Test Report – RESPIRA Back Support

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1. Introduction

Research shows the importance of managing microclimate between the user and the seat cushion ("heat at the skin cushion interface in wheelchair users: a narrative review" (de Groot & Helming, 2022)& the review of WheelAir "Microclimate literature" (N. Conijn & Staels, 2022)). Managing microclimate can reduce the risk of pressure injury (N. F. L. Conijn et al., 2023; Kottner et al., 2018; *PRESSURE ULCER PREVENTION Pressure, Shear, Friction and Microclimate in Context*, 2010). There is no clear definition of an optimal skin temperature. Lachenbruch (2005) talks about 33°C(Lachenbruch, 2005), above which the skin becomes more vulnerable. Flam et al. (2005) shows that at 35°C degrees the strength of the skin is reduced by 25% compared to 30°C (Flam, 2005).

2. Test Method

No specific test protocols for microclimate of back supports currently exist. To measure and compare microclimate on different back supports, a heated indenter has been used according to the RESNA standard. And a modified RESNA SS-1:2019 section 3 and ISO 16840 -6 testing method is proposed.

The protocol stipulates that the test environment is 23 +/- 2°C and the humidity is 50% +/-5%.
5 iButtons are used to measure the temperature and humidity on the cushion, these are placed according to the ISO standard, see figure 1. These 5 iButtons are taped on the indenter with the opening that measures temperature and humidity facing the back support surface. One iButton sensor is used to measure the temperature and humidity under the back support surface. All iButtons measure temperature and humidity every 10 seconds.

3 different tests will be conducted:

1. Test on the Jay J3 back (model: J3MCMTS41), 41wide, 36cm height, foam covered in a spacer fabric. Hard shell without extra holes for ventilation.
2. Test on the Respira back (Respira Sports, silver embedded air-mesh cover, 41 cm width, 36 cm height)
3. Test on the Respira back Respira Sports, silver embedded air-mesh cover, 41 cm width, 36 cm height with air fan highest setting 7000 RPM)

Test Protocol	
Time	**Action**
-01.00	Start Warm up indenter to 37 degrees Celsius
00:00	Start sensors
00:10	Place indenter on the back support
02:15	End test

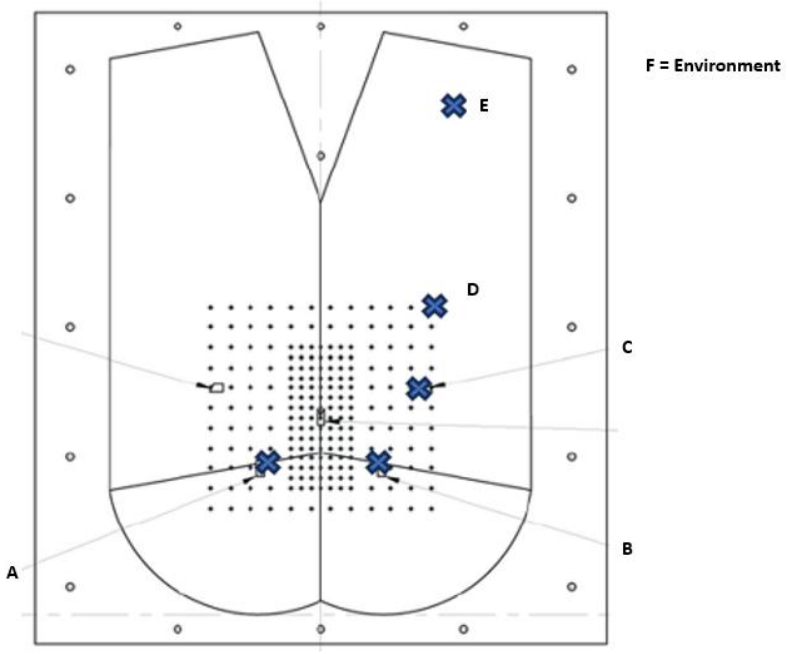


Figure 1. Sensor placement on the heated indenter. In total 5 sensors are placed on the heated indenter, and 1 is not attached to the heated indenter, so that it can measure the environment. The dots on the heated indenter represent small holes, moisture can penetrate through the indenter at these places.

