides with lower number of respiratory fatalities both in the urban and the rural communities. Connections with the different circulation types are less unequivocal, but the proportion of significant effects is 2-3 times higher than a random occurrence.

Key words: mortality, cardiovascular and respiratory illnesses, weather effect, macro-synoptic types, Hungary

1. INTRODUCTION

It is well known also from the Hungarian literature (*Paldy* et. al. 2004) that the daily temperature extremes and their subsequent occurrences increase the mortality in Budapest, as everywhere such extremes occur. The people of Hungary are adapted to the average temperature values, as they occur in the Carpathian basin. Any extreme values largely deviating from these averages stresses our organism, and can be dangerous, since our acclimatisation is restricted.

The connection between temperature and total daily mortality is more expressed in summer. The ideal daily mean temperature for the people living at our latitude is around 18°C (*Paldy* et. al. 2004), around which value the mortality shows its absolute minimum.

There were, however, at least two reasons to repeat the mentioned investigations using a larger data base:

1) the earlier results corresponded to Budapest, only, where the climate influence of the city and the specific (though various) social and housing circumstances might have strongly influenced the correlations,

2) the earlier climate series were not homogenised.

2. DATA AND METHODS

To identify the possible errors and meteorology-independent influences we have first analysed the temporal run of the data collected from the KSH (Hungarian Central Statistical Office). In the 1971-2005 period 2,768,916 deaths occurred in Hungary, 579,588 of them happened in Budapest.

The first step in our investigation was to determine if any non-meteorological changes appearing in gradual trends, or changes in the identification of the illness groups, possibly occurring in abrupt jumps from one year to the other, occurred during the 35 years. The *Fig. 1* shows gradual temporal changes of the two investigated mortality groups.

The *Fig. 2* shows daily average death numbers for the mentioned 35 years. In the case of the cardiovascular death, most publications write about the influences of the summer heat stress in the worldwide and Hungarian literature, as well. However the summer minima and the winter maxima are explicit features of the annual cycle, though this cycle is not really sinusoidal. It consists of one linearly decreasing and one increasing phases, which almost cross each other in a narrow summer minimum. There is no prolonged stagnating extreme which is a remarkable feature of the annual course of cardiovascular death in winter.

Different climate factors and weather situation have influence on respiratory disease death rates. Less expressed temporal deviation from the sinusoidal cycle can be identified. We can rather see an expressed winter maximum and a summer minimum, only (*Fig.* 2).

Because there is an expressed annual course in both disease groups, we have defined and analysed bi-monthly sub-samples to be used in the following. We present our report about two different series of examination. In the first case, seven meteorological elements were paired to the mortality series (see in the next Section), whereas in the second case we compared the mortality data with four macro-synoptic types.

Further, the two death frequency series were correlated with daily values of seven meteorological parameters. The data for the capital city were taken from the Budapest-Pestszentlőrinc- station, the other values were collected and averaged for six WMO stations of Hungarian network. The review of the investigated meteorological elements by the two main death reasons is listed in *Table* 1.

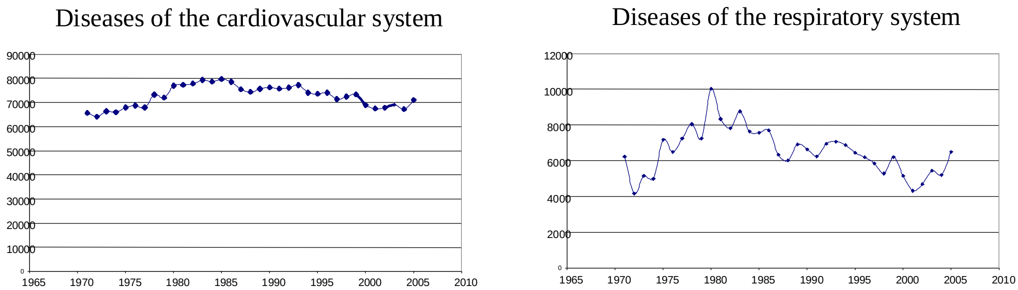


Figure 1. The inter-annual course of the two death reasons during the 35 years in Hungary.

