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Prevalence of nuclear cataract in Swiss veal calves and its possible association with mobile telephone antenna base stations

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Abstract

The purpose of this study was to valuate the prevalence of nuclear cataract in veal calves and to elucidate a possible impact by mobile phone base stations (MPBS). For this experiment a cohort study was conducted. A follow-up of the geographical location of each dam and its calf from conception through the fetal period up to slaughter was performed. The first trimester of gestation (organogenesis) was particularly emphasized. The activities of selected protective antioxidants (superoxide dismutase, catalase, glutathione peroxidase [GPx]) were assessed in aqueous humor of the eye to evaluate the redox status. Of 253 calves, 79 (32 %) had various degrees of nuclear cataract, but only 9 (3.6 %) calves had severe nuclear cataract. Results demonstrate a relation between the location of veals calves with nuclear cataracts in the first trimester of gestation and the strength of antennas. The number of antennas within 100 to 199 meters was associated with oxidative stress and there was an association between oxidative stress and the distance to the nearest MPBS. Oxidative stress was increased in eyes with cataract (OR per kilometer: 0.80, confidence interval 95 % 0.62,0.93). It has not been shown that the antennas actually affected stress. Hosmer-Lemeshow statistics showed an accuracy of 100 % in negative cases with low radiation, and only 11.11 % accuracy in positive cases with high radiation. This reflects, that there are a lot of other possibilities for nuclear cataract beside MPBS. Further studies on the influence of electromagnetic fields during embryonic development animal or person at risk are indicated.

Keywords: calf, nuclear cataract, mobile phone, prevalence, cohort study

Prävalenz von nukleärem Katarakt bei Mastkälbern in der Schweiz und deren mögliche Assoziation mit Handy-Basisantennen Exposition

Das Ziel der vorliegenden Studie war es, die Prävalenz von nukleären Katarakten bei Schlachtkälbern zu bestimmen und einen möglichen Zusammenhang mit Mobilfunkbasisstationen (MPBS) abzuklären. Dazu wurde eine Kohortenstudie unter Feldbedingungen durchgeführt. Aufgrund der Ohrmarke konnten die Koordinaten sämtlicher Standorte eines Kalbes, vom Besamungszeitpunkt des Muttertiers bis zur Schlachtung des Kalbes, bestimmt werden. Spezielle Aufmerksamkeit wurde dem ersten Drittel der Trächtigkeit (Organogenese) gewidmet. Die Aktivität einiger protektiver Antioxidantien wurde im Kammerwasser bestimmt. In dieser Studie wurden bei 253 zufällig ausgesuchten Kälbern beiderlei Geschlechts 79 (32 %) nukleäre Katarakte in verschiedener Ausprägung gefunden. 9 von 253 (3.6 %) Kälber hatten einen stark ausgeprägten Katarakt. Die Ergebnisse zeigen einen Zusammenhang zwischen Standort der Kataraktkälber im ersten Drittel der Trächtigkeit und der Sendeleistung der nächststehenden Mobilfunkantenne. Die Anzahl Antennen zwischen 100 und 199 Metern war mit oxidativem Stress verbunden und es bestand ein Zusammenhang zwischen oxidativem Stress und der Entfernung der nächstgelegenen MPBS. Augen mit Katarakt wiesen auf einen erhöhten oxidativen Stress hin (OR pro Kilometer: 0.80, Vertrauensintervall 95 % 0.62, 0.93). Die Bestimmung nach Hosmer-Lemeshow ergab eine Genauigkeit von 100 % zwischen niederer Handy-Basisantennenstrahlung und Abwesenheit von Katarakt aber nur eine Genauigkeit von 11.11 % bei Kälbern mit Katarakt und einer erhöhten Handy-Basisantennenleistung. Dies zeigt, dass neben dem Einfluss von Handy-Basisantennen noch weitere Faktoren für die Entstehung nukleärer Katarakte beim Kalb in Frage kommen. Inwieweit elektromagnetische Felder die Embryonalentwicklung bei Mensch und Tier beeinflussen, muss in weiteren Untersuchungen abgeklärt werden.