A rig is created to place the back supports in a horizontal position. The heated indenter is placed on the horizontally placed back support. This is done because the heated indenter is filled with water and cannot be placed vertically.

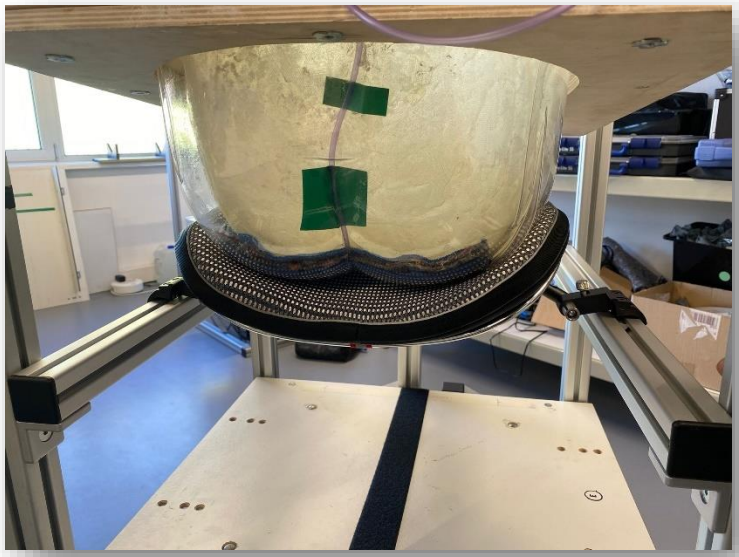


Figure 2: View from the bottom of the back support, with the heated indenter placed on top. The backrest is hanging free, to allow air flow on the outside of the back support.

Figure 3: View from the top of the back support, due to the buttock shape of the heated indenter, there is a recess between the two legs.

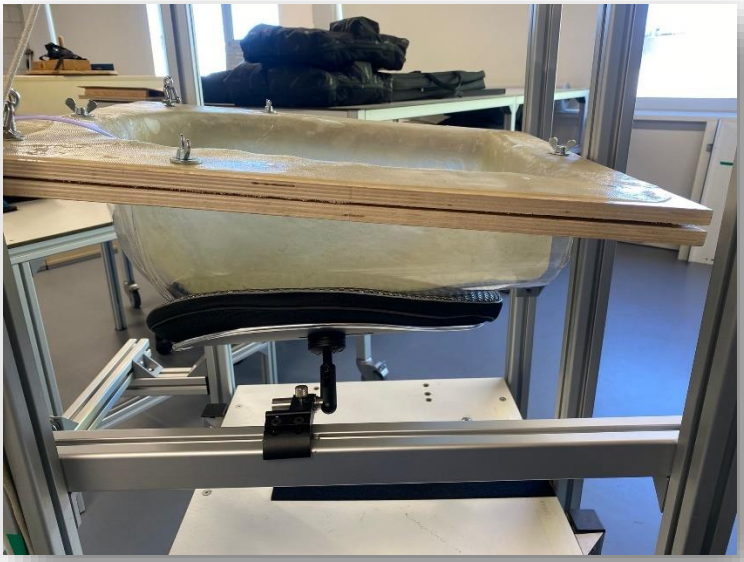
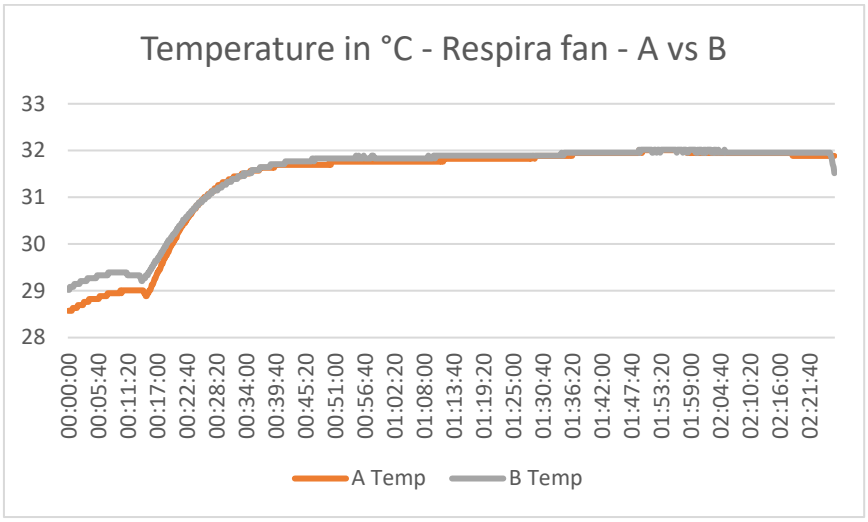