t	°C	daily mean temperature
tn	°C	daily minimum temperature (previous day 7 pm – 7 pm)
tx	°C	daily maximum temperature (previous day 7 pm – 7 pm)
p0	hPa	daily mean sea level air pressure
rh	%	daily mean relative humidity
u	m/s	wind speed, daily average
n	octa	total cloudiness, daily average

Table 1**.** THE LIST OF METEOROLOGICAL ELEMENTS INVESTIGATED TOGETHER WITH THE TWO DEATH REASONS

3. RESULTS

3.1 Relationship with the daily values of climate elements

In the first set of analyses we examined whether there is any connection between the daily death number and the average values of the meteorological parameters. We tried to find an answer for our question in Budapest and in the countryside, separately

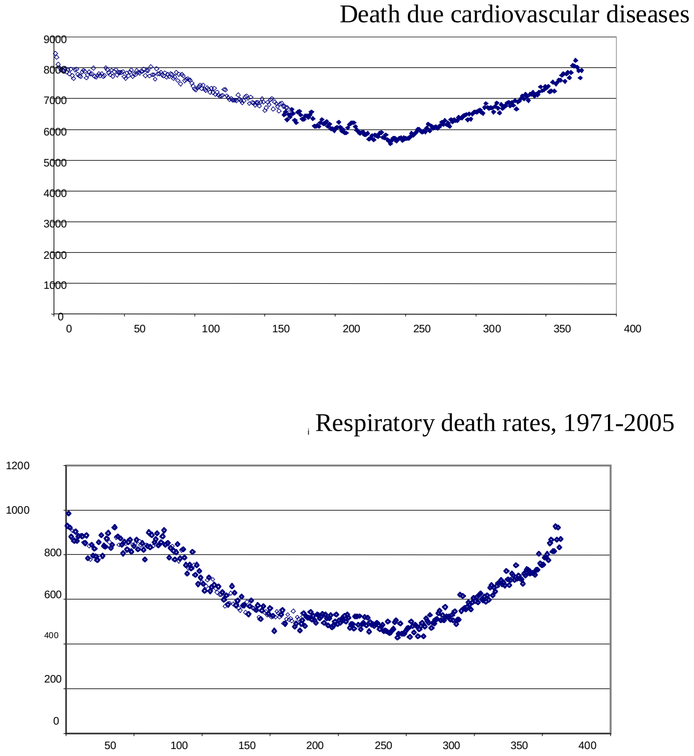


Figure 2. Annual course of death rates due cardiovascular and respiratory diseases in Hungary

Using the bi-monthly frequency values of the death reasons, we found the categories that are given in Table 2.In all cases, we were oriented by two point-of views. The first one was to find at least 25 such days in the given bi-monthly sub-samples of 35-years, where the frequency of the given category reached at least 25 events. If this was not true, we joined the neighbouring categories, but this unification of the groups was necessary only for a few times and only at the edge of the frequency distributions. The second consideration was that because the population rate between the capital and the countryside was ca. 1:4, limits of the individual frequency categories exactly reflected this proportionality. In other words, the upper limits of the countryside categories were divisible by four.

As seen in *Table* 3, proportions of the capital and countryside numbers of death are very close to 1:4. This ratio is higher in the case of the officially registered population, as the ratio of the practical dwellers, which is closer to 1:5. Hence, mortality in the capital is somewhat higher compared to the countryside, than expected from the population ratio.

Country	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Cardiovascular	≤120	121-140	141-160	161-180	181-200	201-220	≥221				
Respiratory	≤4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	≥41

Budapest	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Cardiovascular	≤30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	≥66		
Respiratory	≤1	2	3	4	5	6	7	8	9	10	≥11

