Congenital Heart Disease and Environmental Physical Activity - Kaunas data, 1995-2005

E.Stoupel [1,2], V.Dulskiene [3], R.Kuciene [3], E.Abramson [4], P.Israelevich [5], J.Sulkes [4]

[1] Division of Cardiology, Rabin Medical Center, Israel

[2] Sackler Faculty of Medicine, Tel Aviv University, Israel

[3] Institute of Cardiology, University of Medicine, Kaunas, Lithuania

[4] Informatics and Epidemiology Unit, Rabin Medical Center, Petah Tiqwa, Israel

[5] Department of Geophysics and Planetary Sciences, Tel Aviv University, Israel

e-mail: stoupel@inter.net.il

Received: 6 May 2009 ; Accepted: 12 December 2009

Abstract. Recent studies described a number of fetal development sides related to the environmental physical activity. The aim of this study was to check the possible links between congenital heart disease (CHD) born in a non-selected medical network and indices of environmental physical activity. Children born with CHD in Kaunas, Lithuania, in years 1995-2005 were analyzed at the end of the first year of life (including also those died after birth from this condition). Monthly distribution of CHD (total – 371, both gender (178 boys and 193 girls), 41435 births) were compared with parameters of solar (SA), geomagnetic (GMA) and cosmic ray (CRA) activity, as well as the year, at the month of birth, 9 months before and at year of birth and one year before. CRA was represented by neutron activity on the Earth's surface. Heliogeophysical data were obtained from space research centers in the USA, Russia and Finland. There was found a significant correlation between yearly number of births (r = - 0.9, p = 0.00012). Monthly number of CHD was correlated with SA and CRA often highly at the beginning of pregnancy both in monthly and yearly (r = - 0.7, p = 0.025for SA, r = 0.8, p = 0.005 for CRA) comparison. For boys the correlation was stronger, but also it was significant for girls. GMA has not shown significant effects. It is concluded that the number of yearly and monthly CHD is connected with SA and CRA in pregnancy. Boys show high levels in these correlations. The mechanism of the cosmophysical effects on human development and temporal distribution of CHD deserve special studies.

Keywords: environmental physical activity; solar activity; geomagnetic activity; cosmic ray activity; congenital heart disease

Introduction

The fetal development, number of newborns, their physical characteristics and congenital defects are related to physical parameters of the environment [1-6]. A recent study has been performed checking the time distribution of congenital heart disease (CHD) in two tertiary medical centers in Israel in years 1995-2005 [7].

The aim of this study was to check CHD monthly distribution at birth with concomitant environmental physical activity in the general (non-selected) medical network (hospitals) in other geographic area and with adverse tendency in reproduction (birth) numbers at the same time period (1995-2005).

Data and methods

The study was based on births in Kaunas, Lithuania's second biggest city (355 586 inhabitants at January 1, 2008, many universities, industry and sport facilities). In years 1995-2005 at the end of the first year of life 371 CHD/41435 births (including deaths at the first year of life) were registered in the medical network of this city. There were 178 boys and 193 girls in the studied group of CHD.

Comparing CHD and physical parameters, Pearson correlation coefficients r and their probabilities p were established. Probabilities of 95% and higher were accepted as significant ones meanwhile at 90% - 94% level - as a strong trend towards of significance. Lower levels were described as non-significant (N.S.).

The yearly number of births in the studied time span fluctuated from 4692 (1995) to 3207 (2003) presenting a significant inverse correlation with years of observation (correlation coefficient r = - 0.96, and probability p= 0.00012). The monthly distribution of births with CHD was compared with physical parameters at the month of birth and nine months before – time of conception. Taking into account that approximately 2/3 of women were pregnant a year before giving birth, we also compared yearly CHD numbers (total and each gender in all comparisons) with yearly physical parameters at the year of birth and a year before (1994-2004). The physical indices used in this study were month, year, solar activity (SA) indices (sunspot number; smoothed sunspot number (considering sunspot grouping and used devices for observation); solar radio flux at 10.7 cm wavelength (one of Internationally used index of SA); adjusted solar radio flux).

For geomagnetic activity (GMA), indices *Ap, Cp* and *Am* were used describing integrated monthly indices measured in *nanotesla* (*nT*) units (planetary data) and measured in multiple regions [8].

CRA was represented by neutron activity (*imp/min*) at the Earth's surface. Neutrons are remains of atoms crushed in the high layers of our Universe by cosmic rays of colossal energies. The Sun and geomagnetic fields are shields defending our planet from CRA annihilation. SA and GMA are inversely related to CRA, represented by neutron activity on the surface of our planet [9]. The cosmophysical data were obtained from: the National Oceanic and Atmospheric Administration's National Geophysical Data Center and Space Weather Prediction Center, Boulder, USA; Moscow Neutron Monitor, IZMIRAN, Russian Academy of Sciences; the Neutron Monitoring Station of Oulu University, Finland [10-14].