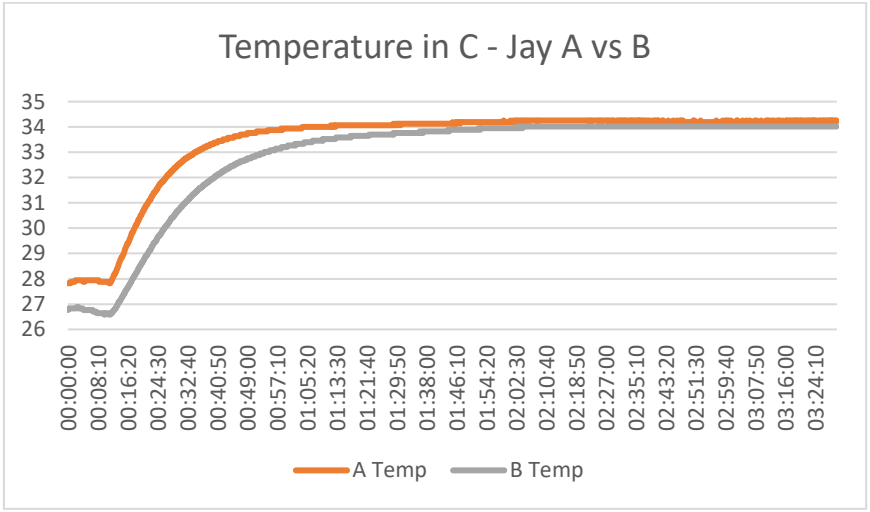
Figure 4. View from the side, the placement of the heated indenter on the back support. Right is the top of the back support, with the legs of the heated indenter and left is the bottom of the back support covered with the buttocks of the heated indenter.

3. Validation of the test set-up

To test the reliability of the set-up, sensor A and B are placed to verify that the same measurements are recorded at the same location of the indenter, but opposite side so they are each other's control. When looking at graph 1, the temperature after the heated indenter is placed on the back support is almost the same. Therefor we can conclude that the results from the tests are reliable.

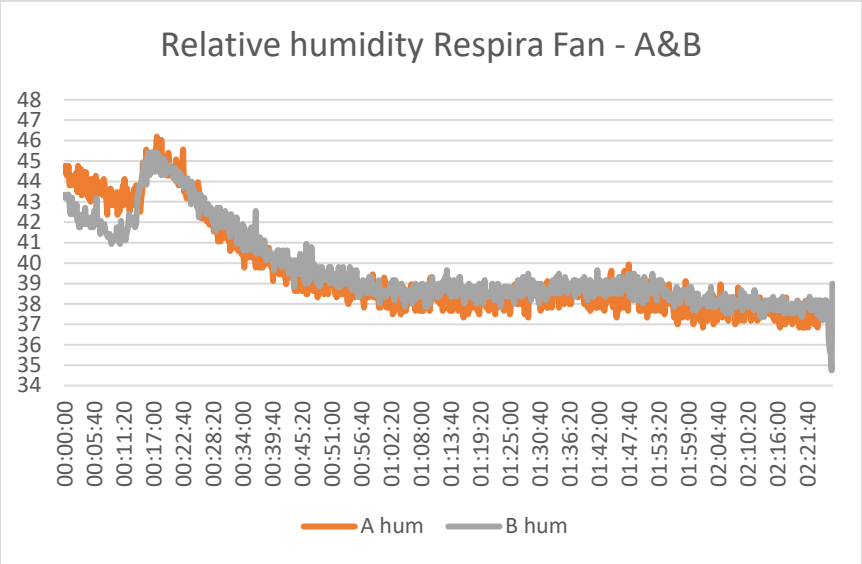


Graph 1: Sensor A and B temperature data Respira Back Support with fan, same location of the indenter but opposite side

