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Artificial turf pitches –
An assessment of health risks for football players and the environment

Dr. Christine Bjørge
Division of Environmental Medicine
National Institute of Public Health

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Agenda

- Background information
- Exposure scenarios
- Measurements and calculations
- Hazardous assessment
- Risk assessment - humans and the environment
- Conclusions

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Background - 1

Artificial turf pitches for indoor football

- Artificial turf = artificial turf fibre and rubber granulates
  - Artificial turf fibre (split- and mono fibre)
  - Rubber granulates
    - recycled rubber from car tyres (Styrene-butadiene-rubber, SBR)
    - newly manufactured rubber granulates (ethene-propylene rubber, EPDM)

Background - 2

Artificial turf pitches have many advantages

- Hard wearing
- Easier to maintain than natural grass
- Expand the football season

However, artificial turf often contains rubber granulates from waste tyres which contains several substances with the potential to affect human health and the environment.

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Background – 3

The assessment was based on the following reports

- *Potential health- and environmental effects related to artificial turf pitches, 2004* (SINTEF, Building and Infrastructure initiated by the Norwegian Football Association and the Ministry of Culture and Church Affairs)
- *Measurements of air pollution in indoor artificial turf sports halls* performed by NILU, 2005 (Norwegian Institute of Air Research)
- *The environmental risk assessment of artificial turf performed* by NIVA, 2005 (Norwegian Institute of Water Research)
- *Artificial turf pitches – an assessment of the health risks for football players, 2006* (Norwegian Institute of Pubic Health and the Norwegian Radium Hospital)

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Background -4

- Worst case exposure scenarios identified
- Highest analysis values form recycled rubber granulate (EDPM rubber contains lower levels of hazardous substances, and the leakage to the environment is lower).
- Substance categories considered:
  PCBs, PAHs, metals, phthalates, alkylphenols and VOC (volatile organic hydrocarbons)
- No Observed Adverse Effect Level (NOAEL) for the most relevant biological endpoint:
  cancer, reproductive damage, organ damage

Background - 5

- Exposure duration and frequency were based on information from the managers of the Valhall and Manglerud sports hall in Oslo, Nordlandshallen and Skarpehallen in Tromsø

- Training, matches and cup tournaments (children) were considered

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Exposure – 1
General

Exposure scenarios:

- Adults (older than 20 years)
- Juniors (16-19 years)
- Older children (12-15 years)
- Children (7-11 years)

- Inhalation, skin and oral exposure

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Exposure – 2
Inhalation

Worst case exposure scenarios

- Frequency and duration of training
- Volume air inhaled during activity
- Absorption of substances via lungs
- Body weight of the sportsmen

Respiration volumes based on information from the Norwegian University of Sports and Education

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Exposure – 3
Skin

- Dust/particles released from rubber granulate will come in contact with bare skin (legs, thighs, arms and hands).
- Skin uptake levels: 100 % worst case (phthalates: 5 %)
- Quantity of dust/particles deposited on the skin: 1.0 mg/cm^2

  (Skin exposure of children playing with soil: 10 mg/cm^2,
  Skin exposure to soil during Rugby matches: 0.2 – 1.0 mg/cm^2)
- Frequency/duration of training/matches, body surface

Exposure – 4
Swallowing

- Children may chew rubber granulate in the mouth for chewing, and possibly swallow it during matches/training/cup tournaments.

- **Worst case estimate:**

  1 gram per match/training session swallowed.

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Measurements and calculations -1

- NILU measured the levels of total VOC (volatile organic compounds), airborne dust (PM10 and PM2.5) (Manglerudhallen, Valhall and Østfoldhallen).
- They identified different chemical substances that are hazardous to health in the hall air with artificial turf (PCBs, PAHs, phthalates, alkylphenols).
- However, the level of exposure is important in the calculation of a potential human health risk.

