# Static breast skin strain and breast support.

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## Introduction

The breast has minimal natural support, with the Coopers ligaments and skin providing the predominant support. It is therefore well established within the literature the effect which varying levels of external breast support (sports bra, everyday bras) can have on breast biomechanics, particulary during dynamic activity [1]. Given the role which the skin plays in supporting the breast it is possible that breast skin damage may occur with inadequate breast support, and this may lead to breast ptosis (sag). In 2001 Silver et al. [2] reported that at ≥30% skin strain the skin enters a resistance zone, whilst at ≥60% skin strain the skin enters a failure zone, in which the skin may undergo permanent deformation. When applied to the breast, these skin strain thresholds may reveal information about any potential damage which may be occuring to breast skin, whilst also informing us about the role of breast support in relation to breast ptosis (sag). As this is preliminary research in the area it is first important to investigate breast skin strain in static conditions. Herein, the purpose of this study was to investigate breast skin strain during standing, in various breast support conditions.

## Methods

Fifty-three females provided written informed consent (Table 1).

| Age [years] | Breast volume [ml] | BMI | Chest circumference (Under bust) [m] | Over bust [m] | Bra size |
|---|---|---|---|---|---|
| 25.5 (19.0 to 38.0) | 754.76 (222.8 to 1540.3) | 24.1 (17.5 to 34.5) | 0.81 (0.72 to 0.98) | 0.95 (0.78 to 1.09) | 32A to 36G |

**Table 1. Participant characteristics (mean and range).**

Breast and torso position data were recorded via an electromagnetic, 14-sensor array, which was applied to participant's left breast (Fig. 1).

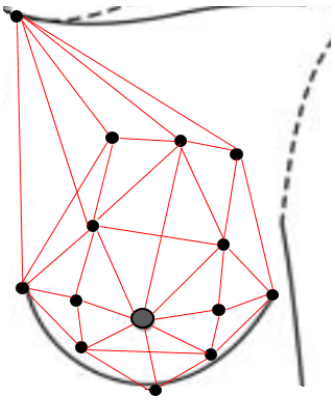

**Fig. 1 The 14-sensor array applied to participants left breast. Sensors are identified via the black circles with an additional sensor placed on the nipple (grey circle). Thirty-five strain lines are identified via the red lines.**

Participants then performed standing for 10 s in a sports bra (high support: Shock Absorber Run Bra, 81% polyamide,10% polyester, 9% elastane), an everyday bra (low support: Marks & Spencer T-shirt bra, 92% cotton, 8% elastane lycra) and bare-breasted. Following this, participants neutral breast position was recorded whilst the participants sat submerged in water (37°C), for 6 s [3]. Breast skin strains were then calculated using,

$$\text{Strain (\%)} = 100 \cdot \left(\frac{(L - L_0)}{L_0}\right) = 100 \cdot \left(\frac{(\Delta L)}{L_0}\right) \quad (1)$$

where L was defined as the average inter-sensor separation during standing (gravity-loaded) and $L_0$ was defined as the neutral (unloaded) inter-sensor separation during water submersion. Thirty-five strain lines were identified for each condition (Fig. 1), and the peak skin strain (%) (across all strain lines) was identified for each participant. Average peak breast skin strains (%) were then calculated for each breast support condition across the 53 participants. Statistical data analysis was undertaken in SPSS 24. All strain data were non-normally distributed (Shapiro-Wilk, $p<0.05$) and therefore a non-parametric Friedman test was utilised to identify significant differences across breast support conditions. Pearson's correlation coefficients were utilised to identify associations between participant characteristics and breast skin strain.

## Results

Peak breast skin strain averaged 23.7% in a sports bra (11.2 to 48.2%), 24.5% in an everyday bra (11.5 to 54.7%) and 31.9% (8.7 to 74.4%) bare-breasted during standing. There was a statistically signifiacnt difference in average peak breast skin strain across breast support condition, $x^2(2) = 15.200$, $p = .001$. Wilcoxon Signed Ranks tests identified significant differences between the sports bra and bare-breasted conditions ($Z = -3.913$, $p = .000$), and the everyday bra and bare-breasted conditions ($Z = -4.134$, $p = .000$) (Table 2). No significant difference in average peak breast skin strain was identified between the sports bra and everyday bra conditions during standing ($Z = -.942$, $p = .346$).

| | Sports bra (high support) | Everyday bra (low support) | Bare-breasted |
|---|---|---|---|
| **Breast skin strain [%]** | 23.7 [a] (11.2 to 48.2) | 24.5 [b] (11.5 to 54.7) | 31.9 [a,b] (8.7 to 74.4) |

[a] Significant difference between sports bra and bare-breasted. [b] Significant difference between everyday bra and bare-breasted.

**Table 2. Average (range) peak breast skin strain values (%) for standing in 53 participants.**

There was one large positive correlation present between bare-breasted skin strain and breast volume, r = .640 (Table 3).

| Breast skin strain [%] | Age [years] | Breast volume [ml] | BMI | Chest circumference (Under bust) [m] | Over bust [m] |
|---|---|---|---|---|---|
| **Sports bra (high support)** | .071 | .318 | .418 | .269 | .386 |
| **Everyday bra (low support)** | .105 | .462 | .349 | .241 | .366 |
| **Bare-breasted** | .236 | **.640** | .396 | .294 | .475 |

**Table 3. Pearsons correlation coefficient values (r).**

## Discussion

Participants reached levels of skin deformation (>60% skin strain) in a bare-breasted condition, and this condition was significantly different from both high and low levels of support, clearly identifying that external breast support is required for females, even in static conditions. Additionally, as peak breast skin strains entered the resistance zone (≥30% skin strain) in both the sports bra and everyday bra during standing, it may be that improvement is required in currently available bras, in order to reduce breast skin strain further. Additionally, a sports bra provides no decrease in breast skin strain, compared to an everyday bra, during standing, possibly identifying a limited requirement for a sports bra unless performing dynamic activity.

## Conclusion

Bare-breasted females may be susceptible to skin damaging levels of skin strain during standing which may contribute to breast ptosis. However, sports and everyday bras may provide support which protects breast skin from reaching skin deformation levels (>60% skin strain, the failure zone) during standing.

## References


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