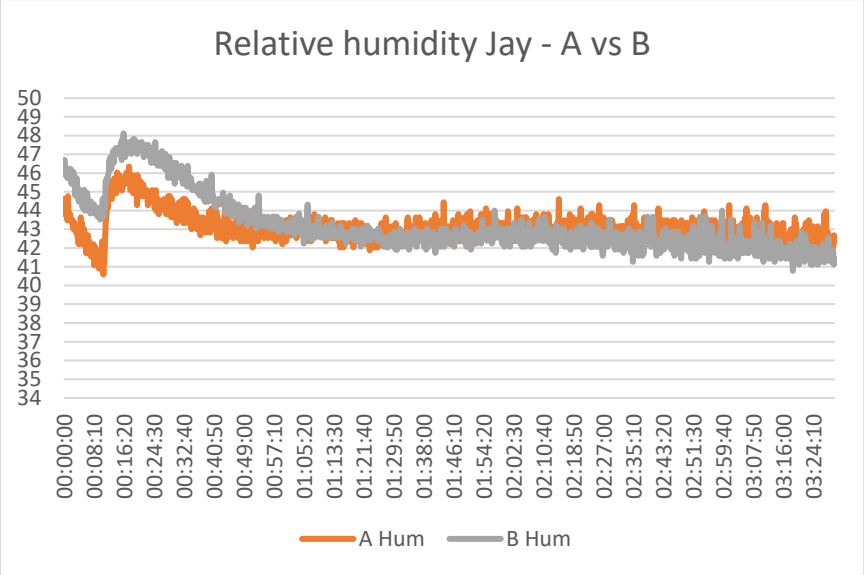


Graph 2: Sensor A and B temperature data Jay 3 Back Support, same location of the indenter but opposite side

The same is done for the relative humidity with the fan of the Respira Back Support on the high setting. To test the reliability of the set-up, sensor A and B are placed to verify that the same measurements are recorded at the same location of the indenter, but opposite side so they are each other's control. When looking at graph 3 and graph 4, the humidity after the heated indenter is placed on the back support is almost the same. Therefor we can conclude that the results from the tests are reliable.



Graph 3: Sensor A and B humidity data Respira Back Support with fan on high setting, same location of the indenter but opposite side. During the entire trial the results are comparable between the two sensors.



Graph 4: Sensor A and B humidity data Jay 3 Back Support, same location of the indenter but opposite side. Especially during the plateau phase the measurements are comparable.