Results

Table 1 presents the monthly comparative data of CHD and physical parameters at month of birth (delivery) and nine months before. Total patients and, separately, both gender patients' data are presented.

Table 2 demonstrates the results for yearly CHD distribution at the year of birth and a year before, having in mind that births in the first nine months of each year are mostly a result of pregnancy conceived at previous year. Despite the small number of years (11), it's obvious that links at year of conception of most of children born in the next year show stronger connection with environmental physical parameters concomitant with the beginning of fetal development.

Despite smaller number of boys included in this study (178 against 193), physical factors studied are strongly related to the occurrence of CHD as in boys as in girls.

CRA is significantly related with CHD in both genders meanwhile SA - more in boys (Tables 1 and 2).

In total monthly account, CRA and SA remain significantly linked to monthly number of CHD. The relatively not high number of monthly patients with CHD is rising in its relationship to physical parameters when the yearly comparison is performed, increasing the number of patients compared. It's especially evident in the comparison with physical data a year before delivery achieving levels of strong correlation (r = 0.7 - 0.8). Comparison by gender shows that CHD significantly differs by gender. In girls there was significantly (p = 0.02) more ASD, TGA (p=0.005); in boys- Dextrocardia (p<0.0001) and Valvular Aortic Stenosis (p<0.0001). PDA demanding surgery was 7 in girls and 2 in boys.

Despite the relative small number of the analyzed CHD patients group we made an attempt for normalization of the data to 10 000 deliveries in relation to the discussed physical factors. There was not significant links between the yearly number of CHD and physical parameters of the year of birth. At year before delivery (when the pregnancy in most of cases undergo the initial stages) it was a 95% significant correlation (r = 0.6) with CRA and a trend (90% significant) of inverse correlation with yearly smoothed sunspot number average (r = - 0.48).

Discussion

The presented data could be considered as an additional chapter in Clinical Cosmobiology. In previous studies newborn number (monthly), their length and weight, number of preterm births, monthly distribution of newborns with Down syndrome were discussed [1-7]. Connection of growth hormone, prolactin and corticosteroids secretion with factors of cosmophysical activity was demonstrated [15]. Also connection with the immune system [16-18] and human behavior [19] was studied.

A special interest for comparison has an analogical study made in two tertiary university centers in Israel at the same time, in 1995-2005 [7]. The specialization of these centers in pediatric cardiology and cardiovascular surgery could concentrate there an additional number of pregnant women with suspicion of fetal CHD made by repeated fetal echocardiography. The discordant trend in delivery rates (r = 0.83, p = 0.0014 in the Israeli study and r = - 0.9, p = 0.00012 in Kaunas, Lithuania) correlation with the 11 observation years can also affect the studied links, having in mind the 11-year SA cycle (here the maximum was in year 2000). The data was obtained in newborns in the Israeli study (n = 1739/79085 births) and at age of one year in Kaunas (n = 371/41435 births). In this study the deliveries in hospitals not always having special affinity to pediatric cardiology and cardiosurgery facilities was given an additional year for completing the diagnostic procedures, but also not excluding the children lost at this year as a result of severe CHD. The comparative trends in these two studies are presented in Fig. 1.

The similarity of the studies is that in both monthly and yearly numbers of newborns with CHD were significantly correlated with CRA and SA. Comparison with physical activity at the beginning of pregnancy (nine months before delivery) strengthens the links with physical parameters in girls that was non-impressive when compared at the end of pregnancy. In the Israeli study separate calculation was done excluding Potent Ductus Arteriosus (PDA) that often undergoes spontaneous closure at the first months of antenatal life [20-23]. In this study the data obtained at the end of first time of life made such procedure unnecessary.

An open question is if some children are not remaining undiagnosed for CHD in this study after their first year of life.

What could be told about teratogenic mechanisms of CRA and SA? Some negative effects from exposure to CRA by high altitude flights were published [24-28]. Neutrons are used in radiotherapy [29].

