

A Comparison of Temperature Regulating Wheelchair Cushions

Aim: Evaluate and compare different technologies that are used in both commercially available and custom manufactured wheelchair cushions to regulate temperature at the user-seat interface

Background

Pressure ulcers cost the NHS over £3.8 million every day and can lead to morbidity and mortality [1, 2].

Skin microclimate changes are a known pressure ulcer risk factor [4].

Half the number of wheelchair users in England develop a pressure ulcer in their lifetime [5].

Method

An appropriate testing standard could not be found to compare the temperature regulating properties of existing cushion technologies. As such, a method was developed, which included:

1 healthy able-bodied participant.

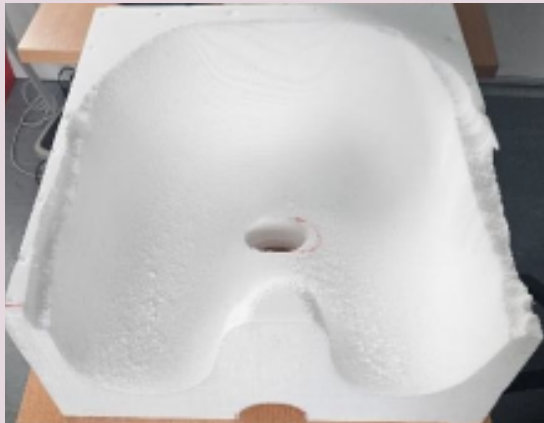
Digital thermometer sensors attached to skin at the mid-thigh and IT.

A 2-hour sitting period on each cushion. Skin and room temperature recorded every 5 minutes.

- 4 commercially available cushions, marketed as temperature regulating:
- JAY ClimaZone, which includes air suspended fibres that aim to encourage airflow [11].
 - JAY Balance with Cryo Fluid, which contains microbeads filled with paraffin wax that aim to actively transfer heat from the skin [10].
 - Recare Supracor Stimulite Classic, whose perforated honeycomb design aims to encourage air circulation [12]
 - Vicair Adjuster O2, whose open structure of SmartCells aims to provide temperature regulation [13].

1 reference cushion, not marketed as temperature regulating: JAY Lowzone+.