Schlüsselwörter: Kalb, nukleärer Katarakt, Handy, Prävalenz, Kohortenstudie

Introduction

Several cases of severe nuclear cataract (Ashton et al., 1977) occurred on a Swiss dairy farm, where 25 % of the newborn calves showed ocular symptoms. Any opacity of the lens, which prevents arriving light of reaching the retina, is called cataract. It may clinically be diagnosed by slit lamp biomicroscopy. Depending on its specific structure, cataract causes reflection, refraction or dispersion of light. Cataracts have various etiologies and the cause often remains unknown. Cataracts can be categorized as primary or secondary. Primary cataracts are not associated with concurrent or antecedents ocular or systemic disease. They may be congenital or developmental. Secondary cataracts are the result of trauma or systemic and/or ocular disease, such as metabolic, inflammatory or infectious diseases, toxic insults, radiation et cetera (Barnett and Sansom, 2001). Congenital cataracts are present at birth, but begin during fetal life. Eyes with congenital lens anomalies often exhibit multiple ocular defects, including microphthalmia, anophthalmia, persistent pupillary membranes and others. Congenital cataracts are not necessarily inherited (Cook, 1995). They may also be of maternal origin, resulting from exposure to an infectious or toxic agent, or intrauterine dietary deficiency (Carmichael et al., 1965; Koch and Rubin, 1967). Oxidative stress has been suggested to play a major role in many ocular diseases, such as cataracts and macular degeneration. The lens has a well-designed system of defense against oxidation (Augusteyn, 1981). If these defense systems are down regulated or overstrained because of oversupply of free radicals, damage results. The damage due to reactive oxygen species in the lens consists of protein modification, lipid peroxidation and DNA (Deoxyribonucleic acid) fragmentation. All of which have been proposed to contribute to cataractogenesis (Spector, 1995; Lou, 2000). There are only a few reports about the prevalence of eye diseases in food animals. In 1968, 502 Brown Swiss cattle were examined, 18.8 % of which showed ocular variations. The prevalence for ocular abnormalities was increasing with age, starting at 3 % in cattle less than 6 years of age, to 43 % in cattle between 7 and 14 years, and finally to 75 % in cattle at an age of more than 14 years (Ammann, 1968). Another study (Spradbrow et al., 1985) showed a 14.6 % prevalence of ophthalmic lesions in 1100 slaughter cattle in Queensland. Herefords were significantly overrepresented, regarding neoplastic and inflammatory diseases. Swiss legislation requires that cattle movements be registered. This allows the tracking of all bovine animals until slaughter. Ocular organogenesis during fetal development takes place during the first trimester of gestation (Zusman et al., 1990) and this time period was of special interest to us.

The effect of electromagnetic fields associated with mobile phone base stations (MPBS) on the health of human beings and animals is still controversial (Löscher, 2003; for details see SCENIHR report, 2007). The first goal of the present cohort study under field condition was to measure the prevalence of nuclear cataract in Swiss calves. The second goal was to evaluate the effect of electromagnetic fields produced from MPBS on the occurrence of nuclear cataracts in veal calves in Switzerland.

Animals, Material and Methods

Animals

The a priori sample size was calculated using EpiInfo 2000 with an expected prevalence according to the literature of 18 % (Odorfer, 1995) and the following limitations: population size 290'000, equals slaughtered calves in Switzerland in 2003 (Anonym, 2004) accepted error 5 %; confidence level 95 %. This results in a minimum sample size of 227. Two hundred and fifty-three veal calves, 83 to 370 days old (mean 146 days), were randomly selected at different abattoirs in Switzerland immediately after slaughter. The 253 calves were from 229 different farms. The highest contribution of one farm was 4 calves. The samples were stratified by the relative frequency of each Swiss canton. Therefore all Swiss regions were represented. The calves were selected by chance when coming out of the slaughtering process for disposal of the head. The inclusion criteria were a health condition acceptable for meat processing and an ear tag for exact identification of the calf. Excluded were calves not accepted for slaughtering and without an ear tag.