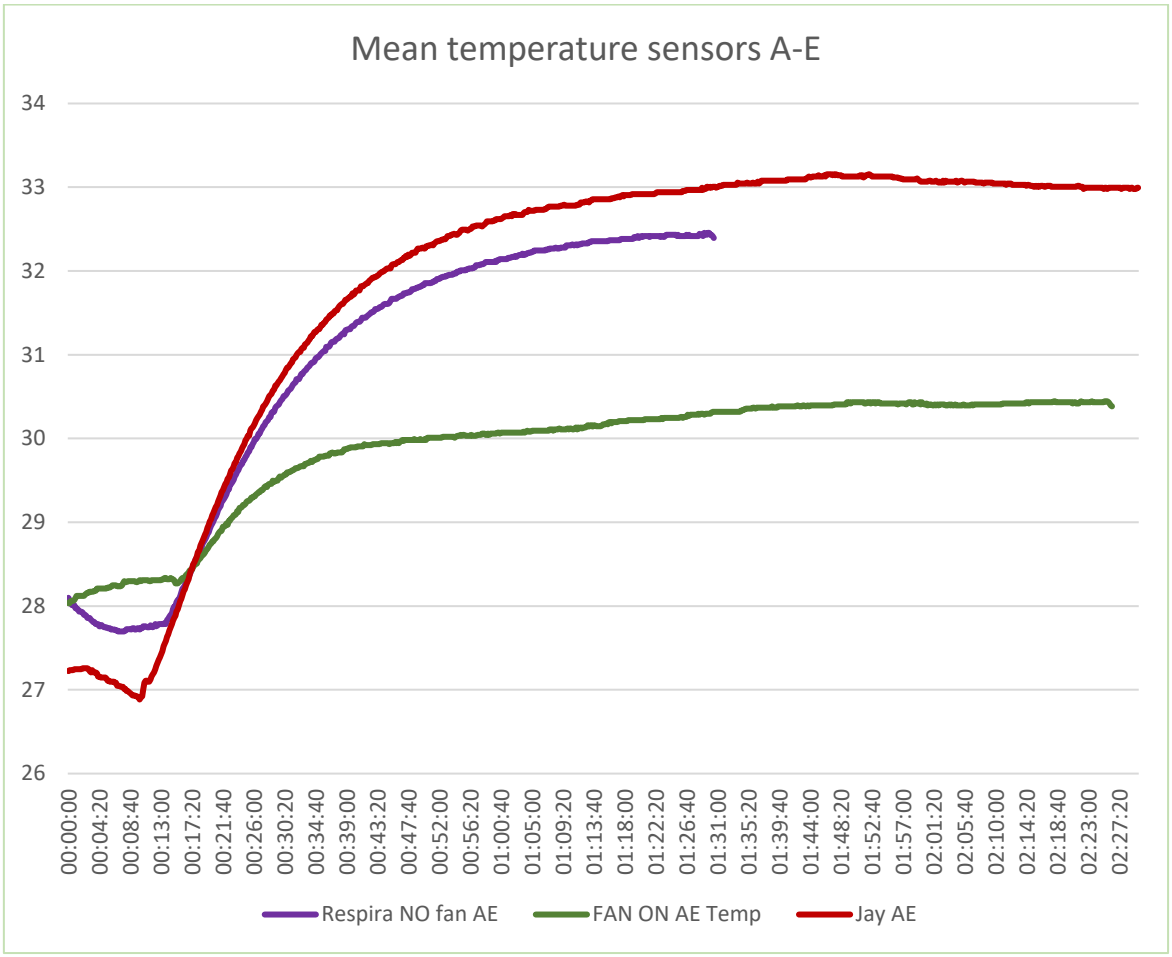
4. Results

Three different tests have been performed: with the Respira Back Support with fan on highest setting, with the Respira Back Support without fan and with the Jay 3 back support. During these tests the environmental temperature remained between the 23 +/- 2°C. Environmental humidity ranged from 58.345% to 63.117% for the Respira back support trial with fan.
The environmental humidity ranged from 50.46% to 54.51% for the trial with the Respira Back support without fan and from 49 to 54% for the trial with the Jay J3. In previous research we saw that it is difficult to regulate the environmental humidity of the test environment.

The tests with the Respira back with Fan and the Jay backrest lasted 2h25m, the test with the Respira backrest without the fan only lasted 1h25m. But at this moment the temperature and humidity seem to have plateaued, so it's not to be expected that the shorter test period has a big impact on the ability to compare the 3 different tests.

