



**Journal
of
Al - Azhar University - Gaza
Natural Sciences**

**This special issue is released on the occasion of the International
Conference on Basic and Applied Sciences (ICBAS2010)
10-12 October 2010**

A Refereed Scientific Journal

**Published by
Deanship of Postgraduate Studies and Scientific Research
Al - Azhar University - Gaza
Palestine**

ISSN 1810-6366

Volume: 12, ICBAS Special Issue

A Dramatic Elevation of Neural Tube Defects in the Gaza Strip, Palestine

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Abstract: The incidence of neural tube defects (NTDs) was monitored between January 2006 and April 2010. During the study period 218,395 deliveries occurred, among which 108 were having neural tube defects (4.99 per 10,000), 42 (1.9 per 10,000) of the malformed babies had spina bifida, 7 (0.32 per 10,000) had encephalocele, 13 (0.59 per 10,000) had anencephaly, and 30 (1.37 per 10,000) had meningocele / meningomyelocele. In 16 of the 108 cases, there were also other NTDs malformations. The incidence of neural tube defects prior to 2009 was 3.3 per 10,000 whilst the NTD rate increased in 2009 to April 2010 to a level of 8.8 per 10,000. The difference was statistically significant. This remarkable change in incidence suggests that this finding may be associated with the different banned weapons which were used against Gaza in 2008.

Key Words: Neural tube defect, Spina bifida, Encephalocele, Anencephaly, meningocele, meningomyelocele, Gaza.

INTRODUCTION: Neural tube defects (NTDs) include spina bifida, meningocele, and anencephaly, as well as many less common types, are one of the major affected anomalies from the Operation "Cast Lead" launched at Gaza strip (South area of Palestine) at September 2008.

NTDs are serious birth defects of the brain and spinal cord (such as anencephaly and spina bifida) occurring during the first 20 days of gestation [1,2] and caused by a combination of genetic and environmental factors [3] such as drugs, lack of necessary foods, chemicals, radiation and genetic abnormalities [4].

The few and stable cases of NTDs before September 2008, particularly, the three years prior the war, which were part of our period of study, verify that the usual factors affected neural tube stages were almost the same and did not cause any incredible change.

The period of study after the war, the most important period, in which our work concentrated on this period and aims to figure out the new factors which played a significant role in increasing the NTD cases.

To achieve this goal, our research group met many families at their homes, in particular mothers of the babies with NTDs; the interviews with the families concentrated on the reasons to have NTDs babies and about the family pedigree of NTDs. Very few families with affected babies had record of NTDs. A small number of the women had a clinical check before the birth.

No doubt that the unconventional weapons and carcinogenic or toxic metals were used in the harshest aggression on the Strip, the assault which lasts three continuous weeks with concentrated bombing from December 28, 2008 to January 18, 2009, are the major factors elevating the NTDs.

The types of the weapons used in the aggression, as checked by the investigators were a Dense Inert Metal Explosive (D.I.M.E.), fletcher shells, depleted uranium (DU), chromium, cadmium, cobalt, lead, tungsten and uranium [5,6].

The pilot study which was done after the war by New Weapons Research Group (NWRG), an independent committee of scientists and experts based in Italy, confirmed the presence of different traces of toxic metals in Gaza soil which might cause NTDs abnormalities through inhalation, drinking, or eating the polluted food which may have radioactive debris and particles deposited on the ground [7].

Radiation and chemicals can mainly cause variations in chromosome number and structure in normal cells [8,9]. Any DNA damage may lead to any kind of mutation which consequently may cause birth defect. Ionizing radiation is one of the most widely known causes of genetic mutations resulting in birth defects. Christopher [9] reported that ionizing radiation has a devastating effect on the residence of many regions.

The aim of the present study was to determine the incidence rate of NTDs in Gaza from January 2006 to April 2010; to see if there is a real effect of the

different band weapons used in the "operation cast lead" launched at Gaza, in increasing the NTDs cases. Data were obtained from Al-Shefa, European, and Al- Nasser hospitals.

MATERIALES AND METHODS

Data collection

Data were collected from the main hospitals in Gaza strip with more or less complete records. Over five years period from 2006 to 2010 were included in the study and were assessed for the presence of NTDs. The main period which we highlight is the period before and after the operation "cast lead". Stillborn babies were omitted because we focused on just specific type of abnormalities. Every newborn was examined by a pediatrician within 24 hours of birth and the numbers of total births and newborns with neural tube defects were determined. The number of babies with spina bifida, anencephaly, encephalocele, meningocele and meningomyelocele was recorded.

The data included date of birth by month and year. The main hospitals in Gaza are El-Shefa hospital, El-Nasser hospital and the European hospital. These hospitals serves almost the whole parts of Gaza, the center, the north area of Gaza, and the south area of Gaza.

The maternity care units at Gaza receives about 400–450 deliveries monthly. The annual deliveries are around 50,000 (total births 218,395, NTD cases 108 within the period 2006- 2010). Patients are

usually from middle class to low class families in terms of socioeconomic status.

The incidence of NTDs were compared in the period before and after the operation "cast lead". Gaza has a population of about 1.8 million and covers an area of about 360 square kilometers. Different parameters were obtained by interviewers such as mothers' age, medications, number of affected babies, consanguinity between parents, and socioeconomic class.

Analysis: Data were analyzed by using SPSS software version 18. A *p* value of 0.05 or less was considered statistically significant.

RESULTS: One hundred and eight patients with neural tube defects were recognized among 218,395 deliveries during the study period. Forty-two cases (38.9%) spina bifida, twenty-one cases meningocele (21.9%), thirteen cases anencephaly (13.5%), Nine cases meningomyelocele (9.4%), seven cases encephalocele (7.3%), eight cases spina bifida with hydrocephaly (8.3%).

