CONGENITAL ANOMALIES IN GUATEMALAN CHILDREN: CAUSES AND ACTIONS
Multiple causes, multiple impacts, multiple approaches.

THE SYMPOSIUM-WORKSHOP

There are many organizations engaging in activities to address the issue of congenital anomalies in Guatemala, and especially in the Department of Alta Verapaz. These practitioners are interested in information about the best practices to prevent them and to reduce their incidence. Knowledge about conditions surrounding congenital anomalies and efforts to address risk factors has been identified, but the evidence has not been integrated as a package and examined to identify further research needs and policies to solve the problem.

To this end, a consortium including of Universidad Rafael Landívar, the George Washington University School of Public Health, Asociación Compañeros para Cirugía (ACPC) [Partner for Surgery Association] and Grupo Chabil Ixim, held a Workshop on Congenital Malformations in Guatemala, on June 14 and 15, 2016, at the Universidad Landívar academic campus in Guatemala City.

The five-part workshop encompassed knowledge about the congenital anomalies in the following contexts: (a) clinical and epidemiological, (b) nutritional and genetic aspects, (c) community action experiences, (d) environmental conditions; culminating with an afternoon discussion on a course of action for future research and prevention activities. The detailed results are found in the report "Workshop on Congenital Malformations in Guatemala". This document is a synthesis of the main messages.

---

1. This document is a synthesis of the principal findings of the workshop. For more detailed information about the results, please consult the workshop report or the presentations made at the workshop.
2. This report is available in Spanish.
THE EPIDEMIOLOGICAL-CLINICAL MESSAGES
Congenital anomalies are structural or functional defects deviating from the normal shape and structure of a body part identified at birth.

Congenital anomalies are produced by a mixture of genetic, nutritional and environmental risks (including infectious, chemical, physical, and consumer), to which the population is exposed in different ways, with varied intensity and duration. The effects of nutritional and environmental agents that most influence congenital anomalies occur during the first 8 weeks of pregnancy.

Management options range from medical-surgical treatment, including rehabilitation and social reintegration of current cases, to clinical prevention, health promotion, and protection against risks by regulatory action that reduces the causative risks.

Updated data have not been available for more than 10 years and the rate of underreporting of these conditions is up to about 300%. Some hospitals report rates of 2/1000 per registered live births for neural tube defects (NTDs); 67% are NTDs, and 15% cleft lip and cleft palate. A community registry of pregnancies and births in Chimaltenango in a community registry of pregnancies and births (at 48 hours and 6 weeks) reported a rate of 2.6 / 1000, with a high probability of underreporting and migration; 36% of the anomalies are leporo-palatine clefts. In Alta Verapaz the incidence of leporo-palatine clefts was 1/250 births or 4/1000; 92% of the anomalies are diagnosed at birth.

Evidence on potential risk factors for congenital anomalies

<table>
<thead>
<tr>
<th>Specific Biological Conditions</th>
<th>Nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic Predisposition (and consanguinity)</td>
<td>- Calorie-protein deficiency</td>
</tr>
<tr>
<td>Developmental stage (infancy, adolescence, perinatal, etc) with exposures</td>
<td>- Folic acid deficiency</td>
</tr>
<tr>
<td></td>
<td>- Obesity and Diabetes Mellitus</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Infectious (viruses)</td>
</tr>
<tr>
<td>Pesticides and herbicides (primarily in agriculture)</td>
<td>Physical (radiation, thermal)</td>
</tr>
<tr>
<td>Phthalates in containers and plastic products</td>
<td>Environmental</td>
</tr>
<tr>
<td>Metals (lead)</td>
<td>- Air pollution</td>
</tr>
<tr>
<td>Medications (some)</td>
<td>- Indoor pollution (wood stoves)</td>
</tr>
<tr>
<td>Teratogenic substances (dioxins, benzenes, other incomplete combustion products)</td>
<td>Consumption</td>
</tr>
<tr>
<td>Food contamination (especially AFLATOXINS, FUMONISINS in corn)</td>
<td>- Tobacco (direct and indirect)</td>
</tr>
<tr>
<td></td>
<td>- Alcohol</td>
</tr>
<tr>
<td></td>
<td>- Narcotics</td>
</tr>
</tbody>
</table>
The rate of cleft lip or palate anomalies identified among Guatemalans in California is 1/579 per live births that is 1.7/1000. The risk of a child developing cleft lip and palate is 2.7 times if a male sibling has the condition. In the United States, the estimated cost per patient of $100,000, or which comes to about US$750 million nationally.