4.1 Temperature

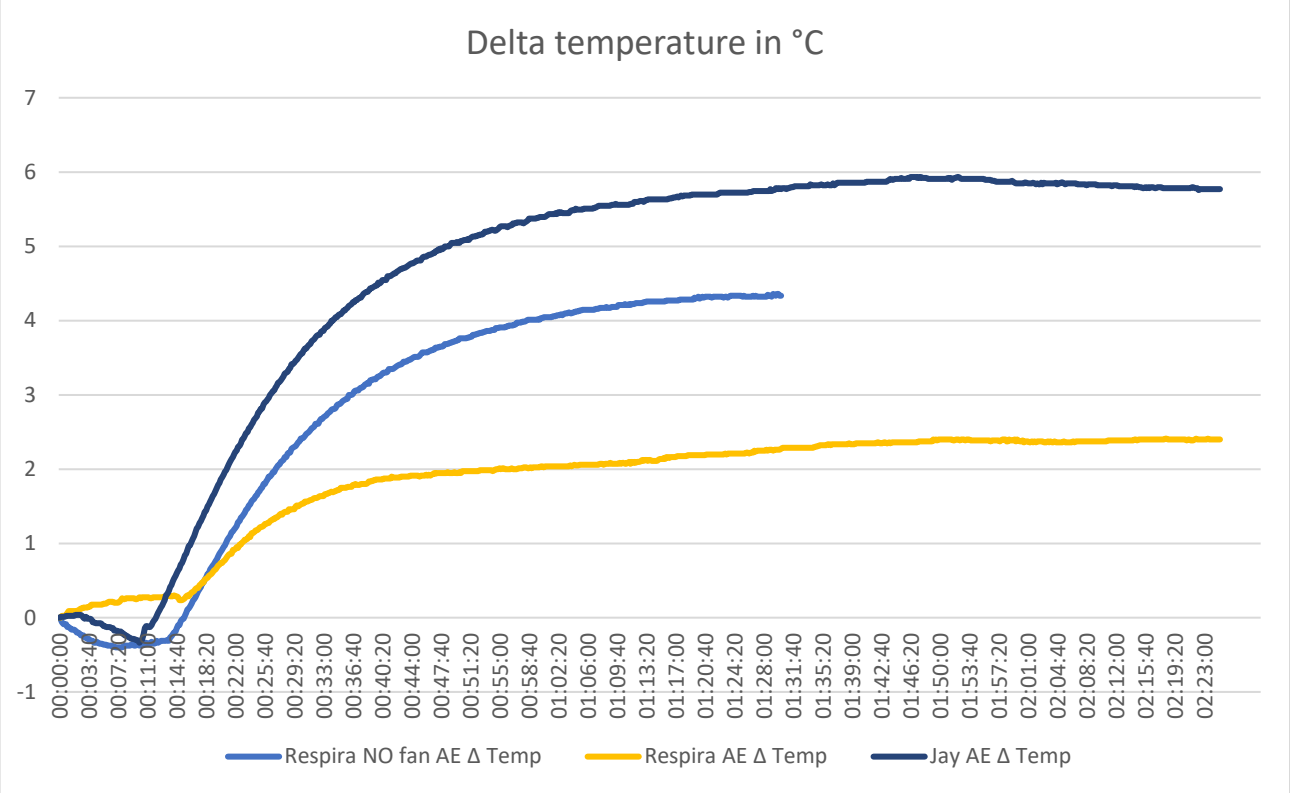
When looking at the mean temperature of all sensors that are placed on the heated indenter it is noticeable that the Jay 3 Back Support has a higher mean temperature compared to the Respira Back Support, even without the Fan on.
Mean temperature of the Jay 3 Back Support over the whole test period is 32.21°C and 31.03°C for 1.5h, for the Respira back support with Fan it is 29.56°C, and 30.82°C for the Respira Back Support with No Fan both over a period of 1.5h. See table 1. below.



Graph 5. The temperature is rising for all tests set-ups, but this graph clearly shows that the temperature rises the fastest and highest for the Jay J3 back supports, followed by the Respira back support without the fan. The temperature only rises 2.5°C for the Respira back support with fan.