Sample collection and analysis

The samples were collected between August 2005 and April 2006. The identity of the calves was determined using the ear-tag number. An ophthalmic examination of both eyes was carried out, and those with cataracts were enucleated for histological examination. All the calves were tested for bovine virus diarrhea (BVD) virus, *Neospora caninum* and *Toxoplasma gondii* to rule out infectious agents that are known to cause nuclear cataracts in Switzerland. For anti-Neospora caninum antibodies-detection in bovine aqueous humor, a somatic antigen ELISA, PCR or an immunoblot was used as previously described by Gottstein et al. (1998). For Toxoplasma gondii detection, a commercially available native, affinity purified P30-antigen (Z.I.SR2B, Avrille, France) was used for the coating of the ELISA plates. Coating and all subsequent test steps were done as previously described for a Neospora-ELISA.

Skin biopsies were taken from the cheek region with a 6mm Ø biopsy punch during examination of the calf in the abattoir. Two different monoclonal antibodies were used for BVD detection (Ca_3 (1:100) and C_{16} (1:100)-Bommeli AG). The EnVision method (DAKO®) was applied while using AEC (Amino-Ethyl-Carbazol) as a chromogen. Because cataracts have been attributed to oxidative injury of proteins and lipids

Diagnosis	Category	N	%
Dense nuclear cataract	severe	9	3.6
Central nuclear opacity	mild	6	2.4
Focal peripheral nuclear opacity	mild	22	8.9
Opacity of the posterior border of the nucleus	mild	15	5.9
Opacity of the posterior part of the nucleus	mild	2	0.8
Moderately developed cataract	mild	13	5.1
Unclassified cataract	mild	1	0.4
Condensed border between nucleus and cortex	mild	11	4.3
No cataract	no	174	68.8
Total	–	253	(100.0)

Table 1: Prevalence of nuclear cataract in calves in Switzerland.

(Ferrer et al., 1991), aqueocentesis was conducted using a limbal approach. The activities of selected protective antioxidants (superoxide dismutase, catalase, glutathione peroxidase [GPx]) were assessed in aqueous humor to evaluate the redox status of the lens.

Electromagnetic field strength and influence on calves

Using the ear tag number, information about the origin of the calf from conception to slaughter and its dam was obtained using Swiss geographical coordinates in a Mercator system. The observational time between fertilization and slaughter was divided in first, second and third trimester of pregnancy and from birth until slaughter. The pedigree of the calves was also determined using the ear tag number. The relationship between the geographical position of the farms (n = 362) on which the dams and calves were housed and the field strength and distance to MPBS within a 10 km radius (n = 608'141 GSM {Global System for Mobile Communications; in earlier time Groupe Spécial Mobile} or UMTS {Universal Mobile Telecommunications System} transmission units on 10'716 locations) was determined.
The Swiss Federal Office of Communication provided information about the location and activity of MPBS and their respective radiation frequency (GSM and UMTS) and field strength (V/m). The maximum theoretical field strengths of the closest MPBS with omni-directional radiation without topographical correction were > 1 V/m (40 locations), 0.5–0.99 V/m (121 locations), 0.1 – 0.49 V/m (190 locations) and < 0.1 V/m (11 locations). All MPBS within a distance of 2000 m from the actual position of the animal, i.e. the cowshed, were included in the study (0 – 99 m: 5 MPBS; 100 – 199 m: 9 MPBS; 200 – 299 m: 9 MPBS; 300 – 399 m: 13 MPBS; 400 – 499 m: 21 MPBS; 500 – 999 m: 124 MPBS; 1000–1999 m: 263 MPBS for distance at first trimester). The grouping was performed according to the selection provided on maps of the Swiss Federal Office of Communication. For calculation of the total field strength, all GSM and UMTS MPBS within a radius of < 10 km of the actual position of the animal were included.

