ASSESSMENT OF INDOOR AIR POLLUTION AND HEALTH COMPLAINTS AMONG OFFICE EMPLOYEES

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Introduction

■ There are not set main priorities for indoor air pollution in the non-idustrial workplaces (offices), while ~ 35% of employees are working in offices in Latvia.

■ Indoor air quality is an important public health factor that influences persons' health and well-being (dry skin, irritation of mucuous membrane, dry cough, allergic rashes etc.).

■ The insufficient information about the new risk factor – nanoparticles in the non-industrial workplaces (offices).

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The aim of study

■ To assess the non-industrial workplace indoor air quality indicators and the health complaints of employees.

Methodes and materials (1)

■ The study was realised from October, 2009 till September, 2011.

■ This report include following parts:

» **measures** of indoor air quality in offices;

» **survey** of office workers.

Methodes and materials (2)

■ During study 24 premises of 10 offices were assessed (measures were done):

- mostly, open type offices (2- 35 persons per room).

- the all measurements were tested during full working day (8 hours) in winter and spring period.

■ **The indoor climate** was characterized by parameters

- air temperature, humidity and air flow,

- also carbon dioxide.

  For measures were used multifunctional equipment TESTO 400.

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Methodes and materials (3)

- The **air quality** was tested by modern equipment, it depends on the aim of measures:

  - VOC's and aldehydes were tested by Gas chromatography (Varian 3800) and High-Performance Liquid Chromatography (Waters Alliance 2695);

  - non-organic gases (NO_2, SO_2) also O_3 were tested by spectrophotometry (Varian Cary 50);

  - particles were tested by

    - ✓ count (P-Track Ultrafine Particle Counter) and

    - ✓ surface area concentration (AeroTrack9000).

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Methodes and materials (4)

- The **exposure index** was used to assess the risk of chemical pollution to office – workers health.

- EI = results of measures/acceptable limit.

- If EI >1, it is mean, that high risk to health exist.

Methodes and materials (5)

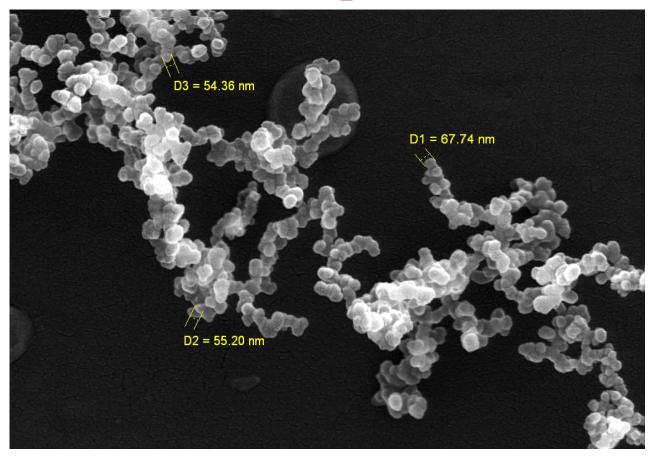- **Questionnaire** (*Örebro-MM40*) for assessment of health complaints and indoor air quality.

- Questionnaire consist of 4 parts: general information, description of work process, health status description and indoor air quality.

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RESULTS

Results– **measures of particles** (1)

Size of particles (nanoparticles) from 40,58 nm to 69,91 nm – agglomerates.
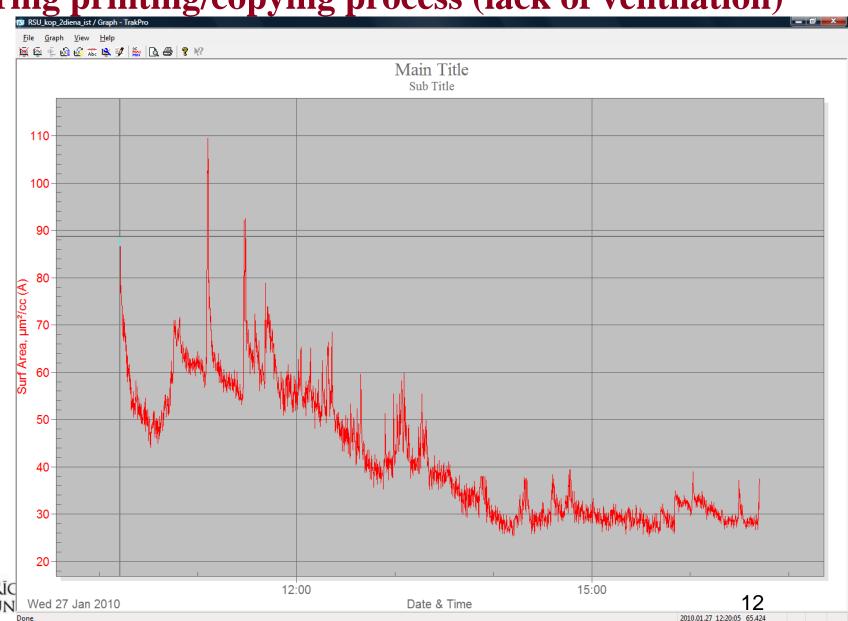
Results– **measures of particles** (2)