2 Evazote (EV30) custom contoured foam carve cushions. One with an air channel (see below).



Literature Review: Key Findings

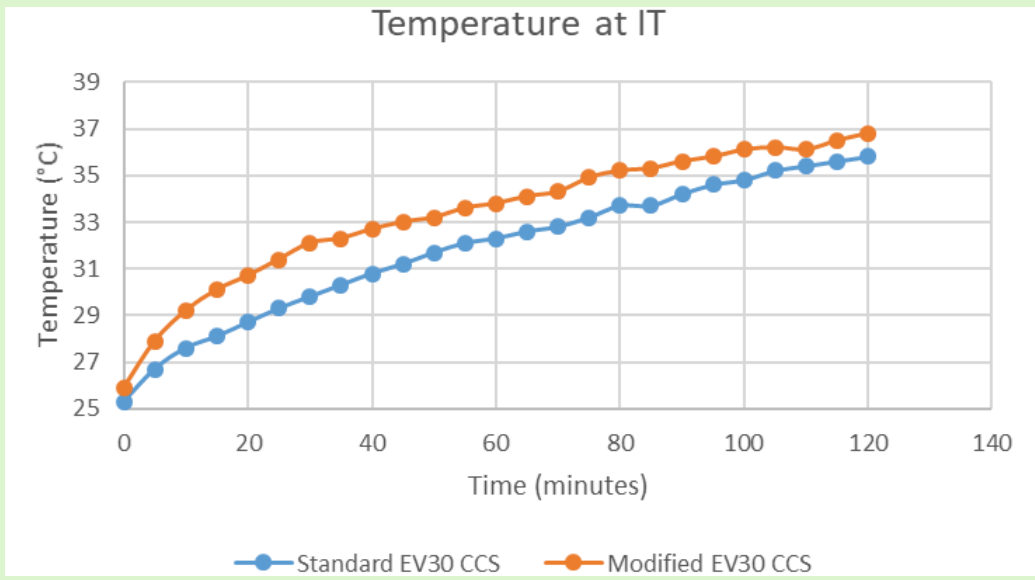
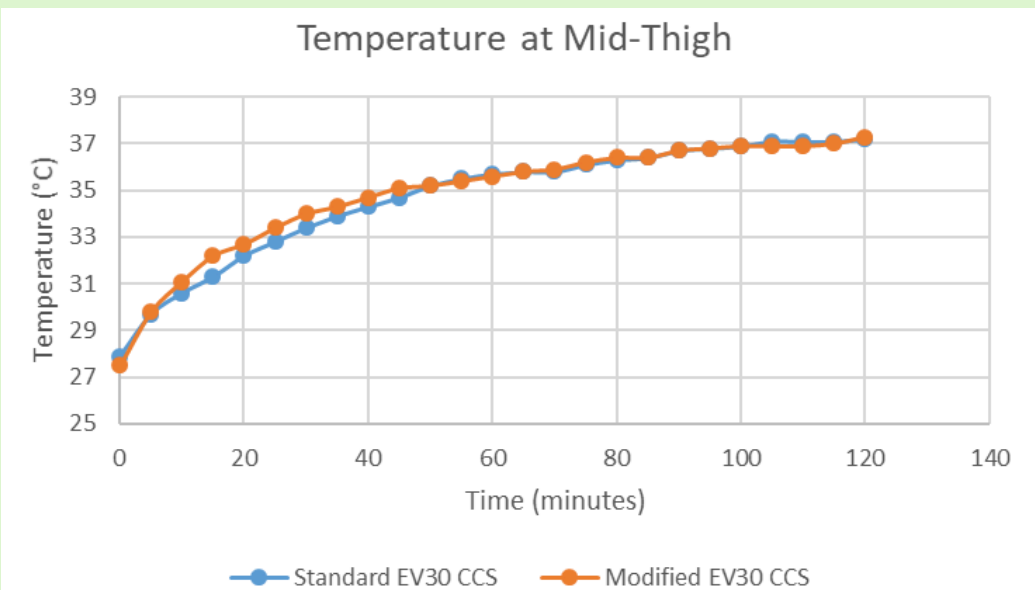
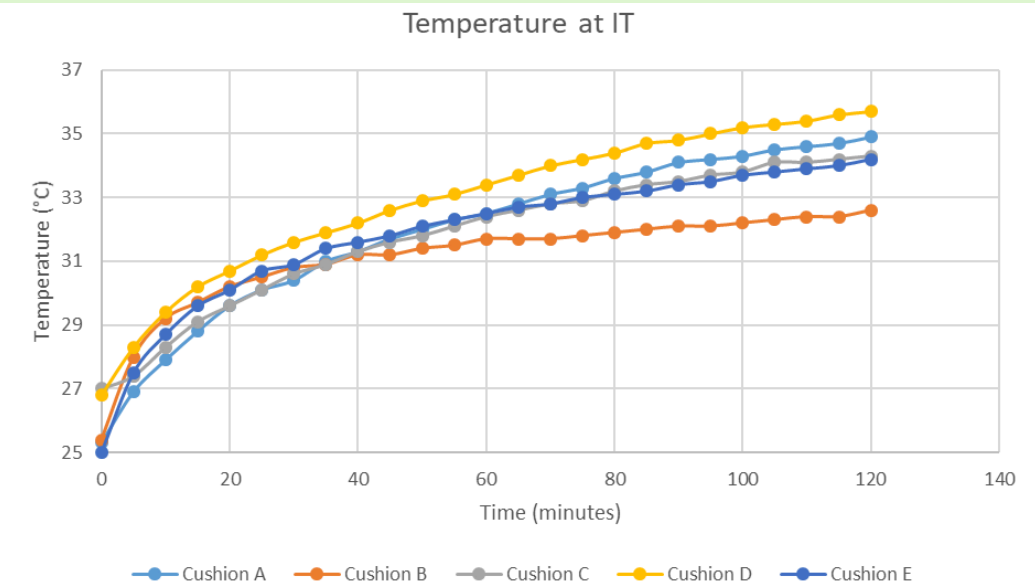
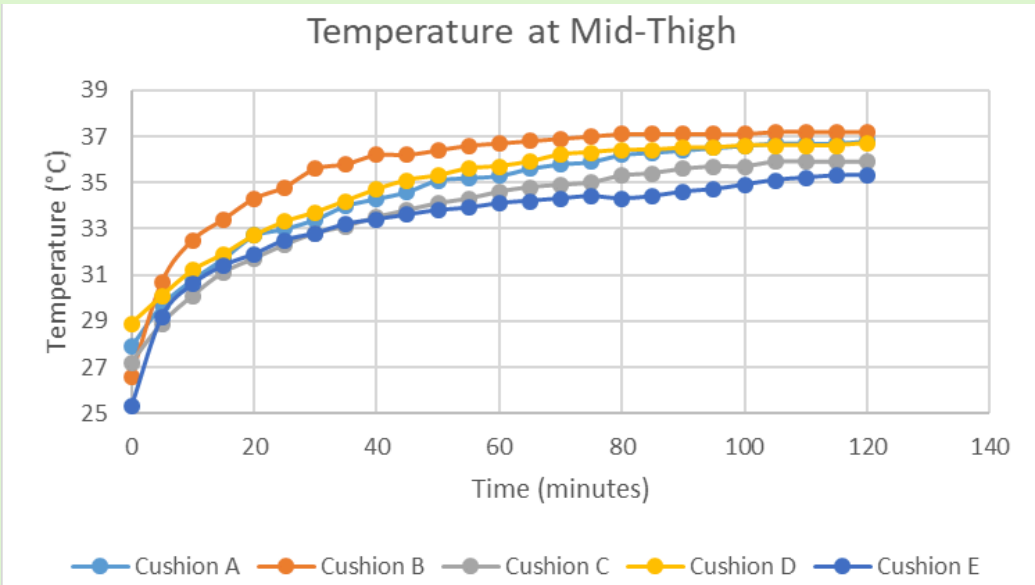
A 1 degree Celsius increase in sacral skin temperature increases pressure ulcer risk as much as an increase of 14mmHg in pressure [6].