Statistical analysis

The data were analyzed (Stata 10) using factorial analysis of variance (ANOVA), logistic regression or simple linear regression modeling to calculate dependency between biochemical data and distance to the nearest MPBS. Distribution of data was analyzed for best fit and goodness of fit was tested either by Shapiro-Wilk W test for normal distribution and Kolmogorov's D test for lognormal distribution. If necessary, log e (ln) transformation of data was performed. Because the number of cases with severe nuclear cataracts was small, results were controlled not only for significance ($p \leq 0.05$) but also for power ($\beta \geq 0.8$). Odds ratio (OR) was calculated by different models: One model compared the OR between severe cataracts and no cataracts, one between severe cataract and moderate to no cataracts and one between all kind of cataracts and no cataract in calves as presented in Table 1. Only results with $p < 0.05$ and power > 0.8 are reported as significant. Accuracy of obtained results was tested using Hosmer-Lemeshow statistics.

Results

Of 253 calves, 79 (32 %) had a unilateral or bilateral nuclear cataract, but only nine (3.6 %) calves had severe nuclear cataracts (Tab. 1). The distribution by distance range and respective numbers of MPBS is given in Table 2. Infection with BVD virus, *Neospora caninum* and *Toxoplasma gondii* was ruled out as a possible cause, and there was no association in each model with breed and pedigree. The prevalence of these infectious agents showed to be the same as in previous studies in Switzerland (Hässig et al., 1995). Cases of positive infectious agents were not eliminated from the study. Out of 156 male calves, 57 (36.5 %) had shown clinical cataracts. Of 95 female calves, only 24 (25.3 %) showed cataracts (p-value = 0.06). An association between the strength of antennas and nuclear cataracts in veal calves was first seen in the first trimester of gestation (factorial ANOVA-test, Tab. 3). The results for the second

Table 2: Distribution of Swiss veal calves by distance range and respective numbers of mobile telephone antenna base stations (MPBS).

Time	Distance (meter)	N	Number of MPBS 0	1	2	3	4	5	> 5
1. Trimester	0 – 99	250	246	4					
1. Trimester	100 – 199	250	244	5	1				
1. Trimester	200 – 299	250	248	2					
1. Trimester	300 – 399	250	240	6	3	1			
1. Trimester	400 – 499	250	238	12					
1. Trimester	500 – 999	250	161	55	17	12	2	2	1
1. Trimester	1000 – 1999	250	71	44	44	27	26	6	32
2./3. Trimester	0 – 99	252	248	4					
2./3. Trimester	100 – 199	252	246	5	1				
2./3. Trimester	200 – 299	252	250	2					
2./3. Trimester	300 – 399	252	243	6	3				
2./3. Trimester	400 – 499	252	240	12					
2./3. Trimester	500 – 999	252	163	57	16	11	2	2	1
2./3. Trimester	1000 – 1999	252	72	43	43	28	28	7	31
Birth	0 – 99	227	223	4					
Birth	100 – 199	227	222	4	1				
Birth	200 – 299	227	223	4					
Birth	300 – 399	227	217	7	2	1			
Birth	400 – 499	227	215	12					
Birth	500 – 999	227	146	50	14	11	3	2	1
Birth	1000 – 1999	227	62	39	39	29	22	6	30

Table 3: Factorial ANOVA-test for association between nuclear cataract in veal calves and mobile telephone antenna base stations (MPBS).