Major congenital anomalies identified in public hospital are characterized by a social gradient determined by disparities in literacy, and malnutrition. In Alta Verapaz, the largest source of patients, the male-female literacy gap is 74% to 49%. Health institutions are poorly equipped for costly long-term care of congenital anomalies. There is a specialized unit in San Juan de Dios Hospital. The best results are obtained with surgical treatment in the first weeks of life.

Research has shown liver cancer mortality is second to gastric cancer worldwide in Guatemala and the trend is increasing. Available data are inconsistent. While there are other known risks, research has identified the mutation of the p53 gene (codon R249S) resulting from aflatoxin exposure; this could be synergistic with other risks.

NUTRITIONAL AND GENETIC MESSAGES
An estimated 10% of the cases are exclusively environmental in origin and 25% exclusively genetic, the remaining 65% being the result of a mixture of both. Malnutrition is a major cause of pregnancy complications and abnormalities. 50-75% of cases are preventable with folic acid; zinc, vitamins B6 and A also matter, as does avoiding exposure to other risk factors.

In Guatemala 49% of children are malnourished; 54% in rural areas. 39% of women have anemia. Malnourished mothers induce birth defects and malnutrition in children.

Malnutrition in 10 municipalities is greater than 75%, 5 in Huehuetenango (up to 91.4%), 2 in San Marcos, 2 in Quiche, 1 in Totonicapan.

Malnutrition with 39% of women with anemia; mineral deficiencies and micronutrients. Low levels of folate (leading to birth defects) of 46.1%, 8 and 4 times higher in the North and Northwest of the country; 2.4 x more in rural areas; 1.2 x more in indigenous populations; 5.4 times higher among the poorest.

Malnutrition with 39% of women with anemia;
mineral deficiencies and micronutrients.
Low levels of folate (leading to birth defects) of
46.1%, 8 and 4 times higher in the North and
Northwest of the country; 2.4 x more in rural
areas; 1.2 x more in indigenous populations; 5.4
times higher among the poorest.

malabsorption syndrome. Micronutrient deficiencies are treatable in pregnant women, but treatment must take place before pregnancy and in the first weeks of gestation; currently, this is not being implemented effectively.

Folic acid deficiency is a risk for congenital anomalies. The prevalence of low folate levels is 46%. A regional gradient has been demonstrated in intra-red blood cell folate
deficiency, 8 and 4 times higher in the North and North-East regions; 2.4 times greater in rural areas; 1.2 times more in indigenous areas; 1.7 times higher in those with no schooling; and, 5.4 times higher among the poorest.

The average per capita consumption of maize is 114 kg. In rural areas the average is 454 gr / person / day (approximately 22 tortillas); its consumption increases as income decreases. The diet complement of beans has practically disappeared. Before consumption was 70% corn, 30% beans; now it is 95% and 5% respectively. The biomarkers for mycotoxins increase according to the consumption of tortillas, these are greatest in the departments of Peten, Alta Verapaz and Suchitepequez.

Food diversification based on revaluing existing crops (such as amaranth, mucuy, radish, carrot and others) is key to addressing malnutrition. This can be done by re-empowering the Rural Development Learning Centers (CADER).

MESSAGES ABOUT RESOURCES FOR COMMUNITY ACTION

- Available staff: community promoters; Municipal councilors of food security and nutrition.
- Technologies for community work: Kawok for epidemiological surveillance; Blue box to identify aflatoxins.

Guatemala has a multi-sectorial National Strategy for Food and Nutrition Security. It is oriented toward access, availability, consumption and prioritizes women of reproductive age. Its greatest application potential is at the municipal level. There are municipal commissions, the COMUSAN, implementing the national level initiative (CONASAN), providing a local intersectoral space with opportunities for improvement.

An intervention with an orthopedic plate from an early age that favors nutrition, bone growth and prompt post-surgical recovery has been developed. It requires a lot of specialized equipment, and thus is a candidate for technological innovation to increase accessibility in rural areas.
The effectiveness and accessibility of telemedicine services has been demonstrated through 400 community facilitators in Alta Verapaz. An estimated 185 lives have been saved per year through the identification and monitoring of pregnant women. For example, in one month the program was able to provide 500 telephone consultations. This instrument has proved useful for epidemiological surveillance (KAWOK) and georeferencing.