■ The study of dust particle surface area evaluation of indoor air **_A-alveolar fraction_** (from 10 - 250 nm) indicates that "the cleanest or the reference room" mean was 6.0 $\mu m^2/cm^3$, but the highest – 55.5 $\mu m^2/cm^3$. The higher particles surface concentrations in premises were detected by the activities with copying/printing, poor ventilation and carpets.

■ The study of dust particle surface area evaluation of indoor air **_TB-traheobronhial fraction_** (from 250 - 1000 nm) indicates that "the cleanest or the reference room" mean was 1.5 $\mu m^2/cm^3$ and the highest - 15.2 $\mu m^2/cm^3$.

■ The concentrations of **_particle count_** were in range from 1060 till 30 000 particles/m^3.

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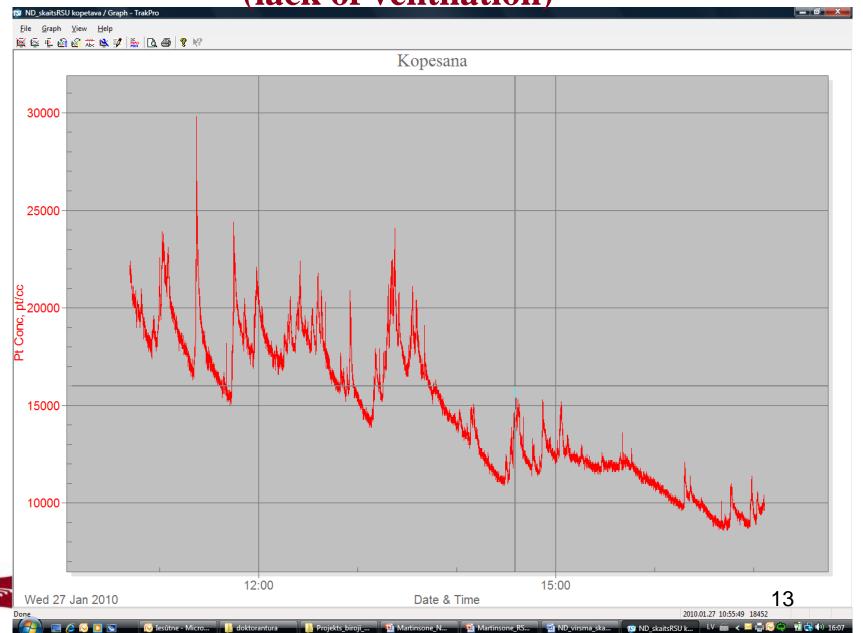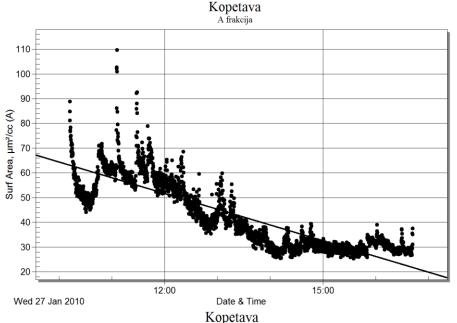# Results: Particles concentration of Alveolar fraction during printing/copying process (lack of ventilation)

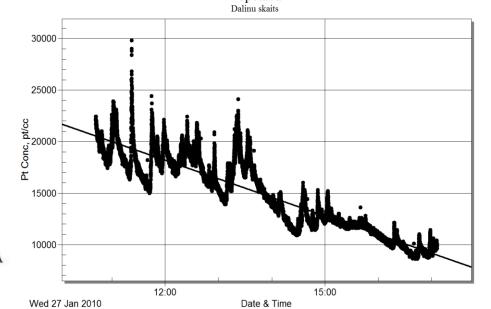# Results: Particles Count during printing/copying process (lack of ventilation)

Results– **measures of particles** (3)

Surface area measurements of **alveolar fraction**

Measurements of **particle count**

The peak concentrations of particles surface area and count concentrations are similar in the same time!