A significant difference has been found between temperature at the mid-thigh and temperature at the ischial tuberosity (IT), regardless of cushion material or type [7, 8].

The majority of sales brochures for temperature regulating cushions do not include quantitative test data.

Whilst some cushion brochures describe 35 degrees Celsius as a therapeutic skin temperature, one study found that holding skin at this temperature causes deep tissue breakdown [9, 10].

Results



Main Findings

In agreement with literature, a statistically significant difference was found between temperature at the mid-thigh (mean = 36.6 degrees Celsius) and that at the IT (mean = 34.9 degrees Celsius) with $p < 0.05$ significance level ($p = 0.0144$).

The total temperature rise at IT was lowest on Cushion B, but highest at mid-thigh on the same cushion.

The maximum difference between final temperatures on each cushion is 3.1 and 1.9 degrees Celsius at the IT and mid-thigh respectively. The effect of this on pressure ulcer risk could be clinically relevant.

There was a minimal difference in total temperature change between modified and unmodified custom cushions, suggesting that the air channel may not be an effective method of limiting temperature build-up.

Under these conditions, the skin temperature measured on the reference cushion (Cushion C) was lower than that on several of the temperature regulating cushions.

Future Work

More trials are required with larger sample sizes, including patient cohorts, so that an analysis of variance may be conducted. This would provide a quantitative comparison of the cushion technologies.

More or different reference cushions should be included in future trials to minimise selection bias.

[1] Liu Z, Cascioli V, McCarth P. Review of measuring microenvironmental changes at the body-seat interface and the relationship between object measurement and subjective evaluation. *Sensors (Basel)*. 2020;20(23):6715. doi: 10.3390/s20236715; [2] Wood J, Brown B, Bartley A, *et al*. Reducing pressure ulcers across multiple care settings using a collaborative approach. *BMJ Open Qual*. 2019;8(3):e000409. doi: 10.1136/bmjopen-2018-000409; [3] HomertonHealthcare NHS Foundation Trust. Causes and risk factors. Date unknown. <https://www.homerton.nhs.uk/causes-and-risk-factors>. Accessed March 18, 2025; [4] Kottner J, Black J, Call E, *et al*. Microclimate: A critical review in the context of pressure ulcer prevention. *Clin Biomech (Bristol)*. 2018;59:62-70. doi: 10.1016/j.clinbiomech.2018.09.010; [5] NHS Improving Quality. Right chair right time right now. NHS England. Published November, 2014. <https://www.england.nhs.uk/improvement-hub/wp-content/uploads/sites/44/2017/11/My-Wheelchair-My-Life-eDigest.pdf>. Accessed March 18, 2025; [6] Zeevi T, Levy A, Brauner N, Gefen A. Effects of ambient conditions on the risk of pressure injuries in bedridden patients - multi-physics modelling of microclimate. *Int Wound J*. 2017;15(3):402-416. doi: 10.1111/iwj.12877; [7] Ferrarin M, Ludwig N. Analysis of thermal properties of wheelchair cushions with thermography. *Medical & Biological Engineering & Computing*. 2000;38(1):31-4. doi: 10.1007/BF02344685; [8] Hsu T, Yang S, Liu J, *et al*. The effect of cushion properties on skin temperature and humidity at the body-support interface. *Assistive Technology*. 2018;30(1):1-8. doi: 10.1080/10400435.2016.1223208; [9] Kokate J, Leland K, Held A, *et al*. Temperature-modulated pressure ulcers: A porcine model. *Archives of Physical Medicine and Rehabilitation*. 1995;76(7):666-673. doi:10.1016/S0003-9993(95)80637-7[10] Sunrise Medical. JAY Balance. Date unknown. <https://www.sunrisemedical.co.uk/seating/jay/wheelchair-cushions/jay-balance>. Accessed March 24, 2025. [11] Helping Hand Pressure Care. JAY ClimaZone High Risk Paediatric to Bariatric Pressure Cushion. Date unknown. <https://www.hipressurecare.co.uk/products/cushions/climazone/>. Accessed March 24, 2025. [12] Recare. Supracor Stimulite Classic XS Cushion. Date unknown. <https://www.recare.co.uk/product/supracor-stimulite-classic-xs-cushion/#:~:text=Supracor%20stimulite%20Classic%20is%20a%20lightweight%2C%20maintenance-free%20cushion,protection%20but%20have%20difficulty%20transferring%20on%20contoured%20surfaces>. Accessed March 24, 2025. [13] Invacare. VICAIR Catalogue 2024. Date unknown. https://www.invacare.co.uk/sites/gb/files/csv_migration/product_docs/sales_docs/DSAL008275_Vicair-Catalogue_070069-EN-REV01_2024_ARTNR_08100007_LR_2.pdf. Accessed March 24, 2025.