

## Structural birth defects in the Gaza Strip, occupied Palestinian territory: a cohort study

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Published Online  
October 8, 2012

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**Background** No data were available for structural birth defects in the Gaza Strip, occupied Palestinian territory. We developed a questionnaire to estimate the incidence of late miscarriages (spontaneous delivery >16 weeks and <28 weeks), premature births (<32 weeks or weight <1.5 kg), stillbirths, structural birth defects, and occurrence in siblings of the fetus and first-degree and second-degree relatives of the parents. We investigated possible associations between birth defects and exposure to weapons during Israel's Operation Cast Lead on the Gaza Strip from Dec 27, 2008, to Jan 18, 2009.

**Methods** A medical team interviewed pregnant women giving birth at the Al-Shifa Hospital, Gaza Strip, using a questionnaire that included questions from the International Clearinghouse for Birth Defects. The defects were then classified according to Eurocat-International Statistical Classification of Diseases and Related Health Problems 10th Revision. All parents were asked about their exposure to white phosphorus. Only parents of a child with a birth defect were asked about birth defects in first-degree and second-degree relatives of the parents, and their exposure to bombing; 44 of 55 parents responded fully. We did subgroup comparisons using Fisher's test; 95% CIs are reported with the point estimates, and a p value of less than 0.05 was judged to be significant. Permission to undertake this study was granted by the Ministry of Health, Gaza Strip. Mothers provided written informed consent for use of information about them and for hair samples to be obtained from their children.

**Findings** Of 4027 consecutive deliveries between May 4, and Oct 4, 2011, we registered 94 miscarriages (23.3 per 1000 births), 77 premature births (19.6 per 1000 births), 30 stillbirths (7.4 per 1000 births), and 55 infants with structural birth defects (14.0 per 1000 births). The types of birth defects were neural tube (12 [22%]), multiple (nine [16%]), kidney (eight [15%]), cleft lip or palate (seven [13%]), limb (four [7%]), facial (four [7%]), cardiac (three [5%]), abdominal wall (three [5%]), gastrointestinal (two [4%]), lung (one [2%]), urogenital (one [2%]), and Edward's syndrome (one [2%]). Comparison with data in the 2009 report of the International Clearinghouse for Birth Defects showed that the frequency of the birth defects registered in the Gaza Strip was in the range of frequencies registered in developing countries and less than those in highly developed countries. The most obvious difference was the higher frequency of kidney birth defects than in northwestern countries, possibly due to a common polymorphism for polycystic kidney in Arab groups. Cardiac diseases, 5% in our register, were lower than the 20–30% reported worldwide. We are aware that this difference is due to a lack of echocardiography monitoring at birth in the Gaza Strip, thus the total frequency we report is likely an underestimation. 16 (29%) of 55 couples with children who had birth defects and 1029 (27%) of 3811 with children without such defects were registered as being intermarried (difference 2%, 95% CI –10 to 14;  $\chi^2$  test,  $p=0.85$ ). 11 (20%) of 55 couples with a child with a birth defect had a previous child with a birth anomaly; five children had the same defect as their siblings and six had different birth defects. No cases of birth defects were reported in 643 siblings of the parents, but 14 of 1423 offspring (9.8 per 1000 births) of the siblings had birth defects. These modalities of presentation of birth defects are compatible with the occurrence of novel genetic or epigenetic sporadic events in the parents or during pregnancy that affect the development of the embryo. In 12 (27%) of 44 families with children with birth defects, one or both parents were exposed to white phosphorus during Operation Cast Lead compared with 49 (2%) of 2933 parents with children without such defects; the difference was significant (25.6%, 95% CI 21.4–29.8;  $p<0.0001$ ). These families' homes were at the site of the attacks. Bombing of the house, removal of rubble, or on-site reconstruction were reported by nine (20%) of 44 couples with children with birth defects. Exposure to bombing was not recorded for parents with children without birth defects.

**Interpretation** Registration and clinical diagnosis of birth defects were possible at Al-Shifa Hospital, the main public hospital in the Gaza Strip. We expect our report of the frequency of birth defects is an underestimate and their frequency will be higher after the inclusion of cardiac and other defects, which manifest shortly after birth, following an improvement of the diagnostic equipment. This step will also certainly improve the general health care for newborn babies. The collaboration of the UN Special Coordinator for the Middle East Peace Process allowed us to confirm the subjective report of exposure to white phosphorus in 19 of 20 couples with children who had birth defects through the confirmation of retrieval of the ammunitions on the ground. Our findings suggest the need to investigate and identify chemical contaminants introduced with the use of weaponry and persisting in the environment, and their bioavailability and potential to cause long-term effects on reproductive health. These findings are a cause for public health concern in the occupied Palestinian territory and other countries where similar western-made weapons

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have been or are being used.

#### **Funding Interpal Gaza.**

##### **Contributors**

PM, coordinator and principal investigator of the study, wrote the Abstract. AN, environmental consultant, contributed to writing of the Abstract. RM provided advice about the experimental plan and statistical analysis, contributed to the writing of the Abstract. HAD, KAM, ES, and MEB interviewed the participants and diagnosed the birth defects. RAS inputted and organised the data.

##### **Conflicts of interest**

We declare that we have no conflicts of interest.

##### **Acknowledgments**

This study was funded by Interpal Gaza, London, UK.