Kopetava
A frakcija

Kopetava
Dalinu skaits

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Concentrations of Particles and Status of Ventilation

Status of Ventilation	Parameters	Min average value	Max average value	Average value	STDEV
Lack of ventilation systems	*Alveolar* fraction, $\mu m^2/cm^3$	46.6	55.0	50.8	5.9
	Tracheobronhial fraction, $\mu m^2/cm^3$	13.2	15.2	14.2*	1.4
	Particle count, number/m^3	9700.0	14756.0	12228.0*	3575.1
Mechanical ventilation system in-flow/out-flow	*Alveolar* fraction, $\mu m^2/cm^3$	11.7	55.5	29.7	15.8
	Tracheobronhial fraction, $\mu m^2/cm^3$	2.4	13.0	5.2*	3.1
	Particle count, number/m^3	3150.0	9570.0	6161.4*	2208.5

* Statistically significant ($p < 0.05$)

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Concentration of Particles and Printing/Copying Activities

Printing/copying activities	Parameters	Min average value	Max average value	Average value	STDEV
Less than 1000 pages per day	*Alveolar* fraction, $\mu m^2/cm^3$	6.0	54.9	25.3	15.5
	Tracheobronhial fraction, $\mu m^2/cm^3$	1.5	15.2	5.0	3.8
	Particle count, number/m^3	1880.0	14756.0	5628.4*	3736.1
More than 1000 pages per day	*Alveolar* fraction, $\mu m^2/cm^3$	23.4	55.5	40.9	16.8
	Tracheobronhial fraction, $\mu m^2/cm^3$	4.2	13.2	8.8	5.0
	Particle count, number/m^3	6462.0	9700.0	8493.3*	1506.1

* Statistically significant ($p < 0.05$)

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Results – **IAQ measures** – **EI>1**

Chemicals	EI>1	Chemicals	EI>1
Acetaldehyde	**100%**	Butilacetate	**0%**
Formaldehyde	**60,3%**	Toluene	**0%**
Propilaldehyde	**39,7%**	Hydrocarbons (total by C)	**8,5%**
Butilaldehyde	**20,4%**	NO_2	**9,5%**
Benzaldehyde	**5,8%**	SO_2	**14,3%**
Ethanol	**0%**	O_3	**62,5%**
Etilacetate	**58,1%**	CO_2	**58,3%**

Acceptable level for acetaldehyde – 0,01 mg/m^3, but for formaldehyde – 0,1 mg/m^3!

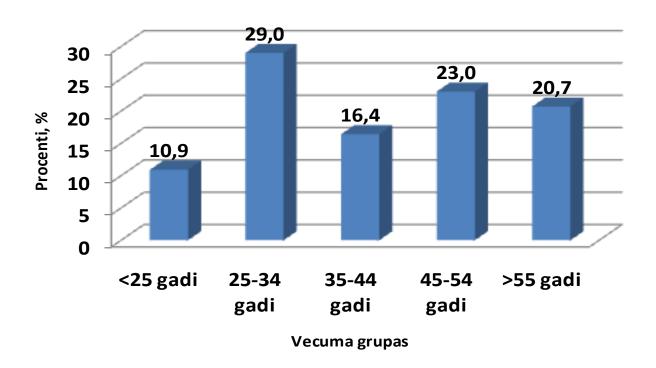RĪGAS STRADIŅA UNIVERSITĀTE

Results – **microclimate measures**

■ Relative humidity, %: from **12,3 to 49,1%, in 55,6% cases humidity were < 30**% (norms: from 30 to 70%).

■ Air temperature, ºC: from **+19,1 to +25,5 ºC** (norms: from +19,0 to +25,0 ºC in winter season and from +20,0 to +28,0 ºC in summer season).

■ Air velocity, m/s: from **0 to 0,04 m/**s (norms: from 0,05 to 0,15 m/s).

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Results – **survey**

- Females - 86% (N=774) un males - 14% (N=121)

- Age:

- Lenght of service: from 2 month to 47 years.

Results – **survey** – **Odds ratio (1)**

If workers observe:

- **Low humidity** (dry air), then:

    - sore, dry throat – OR=1,5 (95% TI 1,1 – 2,2)

    - dry skin **–** OR=2,5 (95% TI 1,8 – 3,6)

- **High air temperature**, then:

    - dry and itchy eyes – OR=1,6 (95% TI 1,1–2,3)

    - fatigue - OR=1,5 (95% TI 1,0 – 2,3)
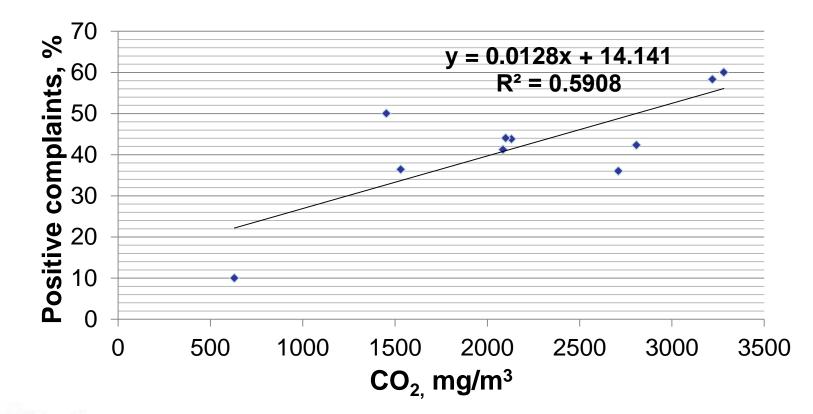
Results – **survey** – **Odds ratio (2)**