Cases/controls	Factors tested for association	1. Trimester P-value	Power	2. / 3. Trimester P-value	Power	Birth P-value	Power
Severe cataracts/ all others	ln (Field strength of next MPBS)[1]	0.0050	0.805	0.0090	0.747	0.0363	0.555
	ln (Strength of next MPBS per distance[3])	0.0007	0.925	0.0042	0.821	0.145	0.689
	ln (Strength total MPBS[2] per distance[3])	0.0003	0.956	0.0041	0.897	0.0097	0.738
Severe cataracts/ no cataract	ln (Field Strength of next MPBS)	0.0103	0.732	0.0136	0.699	0.0486	0.506
	ln (Strength of next MPBS per distance[3])	0.0024	0.866	0.0081	0.759	0.0249	0.615
	ln (Strength total per distance[3])	0.0007	0.931	0.0020	0.877	0.0138	0.696
All cataracts/ no cataracts	ln (Field Strength of next MPBS)	0.0528	0.675	0.0869	0.515	0.1853	0.582
	ln (Strength of next MPBS per distance[3])	0.0569	0.644	0.0645	0.614	0.0835	0.561
	ln (Strength total per distance[3])	0.0651	0.598	0.0608	0.605	0.0953	0.508

[1] Nearest MPBS within 2 km radius
[2] All MPBS within 10 km radius
[3] meter

and third trimester are similar due to a small movement of the pregnant cow or heifer at this stage. There was an association between oxidative stress, measured as ln (GSH), and the distance to the nearest MPBS, which was apparent during the second trimester and around birth (lognormal regression, p = 0.0090 for second trimester and p = 0.0203 for the time around birth, power set at 0.8). The strength of association by means of odds ratio (OR) is given in Table 4 (logistic regression). Only two calves in the group of calves with severe cataract came from the same village. The other 7 calves were distributed all over Switzerland. Four calves had a theoretical exposition of more than 1V/m from the next MPBS, 2 between 0.5 and 0.99V/m and 3 below 0.5V/m. This distribution is significantly different to the number of MPBS in the respective category (p = 0.0115). Oxidative stress was significantly decreased by means of GPx (OR per kilometer: 0.80, confidence interval 95 % 0.62,0.93). Hosmer-Lemeshow statistics showed an accuracy of 100 % in negative cases and only 11.11 % accuracy in positive cases due to the low number of calves with severe nuclear cataracts.

Discussion

Severe cataracts were found in 3 % of animals whereas less severe cataracts seem to have a prevalence of up to 30 %. We conclude, that the prevalence of nuclear cataract reported in veal calves depends on the cut-off for symptoms. These findings on prevalence for Swiss veal calves are in accordance with prior results (Ammann, 1968; Löscher, 2003). Results of this study indicate that during organogenesis the risk for the development of nuclear cataract in calves might be related to MPBS. Regarding the results of Ashton (1977), where no MPBS were yet present, the prevalence numbers are however in the same range. Thus, other potential environmental agents can not be ruled out such as power lines, proximity to highway or industrial plants, air quality, as well as seasonal effects such as ultra violet light or ozone. In this study major infectious etiologies for nuclear cataract in Switzerland such as Neosporosis or BVD virus did not coincide with findings of nuclear cataract. Oxidative stress may also be related to the presence of a MPBS antenna and to total exposure to electromagnetic fields. The cataracts may also be of maternal origin, as actual exposure of fetal calves is expected to near zero. It is not clear whether the results of the redox status, by the measurement of antioxidants, are examining causality or an effect (Lou, 2003). In a further study measurements of the field strength in the last days before slaughtering must be available to elucidate the labile redox status. Due to the wave nature of electromagnetic fields and topographical effects, the association between distances and nuclear cataracts must be interpreted cautiously. The field strength of electromagnetic waves can vary over short distances (Presman et al., 1961). Because pregnant cows and calves move about within the boundaries of the farm, their exposure to electromagnetic fields varies. But contrary to adult cattle or human beings the calves are kept in narrow boundaries and the exposure can be averaged. Because of poor accuracy by means of Hosmer-Lemeshow statistic, which was related to the small number of severe nuclear cataract cases in this study, a back calculation from MPBS distance or field strength to risk of nuclear cataract is not possible. Because of the cohort study design under field condition, the dependent variable nuclear cataract was measured at the end of the calf's life and the independent variable exposure to electromagnetic waves was measured at three different time periods. Thus, it was not possible to specify the exposure to a particular time period. No control measurement was performed for field strength because lack of resources. To our knowledge, this is the first attempt to evaluate the influence of electromagnetic fields on nuclear cataract in veal calves by MPBS under field condition. Biases, such as topographical disturbances or different mobile telephone frequencies, could not be ruled out. A selection bias could be ruled out since the 253 calves