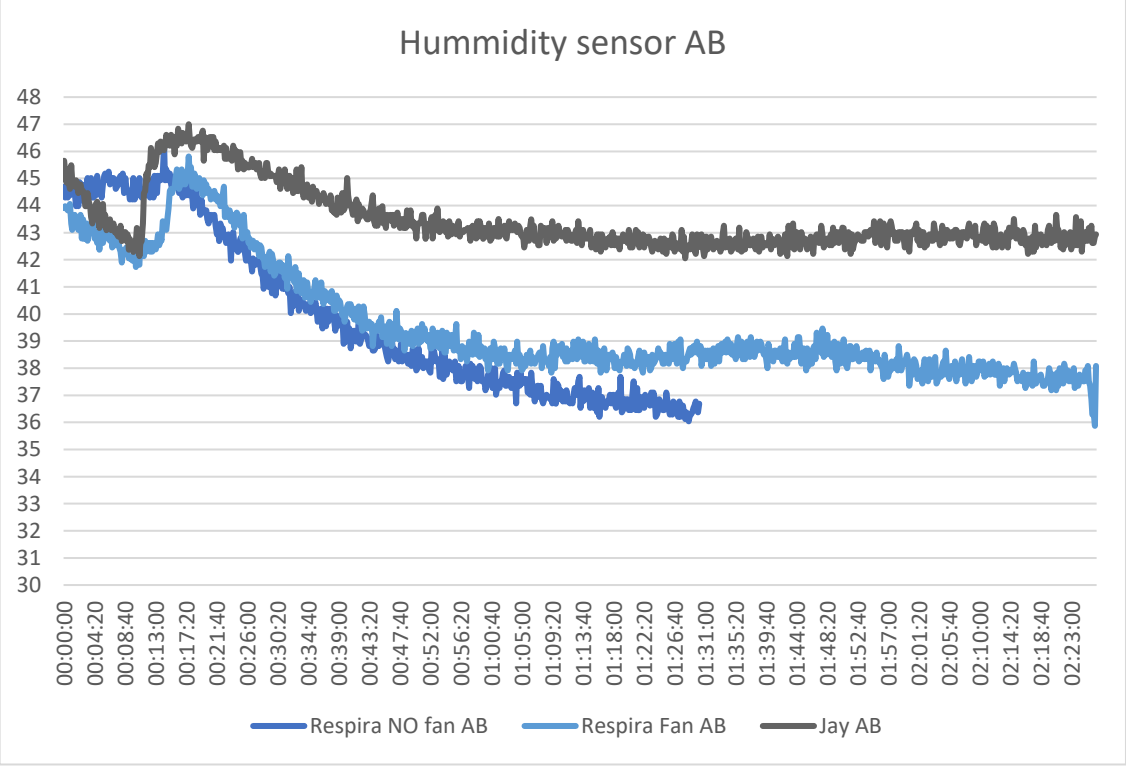
	Jay	Respira Fan	Respira No Fan	Jay vs Respira Fan	Respira On vs OFF
1.5h	31.03	29.56	30.82	1.47	-1.26
Plateau phase	32.95	30.28	32.19	2.67	-1.91
2.25h	32.21	29.88	n.a.	2.33	n.a.

Table 1. The temperature in degrees for the 3 different tests



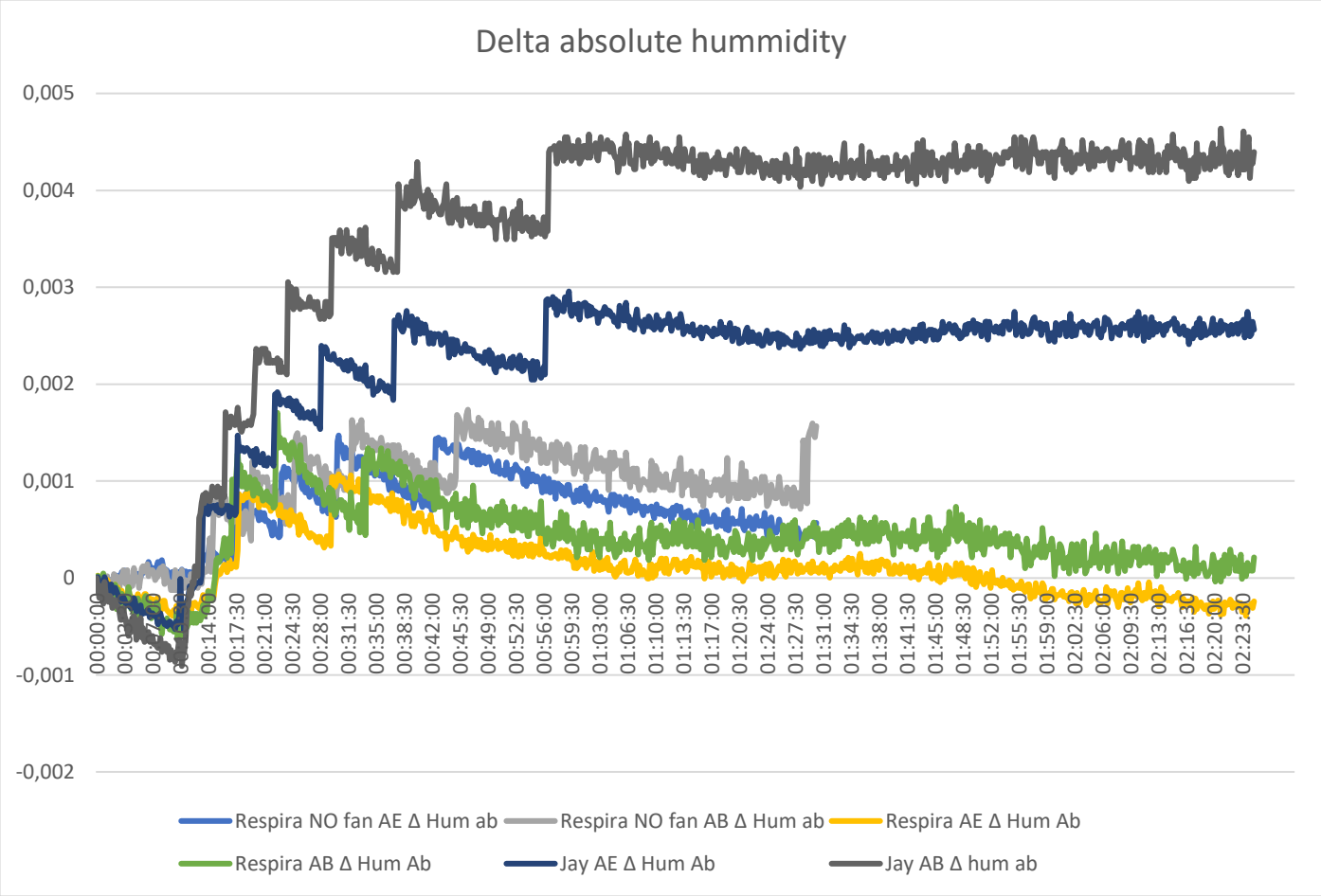
Graph 6. The delta temperature is rising for all tests set-ups, but this graph clearly shows the delta temperature rises the fastest and highest for the Jay J3 back supports, followed by the Respira back support without the fan. The temperature only rises 2.5°C for the Respira back support with fan while it rose 5,99°C for the Jay 3 back support and 4,3 °C for the Respira back support without fan. This is a difference of 3,49°C compared to the Respira back support with fan.