■ If workers observe

Unpleasant odor smell, then:

- headache – OR=1,5 (95% TI 1,0 – 2,3)

- fatigue – OR=2,3 (95% TI 1,5 – 3,5)

- nausea or feeling sick – 2,5 (95% TI 1,3 – 4,3)

- dizziness – OR=1,9 (95% TI 1,0 – 3,6)

- cough - OR=1,5 (95% TI 1,1 – 2,0).

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Results – **correlations (1)**
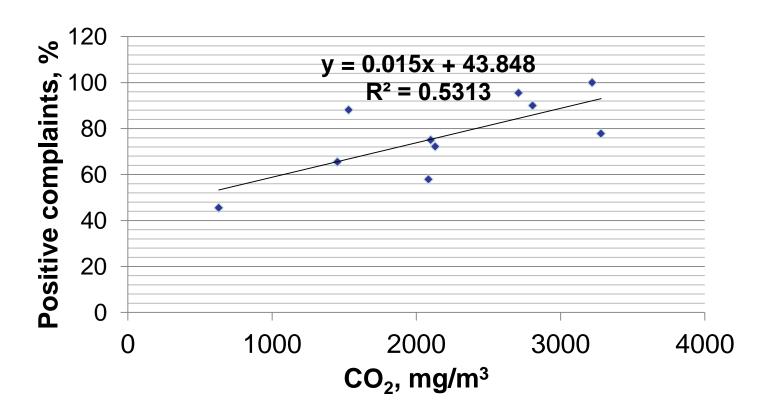
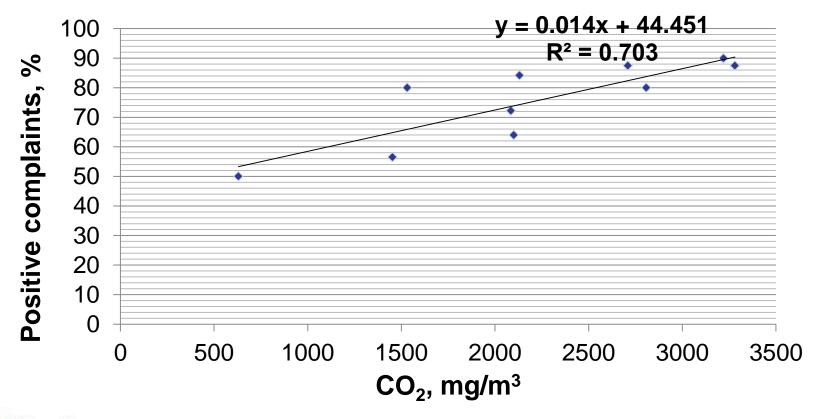- The positive complaints about **difficulties to concentrate** and CO_2 concentrations in the premises.

$y = 0.0128x + 14.141$
$R^2 = 0.5908$

(Chart: X-axis: CO_2, mg/m^3; Y-axis: Positive complaints, %)

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Results – **correlations (2)**

- The positive complaints about **fatigue** and CO_2 concentrations in the premises.

On the chart:
$$y = 0.015x + 43.848$$
$$R^2 = 0.5313$$

Y-axis: **Positive complaints, %** (0, 20, 40, 60, 80, 100, 120)

X-axis: **CO_2, mg/m³** (0, 1000, 2000, 3000, 4000)

Results – **correlations (3)**

■ The positive complaints about **headaches** and CO_2 concentrations in the premises.

$$y = 0.014x + 44.451$$
$$R^2 = 0.703$$

Positive complaints, % (y-axis)

CO_2, mg/m³ (x-axis)

Conclutions

- The main indoor air quality indicators are CO_2, total volitale organic compounds (also aldehydes), microclimate parameters, dust particle concentration (by surface area and count).

- Multifactorial analyse show relations between indoor air quality indicators and health complaints among office workers.

- Long-term and systematic impact of poor non-industrial indoor air can cause health complaints of office workers.

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Acknowledge

Project Nr. EEZ09AP-22 "Determination of indoor air pollution caused by offices equipment and estimation of possible impact on organism"

Thank You for Your Attention!