Table 4: Odds ratio (OR) for nuclear cataract in veal calves from logistic regression model for mobile telephone antenna base stations (MPBS).

Cases/controls	Factors tested for association	1. Trimester OR	CI 95 %[3]	2./3. Trimester OR	CI 95 %[3]	Birth OR	CI 95 %[3]
Severe cataracts/ all others	ln(Strength of nearest MPBS per V/m[1])	1.06	0.76,1.50	1.11	0.79,1.57	1.13	0.79,1.62
	ln(Strength of all MPBS per V/m[2])	1.19	0.86,1.65	1.18	0.85,1.63	1.16	0.83,1.64
Severe cataracts/ no cataract	ln(Strength of nearest MPBS per V/m)	2.50	1.21,5.20	2.39	1.17,4.94	2.09	0.99,4.44
	ln(Strength of all MPBS per V/m)	3.10	1.36,7.08	3.11	1.37,7.03	2.37	1.01,5.56

[1] Nearest MPBS within 2 km radius
[2] All MPBS within 10 km radius
[3] confidence interval 95 %

came from 229 dairy farms. Therefore no hierarchical regression model was used. As there has been a relatively recent increase in the number of MPBS set up in countries across the world, it is perhaps surprising that there is no supporting evidence from routine surveillance data and intelligence of a coincident increase in the prevalence of cataract. This argumentation can be explained by a detection bias. Normally nuclear cataracts are not found in veal calves unless the calf is blind and unable to feed itself, because they are not checked for vision or visual acuity as humans. Another bias could be the overestimation of exposition due to calculations based on maximal power of the antenna and no consideration of vertical and horizontal distribution. There is also only a moderate correlation between the allowed field strength of a MPBS and its realized output (Baumann and Stärk, 2007). A controversy of distribution arouse during discussion: Is there a single asymptotic function of distance underlying the field strength or is there an overlaying second sinus curve as a function of the frequency used, affecting exposition below a distance of 100 meters from the antenna. This effect can only be important up to one meter, since the wavelength (lambda) is within centimeters for GSM and UMTS. Eliminating the calves (n = 4) placed within 99 meters the presented results became not significant but showed still a good tendency ($p \leq 0.2$; not shown). Other shortcomings of the study may be the lack of information on the health status of the mothers. The calf was at least clinically checked during the slaughter process according to Swiss Federal regulation. Other confounders such as air pollution, close road traffic due to a possible interaction of MPBS and roads were not addressed in this study. The possible influence of electromagnetic fields on oxidative processes and following on the fetus have to be elucidated. Follow-up studies, such as experimental case – control studies on the influence of electromagnetic fields need to consider the embryonic stage of the animal or person at risk (Zusman et al., 1990).

Prévalence de la cataracte nucléaire chez les veaux d'engraissement en Suisse et association possible avec les antennes de téléphonie mobile

