Workers exposure to air pollutants and thermal comfort in horse stables: case study

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Horse stable workers and visitors could be exposed to particulate matter during an 8-hour shift (from 6188 pt/cm^3 to 26`445 pt/cm^3) and suffer from thermal discomfort, due to air draft, temperature fluctuation (from 9.8 ℃ to 17.5 ℃) and high relative humidity levels (up to 85%).

Figure 1. Stable 2 (a,b) and Stable 1 (c.d) during measurement process (authors pictures)

Introduction

Air quality and thermal comfort in the horse stables and riding area are important issues for the health of horses as well as workers. Air quality issues and thermal comfort are particularly important in cold climates: where seasonality predominates. There are three main environmental factors affecting stable air quality: ambient temperature, relative humidity (RH) and air pollutant concentration. For physical active work, the optimum work environment temperature is 16 – 23°C in conditions where the humidity is in range 30 – 70% and air velocity 0.1 – 0.4 m/s [1].
However, the horse's well-being temperature is between 5 – 25°C. Relatively low (<50%) humidity increases the risk of respiratory problems for horses. The desired air flow rate for horses in the stable is up to 0.3 m/s. If the air flow in the stable is even and affects practically all horses, it provides thermoregulation - the ability to adjust its thermal insulation to the conditions with the help of a fur coat. In contrast, if localized in one place, cold air can cause frostbite and muscle pain in the horse [2;3].

Stables and data collection

Two horse stables were examined in this stud in the central region of Latvia in the urban environment in late summer/autumn (August – September, 2021) climatic conditions (outdoor temperature during the experiment was from 5°C (night) to 18°C (day)). The indicative parameters of air quality were microclimate (temperature, relative humidity level, air flow rate), chemical pollution (CO_2, NH_3, H_2S, dust concentration, and particulate count). Active sampling and monitoring of selected parameters were performed.
The measurements were conducted in one-week period for each stable in the morning at feeding time before horses were taken out into paddocks and after box cleaning process. In morning stable air environment were expected to be substandard, therefor the horses had been in stables all night with closed doors and windows.

Table 1. Properties of the Stable 1 and Stable 2.

Characteristic	Stable 1	Stable 2
Building year	2020.	1974.
Horse count	31	60
Box parameters	Big: 3.7 x 4.0 m Small: 3.7 x 2.8 m	2.7 x 2.8 m
Bulkheads	2.0 m wall made of fragile wood and metal slats (up to 1.1 m)	2.8 m wall made of bricks and metal slats (up to 1.75m)
Type of window protectors, height	Metal grate, for a horse with the possibility to put his head out of the box, height 1.5 m	Not exists, 1.80 m from the floor
Ventilation type	Natural ventilation with roof outlet and wall supply	Ventilation through the windows and doors
Bedding material	Dusted chips or straw pellets and hay bag	Wooden chips
Height of the bedding material	Dusted chips: 5 - 10 cm Straw granules: 4 cm	15 cm

Results

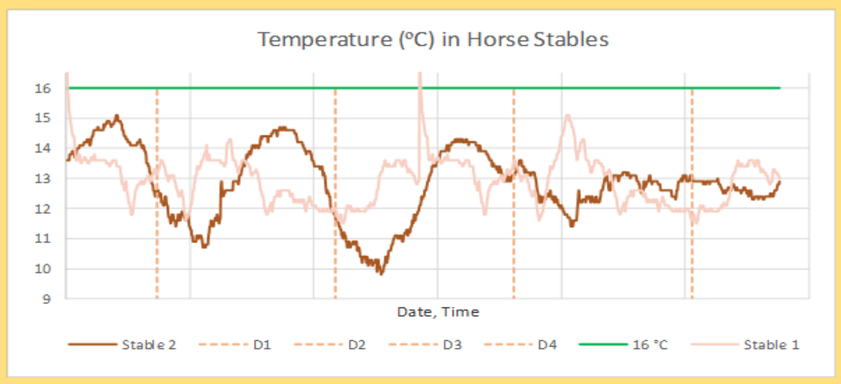

Figure 1. Temperature changes for five-day interval in Stable 1 and Stable 2, Green line - minimum temperature limits for workers (16°C) (D1, D2, D3, D4 midnight of each day).

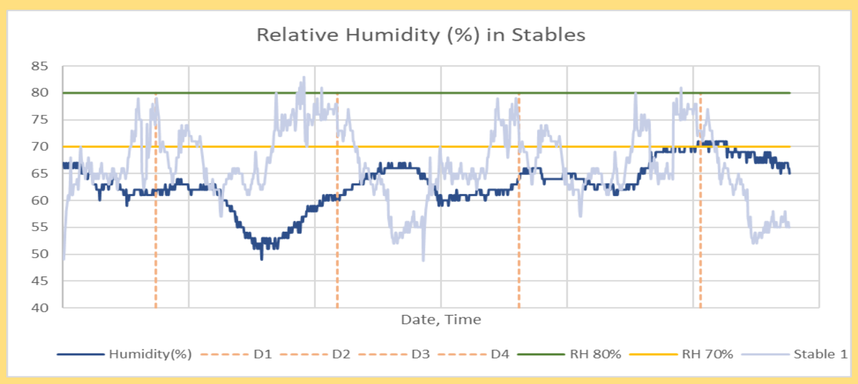

Figure 3. Humidity changes for five-day interval in Stable 1 and Stable 2. Yellow line shows the upper relative humidity limit for workers (RH 70%) and green line for horses (RH 80%) (D1, D2, D3, D4 midnight of each day).