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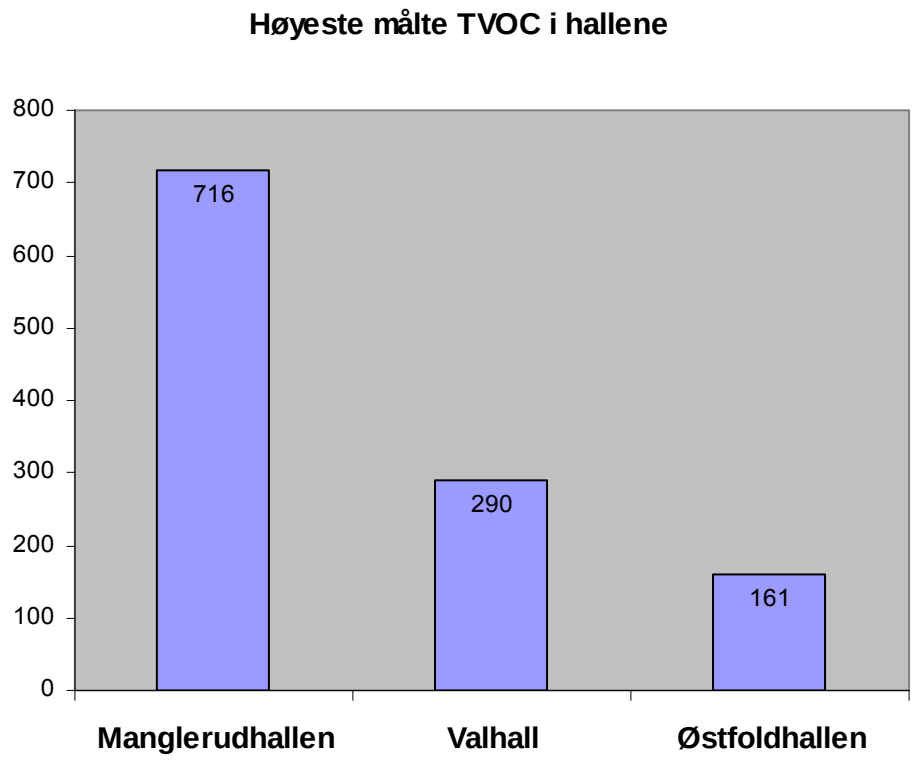
Measurements and calculations - 2

Inhalation - VOC

- Worst case measurements in Manglerudhallen (recycled rubber granulates), 234 different chemicals were found. This gave a total VOC of approx. 716 µg/m^3 (indoor house VOC of 200 µg/m^3)
- For 14 of these compounds the conc. range was from 10-85 µg/m^3 (including acetone, styrene, toluene, xylene and benzene)
- Temperature and ventilation have a great impact on the level of VOC
- The rubber granulates especially from recycled tyres was the main source of the VOCs measured in the halls

Measurements and calculations - 3

Total VOC



Measurements and calculations - 4

Airborne dust (PM10 and PM2.5)

- The quantity of indoor airborne dust is influenced of exertion, room shape, ventilation and building materials.
- Levels of PM2.5 was close to the Norwegian National norm at 20 µg/m^3.
- In Manglerud hall and Valhall it is assumed that the main source of airborne dust is recycled rubber granulate from tyres (from 23 to 50% of the rubber dust).