Le but de la présente étude était de définir la prévalence de la cataracte nucléaire chez les veaux d'engraissement et d'étudier une éventuelle relation avec les antennes de base de téléphonie mobile (MPBS). A cet effet, on a effectué une étude en cohorte dans les conditions du terrain. Sur la base de la marque auriculaire, les coordonnées de tous les emplacements où un veau avait vécu, du moment de l'insémination de sa mère jusqu'à son abattage, ont pu être déterminés. Une attention particulière a été portée au premier tiers de la gestation (organogenèse). L'activité de quelques antioxydants protecteurs (superoxyde dismutase, catalase, glutathion peroxydase) a été mesurée dans l'humeur aqueuse. Dans cette étude on a trouvé chez 253 veaux choisis au hasard, 79 cas (32%) de cataractes à divers degrés de gravité mais seuls 9 veaux (3.6%) présentaient une cataracte nucléaire grave. Les résultats montrent une corrélation entre le lieu de stationnement des veaux durant le premier tiers de la gestation et la puissance de l'antenne de téléphonie mobile la plus proche. Il s'agissait d'une association entre stress oxydatif et distance de l'antenne la plus proche. Le nombre d'antennes situées entre 100 et 199 mètres était associé avec un stress oxydatif et il existait une relation entre le stress oxydatif et la distance de l'antenne de télé-

La cataratta nucleare nei vitelli e la possibile relazione con le antenne per la telefonia mobile in Svizzera

Scopo di questo studio è di rilevare la prevalenza di cataratta nucleare nei vitelli da macello e di chiarire l'esistenza di una possibile relazione con le stazioni di base di telefonia mobile (MBPS). Si è quindi effettuato uno studio prospettivo con condizioni preliminari. Sulla base della marca all'orecchio si sono potute definire le coordinate delle varie posizioni dei vitelli dal momento dell'inseminazione della madre fino alla macellazione degli stessi. La dovuta attenzione è stata data in particolare alla prima parte della gravidanza (organogenesi).
L'attività di alcuni antiossidanti protettivi (superossidismutasi, catalasi, glutatione perossidasi) è stata ritrovata nell'umore acquoso. In questo studio, sono stati scelti a caso 253 vitelli di entrambi i sessi di cui 79 (32%) erano affetti da cataratta nucleare con diverse caratteristiche. Dei 253 vitelli, 9 (3.6%) erano affetti da una forte e ben sviluppata cataratta con lente completamente opaca. I risultati mostrano una relazione tra luogo in cui si trovavano i vitelli affetti da cataratta durante il primo terzo della gravidanza e la potenza di trasmissione dell'antenna di telefonia mobile più vicina. Il numero di antenne tra 100 e 199 metri era collegato a stress ossidativo e sussiste un legame tra questo stress ossidativo e la distanza dell'antenna di telefonia mobile MBPS più vicina. Gli occhi affetti da cataratta

phonie mobile la plus proche. Les yeux présentant une cataracte indiquent un stress oxydatif augmenté (OR par kilomètre: 0.80, intervalle de confiance 95% 0.62, 0.93). Il n'a pas pu être démontré actuellement que les antennes affectaient le stress. Une étude statistique selon Hosmer-Lemeshow a montré une exactitude de 100% avec les radiations basses dans les cas exempts de cataracte et de 11.11% seulement avec les radiations élevées dans les cas positifs. Ceci démontre qu'il existe, outre les antennes de téléphonie mobile, un nombre important d'autres facteurs causant une cataracte nucléaire. D'autres études quant à l'influence des champs magnétiques durant le développement embryonnaire animal ou humain sont donc indiquées.

presentano quindi un alto stress ossidativo (OR per chilometro: 0.80, intervallo di fiducia 95% 0.62, 0.93). Un aumento dello stress causato dalle antenne della telefonia mobile non è stato provato. Il test di Hosmer-Lemeshow ci dà una precisione del 100% tra un'antenna a bassa radiazione e l'assenza di cataratta e solo una precisione dell'11.11% per i vitelli affetti da cataratta e un'alta radiazione dell'antenna. Con ciò possiamo affermare che, per spiegare la formazione di cataratta nucleare nei vitelli oltre all'influsso delle antenne di telefonia mobile rientrano in gioco anche altri fattori. Per questo motivo bisogna continuare le investigazioni per comprendere se i campi elettromagnetici hanno un'influenza durante lo sviluppo embrionale nell'uomo e negli animali.

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