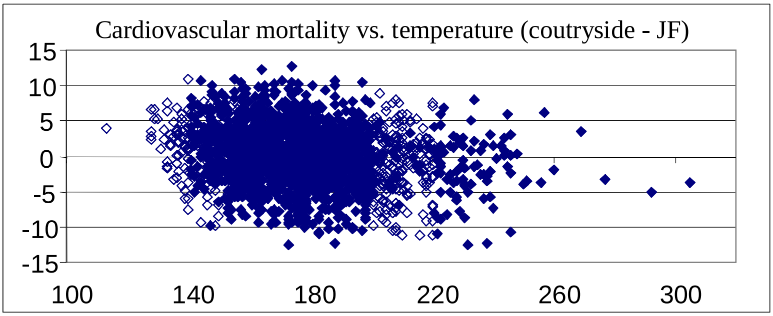
Table 2. THE CATEGORY BORDERS OF THE EXAMINED ILLNESS GROUPS DETERMINED FROM THE DAILY EVENT NUMBERS. IN EVERY CATEGORY AT LEAST 25-25 EVENTS OCCUR IN THE BI-MONTHLY EXAMPLES. IT COULD BE GUARANTEED SOMETIMES ONLY BY REDUCTION OF CATEGORIES AT THE EDGES OF THE SAMPLES.

Countryside	Cardiovascular (I00–I99)	Respiratory illness	Total
JF	367044	40698	407742
MA	367141	36930	404071
MJ	330430	26510	356940
JA	295654	22952	318606
SO	296598	23307	319905
ND	348375	33689	382064
Year	2005242	184086	2189328
Percentage	92%	8%	100 %

Budapest	Cardiovascular (I00–I99)	Respiratory illness	Total
JF	98302	9891	108193
MA	95314	8828	104142
MJ	84237	6185	90422
JA	78668	5548	84216
SO	82761	5796	88557
ND	95350	8708	104058
Year	534632	44956	579588
Percentage	93%	8%	100 %

Table 3. CUMULATED NUMBERS AND PROPORTIONS OF THE TWO MORTALITY REASONS (1971-2005).

We have investigated how close the connection is if, without any reduction, only the 7 meteorological elements and the mortality are correlated. The result is shown in *Fig.* 3. It can be seen that there is weak relationship between the given meteorological parameter and the mortality, notwithstanding the correlation coefficient is as high as 0,38. Relying upon the publications, it is not surprising. For example, the influence of the higher temperature is strong in the extreme categories, mainly if they last for more than one day. Hence, our direct goal is not the improvement of bio-meteorological forecasting, but to examine how a small climate change can modify the mortality statistics, we have to apply different methodology.



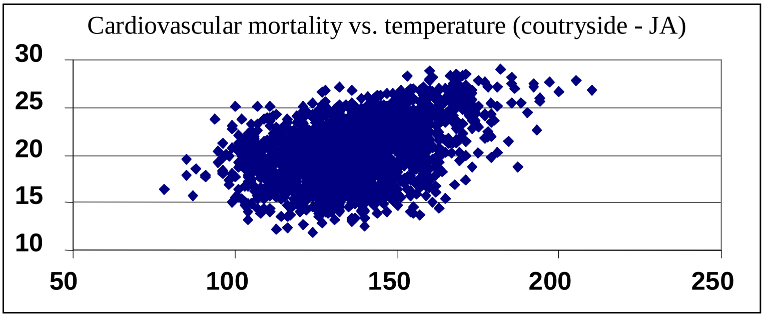


Figure 3. Two examples for information given by temperature and daily mortality rate relationship: cardiovascular death and daily temperature 1971-2005, countryside, January-February and July-August. The -0.21 and +0.38 correlation coefficients are significant, the number of the samples are 2074 and 2170, but their prognostic capability, explaining 4% and 15% of the variance is modest. (In case of Budapest the correlation coefficients are even lower -0.20 and -0.06!)

Hence, we calculated the daily average values of the seven climate parameters for all the six bi-monthly periods, for both regions (countryside and Budapest) and the two mortality reasons. The conditional averages were plotted in graphics first within the death frequency categories. To illustrate these relationships, effects of temperature in the January-February (*Fig*. 4) and July-August (*Fig*. 5) periods are presented. Taking into consideration that the obtained (just partly shown) curves are often close to the linear ones, and also to avoid too quick conclusion by just seeing different slopes in the common co-ordinate system, we have calculated the correlation and regression of the smoothed curve with the category numbers. These numbers are the basis of our further evaluations, though these correlations are obtained by strong suppression of natural variability of the weather elements in each mortality classes.