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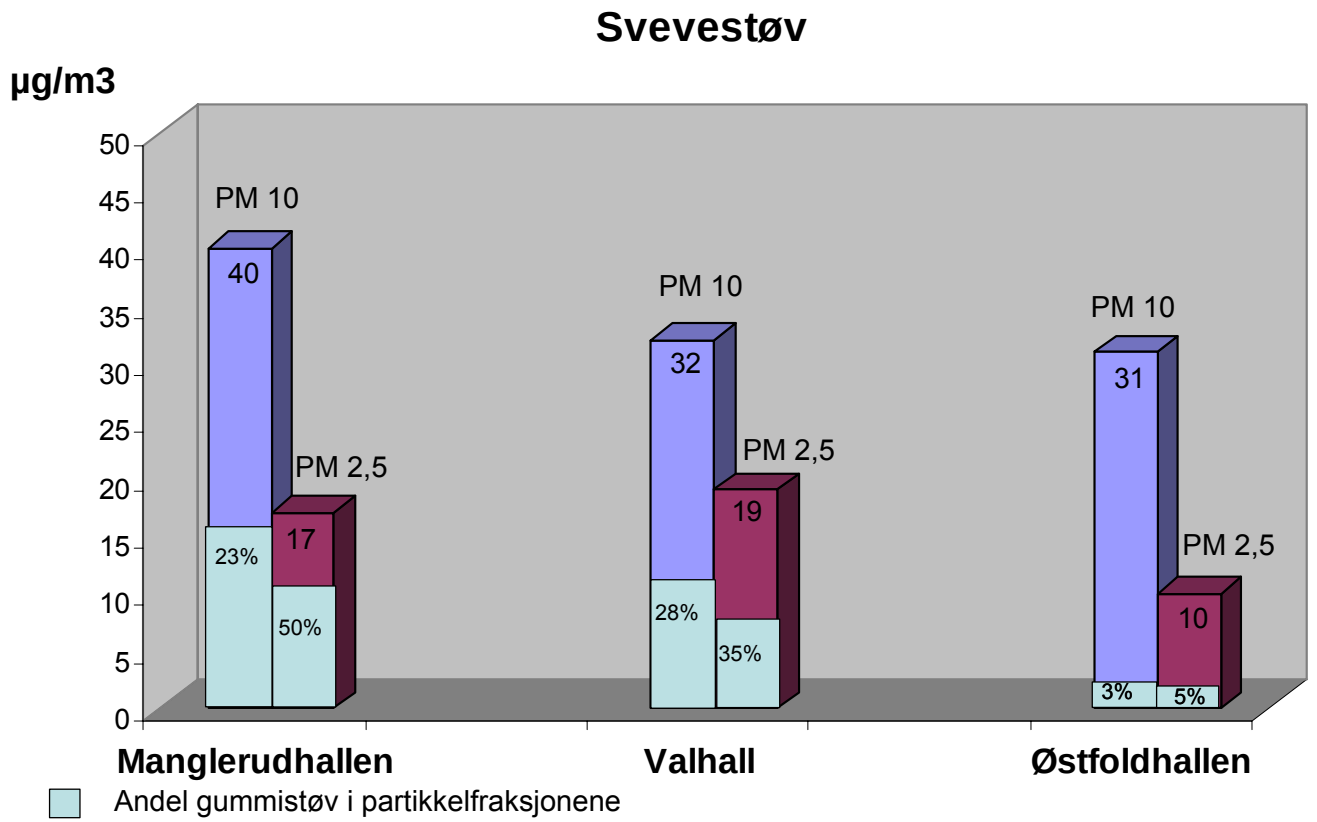
Measurements and calculations - 5

PM10 and PM2.5 in airborne dust ($\mu g/m^3$)



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Measurements and calculations - 6

Daily uptake of PAH, PCB, phthalates and alkylphenols from airborne dust

- PAH: 3800 pg/kg bw/day
- PCB: 3 pg/kg bw/day
- Phthalates: 47 000 pg/kg bw/day
- Alkylphenols: 800 pg/kg bw/day

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Measurements and calculations - 7

Skin exposure

- The skin uptake of the chemical is assumed to depend on the same factors which has been found for leaching into water.
- Degree of leaching into water will depend on how the chemical is bound to the rubber granulate and its water solubility (base on data from SINTEF, Building and Infrastructure)
- **Skin uptake for PCB, PAH, phthalates and alkylphenols were shown to be extremely low**

Measurement and calculations – 8

Oral exposure

- Children may swallow some rubber granulate (1.0 gram) during matches and/ or training sessions.

- **Oral exposure to phthalates and alkylphenols was shown to be very low from this exposure route.**

Hazardous assessment

- Total VOC, PCBs, PAHs, Phthalates, Alkylpenols:
  - may induce adverse effects on the reproductive system nervous system, blood forming organs, liver, kidney, genetic material, as well as allergy and cancer.