During 2006 – 2010, there were around 50,000 live births annually documented at ministry of health and maternity hospitals at Gaza- strip.

The yearly incidence of neural tube defects (Table 1) showed a few and constant cases through three years period from 2006 - 2008 compared with the period after the war from 2009- early four months of 2010.

Table 1: Yearly number and incidence per 10,000 of cases of NTDs

	<i>Year</i>				
	2006	2007	2008	2009	early four months of 2010
<i>Deliveries</i>	48984	49570	50390	53451	16694
<i>No with NTDs</i>	17	12	16	51	12
<i>Incidence (per 10,000)</i>	3.5	2.4	3.2	9.5	7.1

The incidence of NTDs during the five years period was 4.99 per 10,000. The total cases of NTDs at 2006 was 17 (15.7%), at 2007 was 12 (11.11%), at 2008 was 18 (16.7%), and the total at 2009 and early four months of 2010 was 61 cases (56.5%). The highest incidence rate was after the war (8.8 per 10,000) whilst the rates at 2006, 2007, 2008, were 3.5, 2.4, 3.2 per 10,000 respectively. Thus the yearly rate for NTD ranged from 2.4%- 3.5%, suggesting that the frequency of infants born with NTD in the Gazan population was fairly similar every year before the war.

These findings are astonishing. How wide the gap before and after the aggression at Gaza, and is worthy of further research. The rate differences pre war and post war period were statistically significant.

There is also a clear difference among the different regions in Gaza. The number of affected live births at north Gaza from 2006-2008 was 7 (6.5 %), whilst at 2009 and early 2010 was 18 (16.7 %). At Gaza city, the center of Gaza- strip, the number at the period from 2006-2008 was 8 (7.4 %), and after the war was 17 (15.7 %). At the middle region of Gaza which involves Deer El-Balah, El-Nusirat, El-Burage, the number of the cases before the war 4 (3.7 %), and after the war, the number was 6 (5.6 %). At the south area, which involves Khan Younis, and Rafah, the maximal number of the three years before the war was 12 (11.1 %) whilst at only 2009, the number was 20 (18.5 %) (Table 2). The overall NTD cases at the south was higher than that in the other regions of Gaza.

Table 2: Yearly number and distribution of NTDs in Gaza Strip from 2006-early 2010

Region	Year					Total
	2006	2007	2008	2009	early 2010	
North	4	1	2	13	5	25
Center	5	1	3	13	4	26
Middle	1	1	2	3	3	10
South	7	9	11	20	0	47
Total	17	12	18	49	12	108

Spina bifida was the most common type of NTDs affected from the war, thus the cases multiply three times more as before the war, following by anencephaly cases which multiply two

times compared to the cases before the war (Table 3). The other types of NTDs affected lesser than the main two types.

Table 3: Incidence of NTD in Gaza/10,000, at 2006-2008 and at 2009- early2010

NTD	NTDs/at 2006-2008	incidence	NTDs/at 2009-early2010	incidence
Spina bifida	10	0.07	29	4.13
Anencephaly	4	0.27	9	1.28

DISCUSSION: Our results show an incredible increase in the incidence of a NTDs after the aggression launched at Gaza at September 2008. This observation is similar to the work done about Chernobyl and al Fallujah in western Iraq.

In our study, the incidence of NTDs before the operation "cast lead" was 3.3 per 10.000 live births, which is very low compared to that after the war, 8.8 per 10.000.

A clear explanation was needed to figure out the main causes of duplication of NTD cases in comparison with the cases before the war. The causes of NTDs abnormalities could be genetic factors, environmental, enzymatic defects, maternal and paternal age, folic acid deficiency [2,10,11,12], and could be due to radiation effects [13,14,15]. The major link to duplicate the NTDs at Gaza many times more after the war than those before the war could be the unconventional weapons, pollution, depleted uranium, radioactive metal, white phosphorous, war debris, unpleasant smokes transferred by the wind and passed into peoples homes, food, and lungs. It is not easy task for doctors to specify the main reason for NTDs; but definitely the increase of the cases refer clearly to the different types of weapons used in the assault.

The few number of NTD cases at 2006, 2007, and 2008 was due to absence of any external factors and may be due to local diet rich in vegetables and fruits intake which has large amounts of folic acid; which considered among the most important nutrients for prevention of NTDs. The relationship between folic

acid deficiency and NTDs was first mentioned in 1965 [10].

Akar *et al.* [16] reported that radiation is the major factor to increase the incidence of spina bifida in Bursa [15] and that because Bursa is located near the region of Chernobyl disaster. Many other studies were done about the link between the radiation and the early embryogenesis and NTDs on different areas of Turkey [17].

The distribution of the cases all over the different regions of Gaza is diverse. The regions which exposed to the concentrated attack have more NTD cases. The south, the center, and the north regions have more cases than the middle region of Gaza.

Our results were consistent with the results of the study which done after the war by NWRG and found that NTD cases were distributed in north and center of Gaza. The NWRG results were due to metal contamination at these areas.

CONCLUSION: The present study suggests that the increase incidence of NTDs in Gaza strip population after the war is more likely related to the different band weapons used in the aggression at Gaza at late 2008. These considered the main cause to increase the NTDs because pre war cases were few.

ACKNOWLEDGMENT: The authors would like to thank every one collaborates in gathering the data. The authors also wish to acknowledge Dr. Samir Safi for his help in statistical analysis of this work.

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ISSN 1810-6366

المجلد ١٢، عدد خاص