We conclude anything about the regression coefficients if the correlation coefficients are significant between the conditional averages and the category row numbers upon the very highly smoothed category averages. Making a very careful cross-testing we have kept every coefficient was significant at least on 10% level to be able to follow the annual course of the relationship. Among them the coefficient significant at least on 5% and 1% level are much more remarkable. The significance level of the correlation coefficients were determined after category reduction to satisfy high frequency upon the given sample size (category number).

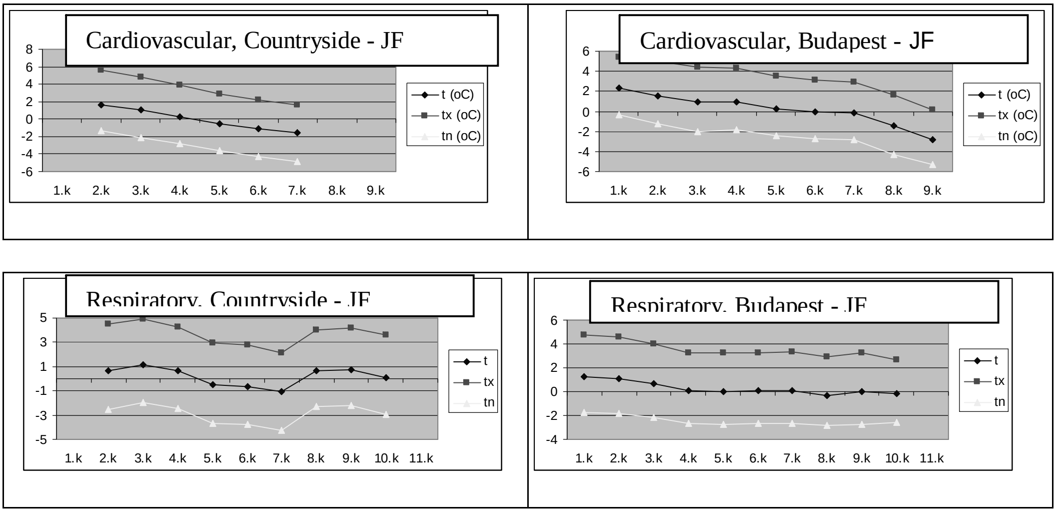


Figure 4. The conditional averages of the temperature characteristics (t –daily mean, tx – daily maximum, tn – daily minimum) in the daily frequency categories of the examined death reasons (see *Table* II), January-February (The categories that occurred less than 25 times during the 35 years were joined to their neighbours.).