TABLE 1. Pearson correlation coefficients (r) and their probabilities (p) for congenital heart disease (132 months data, Kaunas, Lithuania, 1995 – 2005) at month of delivery and nine months before delivery and related levels of cosmophysical activity

	Parameters		All	Male	Female	All	Male	Female
			(at month of delivery)			(9 months before delivery)		
1	Year	*r*	-0.44	-0.43	-0.22	-0.44	-0.43	-0.234
		p	< 0.0001	< 0.0001	0.01	< 0.0001	< 0.0001	0.007
2	Month	*r* / *p*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
3	Sunspot Number	*r*	-0.208	-0.24	N.S.	-0.365	-0.356	-0.19
		p	0.016	0.0056		< 0.0001	< 0.0001	0.03
4	Smoothed Sunspot Number	*r*	-0.226	-0.265	N.S.	-0.34	-0.36	-0.144
		p	0.009	0.002		< 0.0001	< 0.0001	0.1
5	Solar Radio Flux	*r*	-0.23	-0.27	N.S.	-0.358	-0.375	-0.157
		p	0.0079	-0.0018		<0.0001	< 0.0001	0.07
6	Adjusted Solar Radio Flux	*r*	-0.225	-0.273	N.S.	-0.365	-0.375	-0.168
		p	0.0095	0.0015		< 0.0001	< 0.0001	0.05
GMA indices:								
7	Ap	*r*	N.S.	-0.146	N.S	N.S.	N.S.	N.S.
		p		0.09				
8	Cp	*r*	N.S.	-0.182	N.S.	N.S.	N.S.	N.S.
		p		0.036				
9	Am	*r*	-0.157	-0.19	N.S.	N.S.	N.S.	N.S.
		p	0.07	0.0288				
10	Cosmic Ray Activity (Neutrons, *imp/min*)	*r*	0.42	0.397	0.225	0.35	0.35	0.17
		p	<0.0001	< 0.0001	0.0094	< 0.0001	< 0.0001	0.04
11	Newborn's number		371	178	193	371	178	193

TABLE 2. Pearson correlation coefficients (r) and their probabilities (p) for congenital heart disease (371/ 41435 deliveries, data from Kaunas, Lithuania, 1995 – 2005) at the year of delivery and one year before delivery and related cosmophysical activity

Parameters	At year of delivery			One year before delivery		
	All	Boys	Girls	All	Boys	Girls
Smoothed Sunspot Number	r=-0.46	r=-0.58	r=-0.46	r=-0.66	r=-0.75	r=-0.42
	p=0.16	p=0.06	P=0.15	p=0.0258	p=0.0077	p=0.18
Cosmic Ray Activity (Neutrons, *imp/min*)	r=0.39	r=0.52	r=0.13	r=0.77	r=0.83	r=0.56
	p=0.23	p=0.09	p=0.698	p=.0.005	p=0.0017	p=0.07
Number of newborns	371	178	193	371	178	193

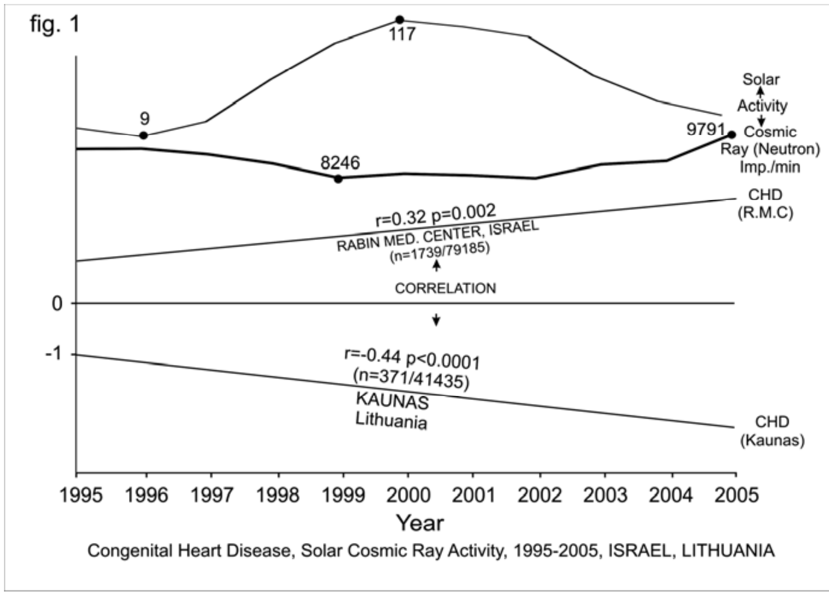

Fig.1. Comparison of two studies on congenital heart disease in Israel and Lithuania (1995-2005) in relation to solar and cosmic ray activities.

Pregnant woman are recommended avoid possible contacts with such radiation sources. The harmful action of neutrons is discussed in projects of their use for military purpose [30, 31]. The transformation of neutrons to protons by joining H+ radicals are a potential way to transform to an harmful agent to cells and, specifically, their nuclei [30].