- However, the exposure has to reach a certain level to induce an adverse health effect

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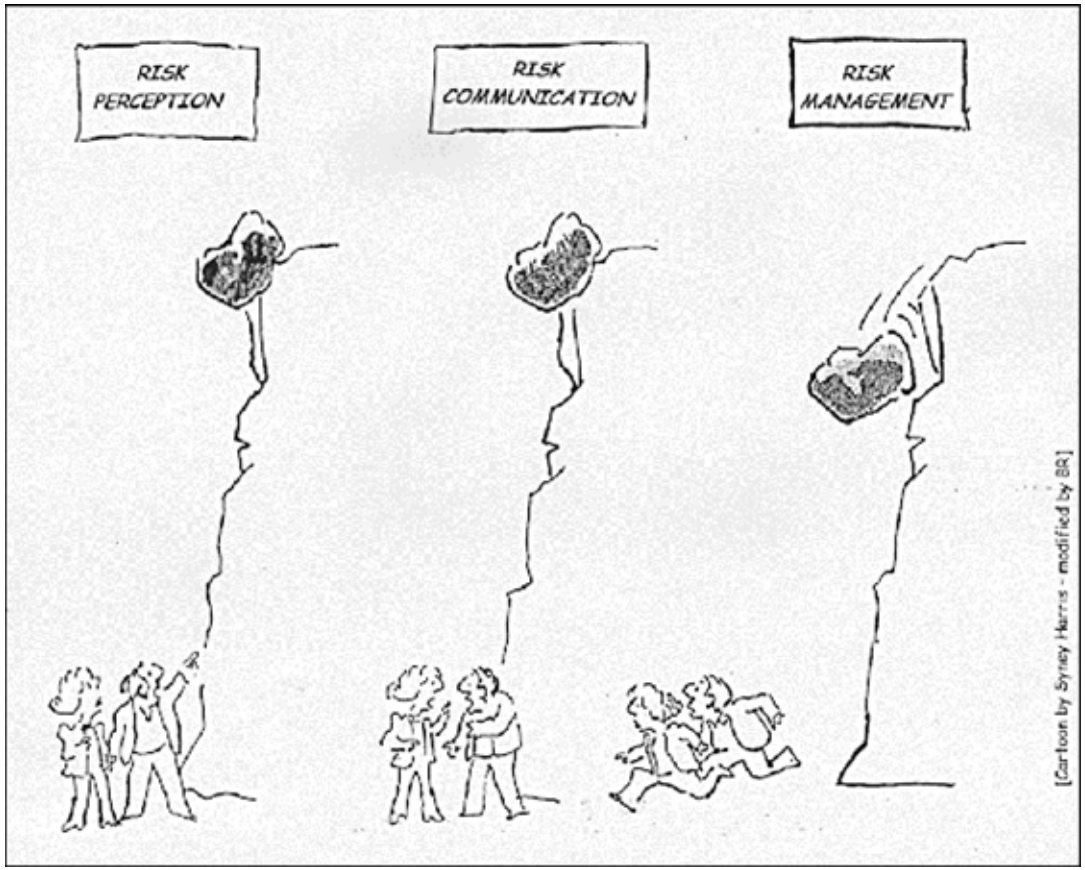
Risk assessment humans - 1



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Risk assessment Humans - 2

Human exposure

↓

Harmful effects (**No A**dverse **E**ffect **L**evel)

↓

Margin of Safety (MOS)

↓

MOS > 100 no concern/ MOS < 100 concern

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Risk assessment Humans– 3
Inhalation

Exposure
- PAH: 3800 pg/kg bw/day
- PCB: 3 pg/kg bw/day
- Phthalates: 47 000 pg/kg bw/day
- Alkylphenols: 800 pg/kg bw/day