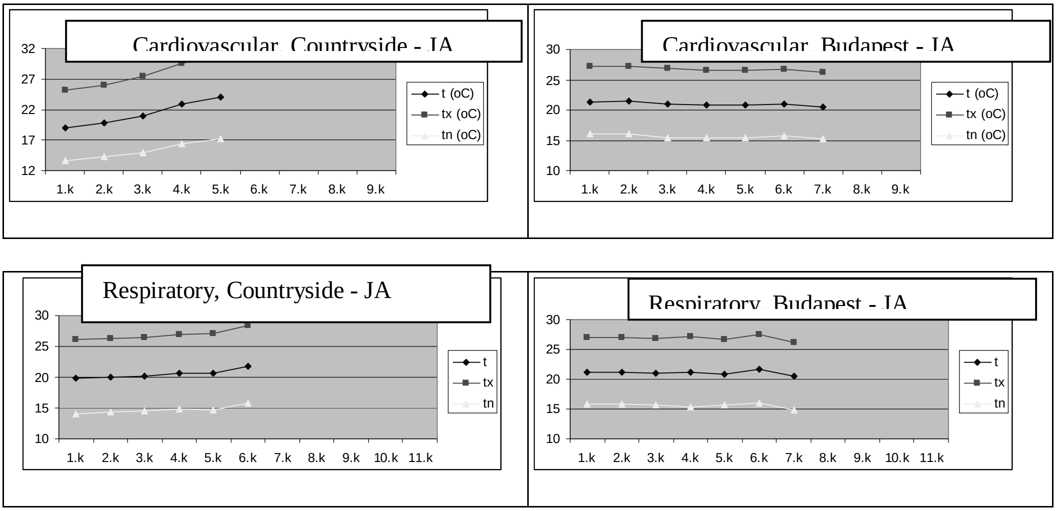


Figure 5. The conditional averages of the temperature characteristics (t –daily mean, tx – daily maximum, tn – daily minimum) in the daily frequency categories of the examined death reasons (see *Table* II), July-August (The categories that occurred less than 25 times during the 35 years were joined to their neighbours.).

The regression coefficient and the correlation coefficients are related as marked in Table 4-5. The coefficients are significant at 1% marked bold, at 5% with italics, and 10% with normal text. No coefficient is given where the significance is lower. Cloudiness is expressed in percent not in okta as in Table I. It means that the averages of cloudiness are multiplied by 100/8=12.5.

Cardiovascular	t (°C)	tx (°C)	tn (°C)	Countryside	rh (%)	p (hPa)	u (m/s)	n %
Jan-Feb	**-0,7**	**-0,8**	**-0,7**	Change of the climate element in the column (unit/category)	*0,6*		-0,09	1,0
Mar-Apr	**-0,7**	**-0,8**	**-0,6**		*0,7*	*0,8*	*-0,06*	*-0,4*
May-Jun	0,2	0,3			-0,3	-0,2	-0,05	*-1,2*
Jul-Aug	**1,3**	**1,5**	**0,9**		**-1,8**		**-0,06**	**-5,8**
Sep-Oct	**-1,2**	**-1,4**	**-1,0**		*0,8*			1,7
Nov-Dec	**-1,0**	**-1,1**	**-1,0**		*0,2*	*-0,6*	*0,03*	

Cardiovascular	t (°C)	tx (°C)	tn (°C)	Budapest	rh (%)	p (hPa)	u (m/s)	n %
Jan-Feb	**-0,5**	**-0,6**	**-0,5**	Change of the climate element in the column (unit/category)	*0,6*	*0,4*	**-0,09**	
Mar-Apr	**-0,5**	**-0,6**	**-0,4**		*1,0*	*0,2*		
May-Jun	0,2	0,2	0,2					
Jul-Aug	-0,1	-0,2						
Sep-Oct	**-0,5**	**-0,6**	**-0,5**		*0,6*	*-0,2*		0,4
Nov-Dec	**-0,4**	**-0,4**	**-0,4**		**0,3**	*-0,3*	0,02	

Table 4. THE CHANGE OF AVERAGES OF METEOROLOGICAL ELEMENTS TOGETHER WITH THE CHANGE OF ROW NUMBER OF CARDIOVASCULAR MORTALITY (HIGHER ROW NUMBER MEANS MORE DEATH, SEE *TABLE* I.) THE BOLD CHARACTER MEANS 1%, ITALIC 5%, SIMPLE NUMBER 10% SIGNIFICANCE LEVEL, EMPTY CELL NO SIGNIFICANT RELATIONSHIP.

The most characteristic relationship between **cardiovascular mortality** and the meteorological elements can be demonstrated by temperature. The less cardiovascular mortality is parallel with the higher temperature in autumn, winter, and spring, i.e. from September until April, in our categories. This relationship is unambiguous and evident not only in the capital, but in the countryside, as well. In other words, the given increase of temperature coincides with more categories shifting in the capital than in the countryside. (The 1:4 ratios of the categories relates to the true ratios of the inhabitant, as we have mentioned earlier.)

Our expectation would be that the sign of the relationship changes summertime, and higher mortality would coincide with higher daily temperatures. However, it is unambiguous only in the country in the July-August period. The significance of the relationship is weak both in Budapest and in the countryside in the first part of the summer. Moreover, the relationship is weak in the capital in July-August, and even the sign is opposite! We did not mention which temperature we consider, because the parameters of the relationships are very similar in case of all three temperature parameters.