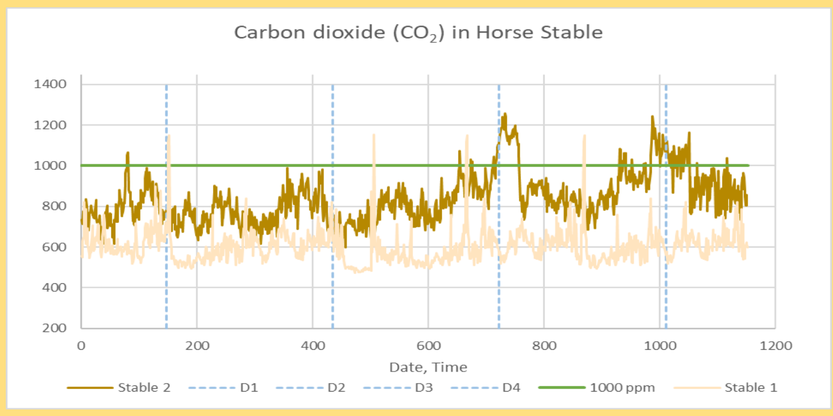

Figure 2. Carbon dioxide changes for five-day interval in Stable 1 and Stable 2, Green line – 1000 ppm limit, (D1, D2, D3, D4 midnight of each day).

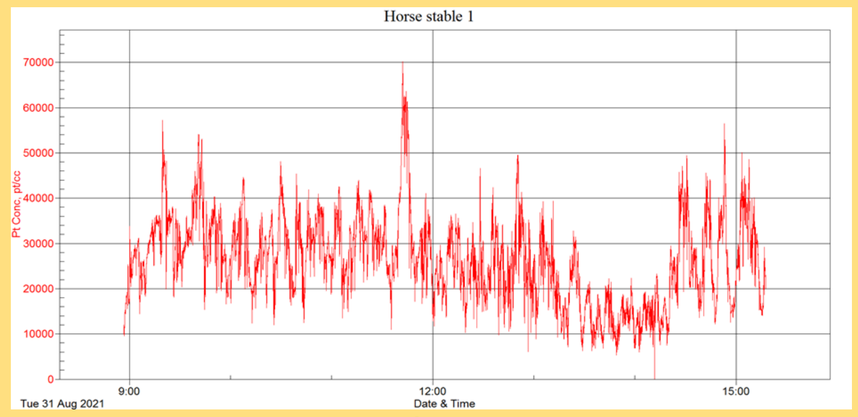

Figure 4. Particle count (pt/cm^3) fluctuation in one day interval in horse Stable 1 (Stable is located next to highway).

Table 2. Parameters of chemical pollution in stables.

Parameter	Stable 1	Stable 2
Mean NH_3, ppm	1.25	0.71
Max NH_3, ppm	5.00	1.50
H_2S, ppm	<0.2	<0.2
Total dust, mg/m^3	0.68	0.60
Max total dust, mg/m^3	1.00	1.50
Particle number, pt/cm^3	26`445	6`188
Max Particle number, pt/cm^3	70`200	6`721
Min Particle number, pt/cm^3	5`340	5`805

Both stables had acceptable air quality as NH_3, H_2S, CO_2 and total dust within thresholds, however UFP (ultra fine particles) count was high and eventual respiratory risk could emerge for both horses and workers, however without particle distribution results we cannot quantify the degree of health problems, we can only conclude that there is potential risk. Besides, low temperature levels and high humidity levels offer potential for condensation on surfaces and are associated with health problems for workers and horses, structural and environmental problems for stable construction.

Conclusions

Additional monitoring studies are suggested for further investigation of UFPs exposure, since particle count was evaluated, also different particle size distribution analyses could show potential risk as well as thermal comfort exploration in this understudied occupational population.

This case study shows that more measurements are needed to estimate real health risk for workers and horses and to provide a workable solution to the indoor air pollution and for changes in thermal comfort in horse stables.

References: [1] Labor protection requirements at workplaces, Pub. L. No. 359, 1 (2010).; [2] Guidelines good animal welfare horses, 33 (2015). https://doi.org/10.13130/AWIN; [3] Mejdell, C. M., Bøe, K. E., & Jørgensen, G. H. M. (2020). Caring for the horse in a cold climate—Reviewing principles for thermoregulation and horse preferences. Applied Animal Behaviour Science, 231(June), 105071. https://doi.org/10.1016/j.applanim.2020.105071