4.2 Humidity



Graph 7: Humidity on sensor A&B for Respira back support no fan, Respira back support with fan and Jay 3.

With regards to humidity, the Respira back support with fan has a 6% lower reative humidity after 2,25 h of testing compared to the Jay 3 back support. It looks like the fan has minimal effect on the relative humidity compared to the Respira back without the fan. This could be explained by the following reasons: one being the fact that the environment humidity during testing is higher during the Respira Back Fan trail. (Environmental humidity ranged from 58.345% to 63.117% for the Respira back support trial with fan.
The environmental humidity ranged from 50.46% to 54.51% for the trial with the Respira Back support without fan and from 49 to 54% for the trial with the Jay J3). The second reason could be that the Respira back support without fan, already provides a good humidity environment and distributes moisture evenly. The heated indenter discharges small amounts of fluid, representing trans epidermal water loss.



Graph 8: Delta Absolute Humidity Sensor AB Respira back support no fan, Respira back support with fan and Jay 3. Data from sensors A to E are combined and data from sensor A and B is combined.

It is also important to look at the absolute humidity because temperature is taken out of the equation. Here it is clear that the absolute humidity for the Jay 3 back support is higher compared to the Respira back support. The Respira back support with fan shows the lowest absolute humidity.

5. Discussion

It is difficult to control the humidity in the test room, this makes making valid conclusions about the humidity difficult.
Sense no specific back support testing protocol exists, the test is conducted with a heated indenter shaped to mimic buttocks, which is not 100% comparable to the human back.

6. Conclusion

Using the Respira back support with FAN on full speed results in a 3.45°C less increase in temperature compared to the Jay J3 back support. The Jay 3 back support increased 5.99°C in temperature while the Respira back support with FAN on only increased 2.5°C. The difference in temperature during the plateau phase is 2.67°C between the Jay 3 and Respira back support with FAN on. Compared to the Respira back support without the fan, the fan decreases the temperature in the plateau phase with 1.91°C.

The Respira back support seems to keep the relative humidity lower than the Jay 3 back support, the biggest difference for sensors A+B is 6%, with the side note that the humidity in the room was difficult to control.

7. References

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PRESSURE ULCER PREVENTION pressure, shear, friction and microclimate in context. (2010). www.epuap.org