SA containing wave and particle radiation has also a potential for teratogenic activity. Both sorts of radiation (CRA and SA) include sorts with high ability to damage young cells and tissues [30-36] what can be related with special effects at the early stage of pregnancy and is reflected by higher correlation in the year before delivery and significant link's in girls, that are absent by comparison made with physical parameters at the time of delivery.

Limitation of the study

Relatively small number of CHD made the statistical study less in strength and significance.

We did not have information about the amount of pregnant woman undergoing fetal echocardiography check up in different institutions of the studied area.

It is not clear if a part of less symptomatic CHD not remained undiagnosed at the end of the first year of life.

Conclusions

Monthly and yearly congenital heart disease number is significantly related to solar and cosmic ray (neutron) activity. This relationship is stronger at the pregnancy first stages.

Gender differences show stronger links of CHD number with the mentioned physical parameters in male patients. The mechanism of the physical influences on the temporal distribution of CHD deserves special studies.

References

[1] E.Stoupel, R.Kalediene, J.Petrauskiene, A.Gaizhauskiene, P.Israelevich, E.Abramson, J.Sulkes, “Monthly number of newborns and environmental physical activity”, Medicina, 2006, v.42(3), pp.238-241.

[2] P.Merlob, S.H.Reisner, M.Shimshoni, E.Stoupel, “Fetal growth in extreme periods of solar activity in the 21-22 solar cycles”, J. Foetal. Med., 1989, v.9(1-2), pp.1-5.

[3] E.Stoupel, L.Sirota, M.Osovsky, et al., “Monthly number of preterm births and environmental physical activity”, J. Basic Clin. Physiol. Pharmacol., 2007, v.18(2), pp.149-157.

[4] E.Stoupel, H.Frimer, Z.Appelman, et al., “Chromosome aberration and environmental physical activity: Down syndrome and solar and cosmic ray activity, Israel 1990-2000”, Int. J. Biometeorol., 2005, v.28(2), pp.1-9.

[5] V.E.Archer, “Anencephalus drinking water, geomagnetic and cosmic radiation’, Am. J. Epidemiol., 1979, v.109, pp.88-97.

[6] F.Halberg, G.Cornelissen, K.Otsuka, E.V.Syutkina, et al., “Chronoastrobiology: Neonatalnumerical counterparts to Schwabe's 10.5 and Hale's 21-year sunspot cycles In memoriam Boris A. Nikityuk’, Int. J. Prenat. Perinat. Psychol. Med., 2001, v.13, pp.257-280.

[7] E.Stoupel, E.Birk, A.Kogan, G.Klinger, E.Abramson, P.Israelevich, J.Sulkes, N.Linder, “Congenital heart disease: correlation with fluctuations in cosmophysical activity, 1995-2005”, Int. J. Cardiol., 2009, v.135(2), pp.207-210 (E-publ. 2008, June 25).

[8] National Oceanic and Atmospheric Administration (NOAA). United States Air Force. Space Environment Services Center. Glossary of Solar-Terrestrial Terms. Boulder CO, USA, 1988; Revised in 1992.

[9] G.Sigl, “Ultrahigh-energy cosmic rays: physics and astrophysics of extreme energies”, Science, 2000, v.291 (5521), pp. 73-79.

[10] National Oceanic and Atmospheric Administration (NOAA). National Geophysical Data Center. Solar Indices Bulletin. Monthly. Boulder. CO, USA.

[11] National Oceanic and Atmospheric Administration (NOAA). National Geophysical Data Center. Geomagnetic Indices Bulletin. Monthly. Boulder. CO, USA.

[12] National Oceanic and Atmospheric Administration (NOAA), United States Air Force. Space Environment Service Center.