With "Purchase for Progress" the World Food Program has adapted a qualitative laboratory (the Blue Box) that detects the presence of aflatoxin and thus the quality of corn with lower concentrations of 20 ppm of aflatoxins and 11-14% humidity. The blue box has a current cost of US $2.33 per sample, making field monitoring feasible.

MESSAGES REGARDING THE ENVIRONMENTAL CONTEXT

Mycotoxins are a family of toxins that are produced biologically in maize, with demonstrated teratogenic (damage to the product of the gestation) and carcinogenic effects in the kidneys and the liver.

Approximately 91% of maize produced in Guatemala contains mycotoxins. Exposure studies showed that their high exposure generated anencephaly. 35% of the crops are affected by mycotoxins; post-harvest losses of up to 50% are common. The concentration of aflatoxins doubles during corn storage. Humidity levels, affected by climate change, increase the expression and production of mycotoxins. Continued research in the development of alternatives to reduce moisture and drying alternatives is required. In Peten - the granary of Guatemala - aflatoxin levels of up to 10,000 ppm were measured in 2012.

Communication of the risk to farmers is essential; they don’t understand the problem. Nixtamalization produces some benefits in maize nutrients (releases niacin), and reduces the concentration of mycotoxins.
In Alta Verapaz 87% of the energy is produced by firewood. The use of fuelwood and biomass as fuel generates a toxic mixture in the smoke in the home, causing mucosal irritation, which is potentially teratogenic (produces congenital anomalies) and carcinogenic; it can have a synergistic effect with mycotoxins that are ingested. 30% of respiratory diseases in women and children are attributable to the use of biomass to produce energy. The relationship of these fuels with congenital anomalies in Guatemala has not been studied, although the effects on birth in other countries have been documented.

In 200 blood samples from municipalities with chronic malnutrition, there were micotoxin exposures in women of childbearing age of greater than 3000 ppm. Given the high tortilla consumption in the Guatemalan population, the tolerable mycotoxin concentration in maize has to be modified in the country.

Integrated agricultural interventions which include technological transfer and access to credit have been developed; these have demonstrated increasing harvests by up to 3 times the size of current harvests. Progress regarding the availability of agricultural insurance is essential. There are opportunities in agricultural extension, with the rational use of agrochemicals.
RESEARCH RECOMMENDATIONS THAT EMERGED FROM THE WORKSHOP

**Epidemiological / Organizational Development**
Feasibility of the Epidemiological Surveillance System
Technological innovation
Regulation
Link to the experiences of Telehealth and community registry
Use of the p53 mutation (codon R249S) on exposure to aflatoxins
Monitoring for congenital anomalies
Monitoring for chronic effects of renal and liver cancer
Exposure mix and attributable risk
Aflatoxins + Malnutrition (mono-consumption) + biomass + pesticides
Quality of care and improvement in the diagnosis and management of congenital anomalies

**Technological**
Innovation of appropriate technology to rural technicians for oral-palatine plates
Integrate innovation projects into post-harvest management

**Policy Development**
Evaluation of the critical success factors of the Local Development Committees
Characterization of aflatoxin and other risks for CA in Guatemala
Economic evaluation of opportunity costs:
For congenital anomalies
Malnutrition
Biomass
Health promotion
Risk perception for congenital anomalies and aflatoxins in producers and consumers

**ACTION RECOMMENDATIONS MADE DURING THE WORKSHOP**

**Health Systems**
**Epidemiological surveillance with secondary data**
Folic acid and vitamin B12 distribution programs targeting women of reproductive age
Promote the Specialized Clinical Unit, reference center and clinical knowledge, integrated to a national reference system

**Empowerment / Social Networks**
Target group risk communication plan
Expand health promotion work with community promoters and workers

**Food System**
Integrate nutritional diversification program, including the recovery of beans and other traditional crops
Integrated development program: technology transfer, agricultural extension, credit and insurance
Promote and improve the nixtamalization processes
Promote the CADER Learning Centers
Post-Harvest / Innovation Management

Health Protection
Protect the population from the commercialization process
Revise and modify standards on a temporary basis, while strengthening risk analysis
Application of regulations in import ports and markets
Generalized extension of monitoring via blue box

Internal
Inter-institutional work with CODESAN
Continuous dialogue and engagement forum of NGOs
Shared databases (Observatory) and their socialization