Examining the other parameters connected with the circulation, we have found positive relationship between relative humidity and cardiovascular mortality in the April-September period. It is questionable if this relationship is an independent influence, or a consequence of the temperature influence, because low temperature in case of the same water vapour content produces higher relative humidity. The parallel behaviour of humidity with the temperature is repeated in the other two summer periods from May till August, too.

We can find negative correlation between cardiovascular mortality and the relative humidity in the countryside, which is weakly significant in May-June, but strongly significant in July-August. But there is no relationship of any sort in the capital, at least a very weak or, unexpectedly, opposite as happened in the case of temperature. It seems that the artificial life circumstances in the capital can strongly modify the weather influences.

According to the linear evaluation, we can find many significant relationships between cardiovascular mortality and the air pressure. We do not make further evaluation, however, because of the frequent jumps from one group to the other and of the frequent signal change from one bi-monthly period to the other. The influence of circulation will be analysed later.

The wind speed shows weak negative correlation with the cardiovascular categories in countryside from the middle of winter until the end of summer. We do not take into consideration these changes in Budapest, because there is a significant effect only in January-February. Furthermore, it is positive in both region groups already in November-December, and magnitude of the regression coefficient is cm/s' category. It is not important; especially as regional climate change indicate no unequivocal changes of wind speed in Hungary, either.

It is difficult to explain the negative relationship with the cloudiness from spring until the end of summer, including July-August with very strong differences between the mortality categories. The other problem is that this relationship suddenly changes in September-October and January-February, notwithstanding there is no connection between the two periods. It is also questionable that there is only one significant period in the capital and even this significance is the lowest considered exhibiting small regression coefficient.

Examining the **respiratory mortality,** we can conclude that the highest proportion of significant relationships occurs with the temperature. The sign of the significant relationships is always negative in the capital and, except July-August, in the countryside, as well. In other words, the respiratory death occurs together with lower temperature in the most categories. The regression coefficients are not high. They are only a few tenths of Celsius, which is true in the only period with positive coefficients in July-August. In this case, no significant relationship with the temperature is found in the capital during the high summer period, despite the strong smoothing within the mortality categories. Among the three temperature parameters, the regression coefficients of the minimum show smaller and less significant values. The daily mean temperature is the best, but the maximum temperature is close to it.

It seems to be normal that the (almost always) negative correlation with temperature coincides with the positive correlation between the relative humidity and respirator mortality categories. There is almost no difference in the significance of the relationship and regression coefficients between the capital and the countryside.

In the case of the three other circulation-related elements the proportion of significant relationships are week and the inter-annual distributions differ not only among others, but also between the capital and the countryside, as well. We can find unusual results when comparing the few significant positive coefficients of the cloudiness with significant negative coefficients of the temperature. Wintertime the higher cloudiness has a warming effect. Consequently, the two signals should be the same, as summertime they have opposite sign, which is the true case. We need further investigation to discover if there are only less significant connections, or there is independent influence of the two investigated elements that can strongly modify the respiratory mortality. Maybe we have to involve air pollution data in the later evaluation, too.

Respiratory	**t**	**tx**	**tn**	**Countryside**	**rh (%)**	**p (hPa)**	**u (m/s)**	**n %**
Jan-Feb					*0,3*			0,6
Mar-Apr	**-0,4**	**-0,5**	**-0,3**	Change of the climate element	*0,9*			
May-Jun	**-0,3**	**-0,3**	**-0,3**	in the column (unit/category)		**-0,2**		**0,6**
Jul-Aug	**0,3**	**0,4**	*0,3*				**-0,06**	**-1,4**
Sep-Oct	-0,3		*-0,3*		**0,6**			
Nov-Dec	**-0,4**	-0,4	**-0,4**					

Respiratory	**t**	**tx**	**tn**	**Budapest**	**rh (%)**	**p (hPa)**	**u (m/s)**	**n %**
Jan-Feb	**-0,2**	**-0,2**	**-0,1**		**0,4**			
Mar-Apr	**-0,3**	**-0,4**	**-0,3**	Change of the climat	**0,8**	**0,2**		
May-Jun	*-0,1*	*-0,1*		e element	*0,2*	*-0,2*		
Jul-Aug				in the column (unit/category)				
Sep-Oct	-0,3	**-0,3**			**0,7**		*0,04*	0,9
Nov-Dec	**-0,2**	**-0,2**	-0,2			*-0,4*	**0,06**	0,3