Preliminary Report and Forecast of Solar-Geophysical Data. Weekly, Boulder, CO, USA.
[13] Moscow Neutron Monitoring Data. Monthly/Daily. IZMIRAN, Russian Academy of Sciences, Moscow.
[14] Neutron Monitoring Data. Monthly/Daily. Oulu University, Oulu, Finland.
[15] E.Stoupel, A.Silbergeld, I.Gil-Ad, R.Keret, M.Shimshoni, Z.Laron, "Relationship between solar activity and levels of plasma growth hormone and prolactin", Neuroendocrin. Lett.,1989, v.11(5), pp.291-295.
[16] E.Stoupel, E.Abramson, P.Israelevich, J.Sulkes, D.Harell, "Dynamics of serum C-reactive protein (CRP) level and cosmophysical activity", Eur. J. Int. Med., 2007, v.18(2), pp.124-128.
[17] E.Stoupel, Y.Monselise, J.Lahav, "Changes in autoimmune markers of the anti-cardiolipin syndrome on days of extreme geomagnetic activity", J. Basic. Clin. Physiol. Pharmacol., 2006, v.17(6), pp.269-278.
[18] E.Stoupel, E.Abramson, U.Gabbay, A.J.Pick, "Relationship between immunoglobulin level and the extremes of solar activity", Int. J. Biometereol., 1995, v.38, pp.89-91.
[19] E.Stoupel, R.Kalediene, J.Petrauskiene, et al., "Suicide-homicide temporal interrelationship, links with other fatalities, and environmental physical activity", Crisis, 2005, v.26(2), pp.85-89.
[20] G.D.Webb, F.Smallhorn, J.Therrien, A.N.Redington, "Congenital heart disease", in: Braunwald E., Zipes D.P., Libby P., Bonow R. (Eds.), Braunwald's heart disease, Philadelphia, W.B.Saunders, 2005.
[21] H.D.Allen, H.P.Gutgessel, E.B.Clark, D.J.Driscoll, "Moss and Adams' heart disease in infants, children and adolescents: including the fetus and young adult", 6th edition. Lippincott Williams and Wilkins, 2001.
[22] S.C.Siu, J.M.Colman, "Heart disease and pregnancy", Heart, 2001, v.85, pp.710-715.
[23] R.H.Andersen, E.Baker, F.J.Macartney, et al., "Pediatric cardiology", London, Churchill Livingston, 2001.
[24] J.F.Bottollier-Depois, Quang Chau, P.Bousset, G.Kerlau, L.Plawinski, L.Lebaron-Jacobs, "Assessing exposure to cosmic radiation by long-haul flights", Radiat. Res., 2000, p.153(1), No5, pp.526-532.
[25] V.Rafnson, H.Tulinius, J.-G.Jonasson, J.Hrafnkelson, "Risk of breast cancer in female flight intendants: a population-based study", Cancer Causes Control, 2001, v.12, pp.95-101.
[26] G.-P.Hammer, H.Zeeb, U.Tveten, M.Blettner, "Comparing different methods of estimating cosmic radiation exposure of airline personal", Radiat. Environ. Biophys., 2000, v.39, pp.227-331.
[27] J.-D.Boice, M.Blettner, A.Auvinen, "Epidemiological studies of pilots and aircrew", Health Phys., 2000, v.79, pp. 576-584.
[28] A.Brooks, S.Bao, K.Rithidech, L.-A.Couch., Relative effectiveness of HZE iron – 56 particles for introduction of cytogenetic damage in vivo", Radiat. Res., 2000, v.155, pp.353-359.
[29] A.W.H.Nias, "An introduction to radiotherapy", 2nd edition, John Wiley and Sons, New York, 2000.
[30] E.Fenig, M.Mishaeli, Y.Kalish, M.Lishner, "Pregnancy and radiation", Cancer Treatment Rev., 2001, v. 27, pp.1-7.
[31] E.Stoupel, P.Israelevich, J.Petrauskiene, R.Kalediene, E.Abramson, J.Sulkes, "Cosmic rays activity and monthly number of deaths: a correlative study", J. Basic. Clin. Physiol. Pharmacol., 2002, v.13(1),pp.23-32.
[32] E.Stoupel, R.Kalediene, J.Petrauskiene, et al., "Three kinds of cosmophysical activity - links to temporal distribution of deaths and occurrence of myocardial infarction", Med. Sci. Monit., 2004, v.10(2), pp.CR 80-84.
[33] E.Stoupel, P.Israelevich, J.Kusniec, et al., "Are neutrons involved in the pathogenesis of life-threatening arrhythmias?", J. Basic. Clin. Physiol. Pharmacol., 2006, v.1, pp.55-66.
[34] E.Stoupel, E.Babayev, F.Mustafa, E.Abramson, P.Israelevich, J.Sulkes, "Acute myocardial infarction occurrence: Environmental links – Baku – 2003-2005 data", Med. Sci. Monit., 2007, v.13(8), pp.BR 175-179.
[35] E.Stoupel, S.Domarkiene, R.Radishauskas, E.Abramson, P.Israelevich, J.Sulkes, "Neutrons and sudden cardiac deaths (SCD), codes 121-125, ICD-10", J. Basic Clin. Physiol. Pharmacol., 2006, v.17(1), pp. 45-54.
[36] A.Kirby, F.Hollfelder, "Biochemistry: Enzymes under the nanoscope", Nature, 2008, v.456, pp. 45-47.