NOAEL
- PAH: 40 mg/kg bw/day
- PCB: 0.0005 mg/kg bw/day
- Phthalates: 4.8 mg/kg bw/day
- Alkylphenols: 1.5 mg/kg bw/day

MOS
- PAH: 10 000 000
- PCB: 160 000
- Phthalates: 100 000
- Alkylphenols: 2 000 000

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Risk assessment Humans – 4
Inhalation

Airways allergy/asthma:

- Car tyres contains large quantities of latex. Latex (natural rubber) is a potent allergen, and latex allergy is not unusual. The amount of rubber dust in the airborne dust was 23 to 50 % in halls with recycled rubber granulate (compared to 4% in halls with new rubber granulate).

- Due to the absence of data on concentrations of latex allergens in the rubber dust, the possibility of a risk of developing latex allergy/asthma as a result of regular training on artificial turf pitches cannot be evaluated.

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Risk assessment Humans - 5

Skin contact

- The skin exposure to PCB, PAH, phthalates and alkylphenols were shown to be extremely low.

- No human health risk is assumed from this exposure route.

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Risk assessment Humans - 6

Swallowing:

- Exposure of children to phthalates and alkylphenols from swallowing of rubber granulates is estimated to be very low.

- No human health risk is assumed from this exposure route.

Risk assessment Environment - 1

- Based on the leakage of the hazardous substances in the rubber granulates
- Recycled rubber was the major source of potentially hazardous substances
- An exposure scenario was performed where the run-off of surface water from a football field was drained to a small creek. This scenario showed a positive risk of toxic effect on biota in the water phase and in the sediment.

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Risk assessment Environment – 2

- The environmental risk was attributed to the leakage of **zink , PAH** and **alkylphenols**. For these compounds the environmental concentrations exceeded the No Environmental Effects Concentrations.

- It is expected that the substances will leak from the artificial turf slowly, which indicates that aquatic organisms may be affected for many years.

- The total amount of hazardous substances leaking from a normal sport ground was, however, fairly low which means that any environmental effect are considered to be local.

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Conclusion -1
Human Health

- Rubber granulates used in artificial turf pitches contains many different chemicals which are considered as potentially harmful to human health.
- The amount of these chemicals were much higher in rubber granulates from recycled car tyres compared to newly manufactured rubber granulate.
- The risk assessment was therefore based on the use of recycled rubber granulates in artificial turf.

Conclusion -2
Human Health

- A number of worst case scenarios were identified based on the frequency and duration of matches/training as well as physiological parameters (skin surface, body weight, inhalation volume) and analyses of the chemicals in the hall air.

Conclusion -3

Human Health

- Based on the exposure and the known harmful health effects of the chemicals in the hall air, it was concluded that the use of artificial turf pitch did not cause any elevated health risk for the football players.
- However, little or no toxicological information is available for many of the volatile organic compounds (VOC) which was present in the hall air.

Conclusion – 4
Human health

- Car tyres contains large amount of latex, and possibly also latex allergen. Latex is a potent airway allergen. Recycled rubber granulates from car tyres may therefore also contain latex allergens.
- As there is no information available regarding the levels of latex in rubber granulates from recycled tyres it was not possible to assess the risk of developing airway allergy/asthma.

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Conclusion – 5
Environment

- Artificial turf that contains rubber from recycled tyres may give rise to local environmental risk.

- The environmental risk was attributed to the leakage of **zink, PAH** and **alkylphenols**. For these compounds the environmental concentrations exceeded the No Environmental Effect Concentrations.

Conclusion – 6
Environment

- The total amount of hazardous substances leaking from a normal sport ground was, however, fairly low which means that any environmental effect are considered to be local. The leakage of the substances is expected to be slow, consequently the aquatic organisms may be affected for years.

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Recommendations

- Artificial turf that contains substances of very high concern should not be used.
- Recycled rubber granulate from car tyres should not be used when rubber granulate is supplemented/replaced.
- More information is needed regarding the amount of latex allergens in hall air, due to its potential to induce of airway allergy/asthma.