

# SUMMARY:

## BENZENE, FORMALDEHYDE AND ACUTE MYELOID LEUKAEMIA RISK

### Overview

**Benzene and formaldehyde** – both present in rubber crumb infill used in 3G artificial turf pitches – are recognised carcinogens. Both chemicals are linked to **Acute Myeloid Leukaemia (AML)**, with benzene being one of the most well established leukemogenic agents known.

### 1. Benzene

#### 1.1 Classification and toxicity

- Classified by the International Agency for Research on Cancer (IARC) as a **group 1 human carcinogen** and by the Environmental Protection Agency (EPA) and National Toxicology Program (ITP) as a **known human carcinogen**.
- Causes **genetic damage, bone marrow toxicity** and **cancer**, particularly AML.
- Regulatory bodies state **no safe level of exposure** due to its genotoxic mode of action.

#### 1.2 Exposure limits

- EU worker exposure limit: **1 ppm (3.25 mg/m<sup>3</sup>)** over eight hours.
- No DNEL (Derived No Effect Level) can be set because benzene is genotoxic.

#### 1.3 Health effects

- Strongly linked to:
  - **AML**
  - **Myelodysplastic syndrome (MDS)**
  - **Lymphomas**
  - **Aplastic anaemia**
- Causes bone marrow depression, reduced blood cell counts, immune suppression and chromosomal abnormalities.

#### 1.4 Evidence base

- **Human epidemiology:**
  - Repeated studies of workers in rubber, chemical, shoemaking and petroleum industries show significantly increased AML risk.
  - Large Chinese cohort (74,828 exposed workers):
    - AML risk **tripled** (RR = 3.1).
    - Increased lymphoma, lung cancer and aplastic anaemia.

- **Animal studies:**

- Benzene is routinely used to induce leukaemia in rats for research because of its reliability as a leukemogen.

### 1.5 Environmental and occupational sources

- Petrol and diesel fumes.
- Rubber and plastics manufacturing.
- Solvents, degreasers, paint thinners.
- Cigarette smoke.
- Industrial emissions.
- Building materials.

## 2. Formaldehyde

### 2.1 Classification

- Classified as:
  - **Carcinogen 1B**
  - **Mutagen category 2**
  - **Acute toxic (oral, dermal, inhalation)**
  - **Skin corrosive and sensitiser**

### 2.2 Exposure limits

- Worker DNELs (France):
  - Long-term: **0.3 ppm (0.37 mg/m<sup>3</sup>)**
  - Short term: **0.6 ppm (0.75 mg/m<sup>3</sup>)**
- Indoor air guideline: **0.1 mg/m<sup>3</sup>**

### 2.3 Health effects

- Evidence of carcinogenicity in humans (nasopharyngeal cancers) and strong evidence in animals.
- Acts as a local genotoxic carcinogen, with no clear threshold for safe exposure.
- Long term inhalation exposure is the primary concern.

## 3. Benzene and AML: scientific consensus

### 3.1 Mechanism

AML develops when DNA damage accumulates in **hematopoietic stem/progenitor cells**.

Benzene:

- Causes DNA breaks, chromosomal abnormalities and mutations.
- Disrupts blood cell development.
- Promotes clonal expansion of damaged cells.

### 3.2 No safe level

Multiple reviews conclude:

- Even **low dose, chronic exposure** increases AML risk.
- Ambient environmental benzene may contribute to 'de novo' AML cases.

### 3.3 High risk occupations

Workers repeatedly identified as higher risk include:

- automotive and petrol industry workers;
- janitorial and construction workers;
- agricultural workers;
- rubber and plastics manufacturing workers.

## 4. Rubber crumb (3G pitches) context

**Both benzene and formaldehyde are present in rubber crumb infill** used in 3G artificial turf pitches.

Both chemicals:

- are established carcinogens;
- are linked to AML;
- have **no safe exposure threshold** due to genotoxicity.

This raises concerns about chronic, low level exposure – especially for children and athletes with repeated contact.

## 5. Key takeaways

- **Benzene is one of the most potent and well studied causes of AML.**
- **Formaldehyde is also carcinogenic and genotoxic**, with inhalation being the primary risk route.
- Both chemicals are present in **rubber crumb infill**, raising legitimate public health concerns.
- Regulatory agencies agree: **no safe level of benzene exposure can be recommended.**
- Epidemiological, animal and mechanistic evidence all converge on the same conclusion: **chronic exposure increases the risk of AML and other blood cancers.**