Table 5. THE CHANGE OF AVERAGES OF METEOROLOGICAL ELEMENTS TOGETHER WITH THE CHANGE OF ROW NUMBER OF RESPIRATORY MORTALITY (HIGHER ROW NUMBER MEANS MORE DEATH, SEE *TABLE* I.) THE BOLD CHARACTER MEANS 1%, ITALIC 5%, SIMPLE NUMBER 10% SIGNIFICANCE LEVEL, EMPTY CELL NO SIGNIFICANT RELATIONSHIP.

3.2 Examination of circulation types

A few specialists created weather types, using the daily observations, and they characterised the climate with the type frequency instead of mean values. In our study we tried to find connections between the two mortality frequency series and four different weather type categories. They are named after their authors as Peczely-types, Puskas-types, OMSZ front-codes and Makra-types (see below). The mortality frequencies are already de-trended.

The Peczely-type classification (*Peczely, 1957*) is useful, among others, for atmospheric environmental classification. Peczely generated 13 types of macro-synoptic situation to characterise the weather types in Hungary. Using these classifications, we can approximately characterise the regional scale circulation, temperature, precipitation, cloudiness, and etc. conditions by one single class (character).

The second classification was established by *Puskas* (2001). He produced a set of 9 groups, and applied them for evaluation of the insects' behaviour, based on the 00 UT Bulletin map of

OMSZ – Hungarian Meteorological of Service, issued every day. He distinguishes warm, cold and occlusion fronts, and characterise their positions relative to the country. The 9 categories are as follows:

1) approaching cold front ,
2) stationery cold front ,
3) approaching warm front ,
4) stationery warm front ,
5) approaching occlusion ,
6) stationery occlusion ,
7) approaching cold and warm front ,
8) stationery cold and warm front ,
9) approaching cold, warm front and occlusion.

The third categorisation is a front-coding system, used by the OMSZ, in which anti-cyclonic situations, warm fronts, cold fronts, and instability are distinguished, allowing more than one of them during the day, if this is the case. The established codes are indicated in relation to a typical temperate-latitude cyclone in *Fig.* 6.

Finally a fourth coding system was chosen which is based on sea-level pressure fields, and which is used in biometeorological and air pollution investigations (*Makra* et al. 2006). This classification uses 10 objectively derived types, but their interpretation in terms of synoptic situations is not simple.

The first two steps in the investigation were to eliminate the long trends and annual courses in the mortality series. These two components could be rather interpreted by the socio-economic and public health system, reasons and seasonal physiological and life style reasons, than by meteorological effects. The influence of long trends and annual courses was examined by three-degree polynomials, defined for each month, separately. The optimum degrees to retain were calculated by multivariable linear regression, stepwise forward method. Later the influence of meteorological elements was examined in the residual series.

The weather data series, already free of long trends and annual course, and the four sets of weather types were grouped into the same bi-monthly units, as in the previous section.

It was necessary because a certain weather type occurs more frequently in one season and less frequently in other months, and, also, because the macro-circular situations bear different weather characteristics in different periods of the year. This bi-monthly grouping keeps in the same category the months with similar temperature extremes, it does not put the really differing months of transient seasons together, and, finally it sorts the months of the absolute and of secondary maxima of precipitation together, as well.

Having a look at the conditional frequency distributions describing the relation of the examined 2,768,916 death events to the four parallel sets of macro-synoptic types, we can conclude that

Figure 6. Biometeorological classification (coding) of the weather sector in a temperate latitude cyclone. The 3,4 category, causing pre-frontal thunderstorms, frequently occurs in geographical circumstances of the Carpathian basin. The practice shows that this weather type has got the most expressed physiological and pathological influence (*Bartfai* and *Gal* 1998)

weather has got slightly more frequent significant influence on the mortality, than randomness. Consequently, there are weather situations in which we could give useful information about above or below normal the risks of mortality. Table 6 shows summarising that certain weather types gave explanation above 10% significance level in capital and the in the country in percent.

	Cardiovascular mortality		**Respiratory mortality**	
	Budapest	Countryside	Budapest	Countryside
Peczely	**26%**	**18%**	**12%**	**22%**
Puskás	**23%**	**13%**	**13%**	**8%**
Front code	**17%**	**21%**	**7%**	**10%**
Makra	**20%**	**27%**	**20%**	**8%**

Table 6. THE PROPORTION OF SIGNIFICANTLY HIGHER OR LOWER THAN AVERAGE RATE OF MORTALITY RELATED TO THE FOUR CIRCULATION TYPES. THE SIGNIFICANCE THRESHOLD IS 90%, I.E. THE RANDOM PROPORTION IS 10%.

Summarising the rate of significant conditional averages is 16.6% according to the four types, i.e. it is just a little higher than the chance. The conditional averages are 19-19% in case of Peczely and Makra types, but the OMSZ front-codes and Puskas categories gave 14-14% only. The cardiovascular mortality shows the more frequent relationship with 22 and 20%, in the countryside and in the capital respectively. The same rate in the case of respiratory mortality is only 13 and 12%, respectively.

Neglecting the two weaker front code based categorisation, the relationship in both illness group will increase in case of cardiovascular reasons to 23% in the country and in the capital, as well. In case of respiratory reasons these numbers are 16% and 15% respectively.

The mentioned values give significantly different conditional averages only in small ratio above the randomness, hence we do not present their detailed analysis.

4. CONCLUSION

The possible meteorological reasons of cardiovascular and respiratory mortality were examined in Budapest and in the country using the data of the Hungarian Central Statistical Office in the recent 35 years between 1971 and 2005.

The first step of the investigation was to filter out the long-term trends from the mortality data series, since they could rather be connected with socio-economic and public health system reasons. The annual course of mortality is also unambiguous, but it is partly of meteorological influence. This is the reason why the year was grouped into 2-2 months, and the possible weather influences were examined in these 6 sub-samples, separately.

The data series were compared with 7 meteorological parameters (daily maximum, minimum, mean temperature, sea-level pressure, relative humidity, wind speed, cloudiness) and with four different weather classifying (Peczely, Puskas, Makra and OMSZ front coding).

We can conclude our investigations, as follows:

1) The trends of the cardiovascular and respiratory illness and the annual courses can be characterised well by simple functions. The seasonal temperature peak in summer, together with other, just partly meteorological factors of the seasonal cycle, yields a minimum in cardiovascular and respiratory mortality.
2) These features of the annual course can also be found in the countryside data series if we group them bi-monthly. The temperature increase has a decreasing effect in the cardiovascular and respiratory mortality in the majority of the year, unambiguously. The high-summer temperature peaks increase the mortality only in the countryside.
3) From among the variables connected with the circulation, the relative humidity has got positive correlation with the cardiovascular and respiratory mortality, which coincides with death-reducing role of temperature in the majority of the year.
4) The conditional means of wind speed in the mortality categories showed very small, cm/s differences between the categories even in the significant cases. The

sign of them is negative in the majority of the seasons for the cardiovascular mortality.

5) The significant relationships of the cloudiness in both examined mortality reasons showed varying sign.
6) We have found monotonous relationship between air pressure and the mortality more frequently than their random proportion. Nevertheless, these relationships are erratic, and, although we have found more than random connections also with the circulation types, the statistical coincidence of the sea-level pressure with the mortality is rarely stable, i.e. the coefficients differ among the two dwelling types and among the neighbouring seasons.
7) It is unambiguous that not only the extreme summer temperature, hence, not only the future changes of extremes has influences on the mortality. The temperature statistically decreases the mortality in the bigger part of year.
8) Finally, the belief that the warming has negative effects mainly in big cities should also be revised. In our investigation, these negative effects on mortality could mainly be detected in the countryside, unambiguously. On the other hand, we have detected relations of the mortality with a few circulation types in the capital, as well, where the types are likely precursors of heat waves.

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