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Upper torso pain and musculoskeletal structure and function in women with and without large breasts: A cross sectional study

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ABSTRACT

Background: Women with large breasts frequently experience upper torso pain secondary to their breast size. Evidence is lacking on the underlying causes of this pain. This study investigated whether upper torso pain and musculoskeletal structure and function differed between women with large breasts and women with small breasts.

Methods: A linear regression, adjusting for body mass, compared the upper torso pain, thoracic flexion torque due to breast mass, thoracic kyphosis, shoulder active range-of-motion, and scapular retraction muscle strength of 27 women with large breasts (bilateral breast volume > 1200 ml, age 45.9 y SD 9.9 y, BMI 29.0 kg/m^2 SD 3.8 kg/m^2) and 26 women with small breasts (bilateral breast volume < 800 ml, age 43.8 y SD10.9 y, BMI 23.3 kg/m^2 SD 2.9 kg/m^2).

Findings: Women with large breasts reported had a higher upper torso pain score (46.6, 95%CI 33.3–58.0 versus 24.1, 95%CI 12.5–37.8), accompanied by a larger flexion torque (5.9 Nm, 95%CI 4.5–5.8 Nm versus 0.9 Nm, 95%CI 0.8–2.4 Nm), greater thoracic kyphosis (34°, 95%CI 31–38° versus 27°, 95% CI 24–31°), decreased shoulder elevation range-of-motion (160°, 95%CI 158–163° versus 169°, 95%CI 166–172°), and decreased scapular retraction endurance-strength (511.4 s, 95%CI 362.2–691.3 s versus 875.8 s, 95%CI 691.5–1028.4 s) compared to the women with small breasts.

Interpretation: Differences in the upper torso posture, range-of-motion, and muscle strength of women with large breasts provides insight into underlying causes of their musculoskeletal pain. This information can be used to develop evidence-based assessment and treatment strategies to relieve and prevent symptom progression.

1. Introduction

Large breasts can contribute to serious negative health consequences for women, including neck and back pain, headaches, painful bra-strap grooves in their shoulders, and disabling neural symptoms in their upper limbs (Barbosa et al., 2012; Benditte-Klepetko et al., 2007; Findikcioglu et al., 2007; McGhee et al., 2013; Spencer and Biffa, 2013). These factors can also limit the ability of women with large breasts to participate in physical activity and, in chronic cases, necessitate breast reduction surgery (Benditte-Klepetko et al., 2007; Blomqvist et al., 2000; Chao et al., 2002; Findikcioglu et al., 2013). In addition to the well-documented negative consequences associated with reduced physical activity, physical inactivity due to symptoms associated with a large breast size, high BMI or musculoskeletal pain can lead to weight gain, as well as further increases in breast size because increases in BMI have been associated with increases in breast volume (Coltman et al., 2017). Alarmingly, the prevalence of this unique women's health problem is likely to escalate because the average bra size has increased over the past two decades from a small bra cup size (34B) to a large bra cup size (34DD) (Dale, 2013). Despite the potential negative health consequences associated with large breasts, there is a lack of evidence upon which to base appropriate interventions to treat symptoms. No guidelines exist to develop pre-emptive strategies in order to prevent the progression of symptoms to a situation where breast reduction surgery is required. Most previous research in this field has focused only on women who have reached the stage where they require breast reduction surgery. There is a paucity of research investigating the underlying mechanisms of musculoskeletal pain associated with large breasts and a lack of evidence on the intensity, severity and incidence of musculoskeletal symptoms suffered by women with large breasts, who are not yet seeking breast reduction surgery.

One mechanism underlying the musculoskeletal symptoms associated with large breasts is thought to be increased thoracic kyphosis

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(Barbosa et al., 2012; Findikcioglu et al., 2007; Findikcioglu et al., 2013; McGhee et al., 2013). This increased forward curvature of the upper torso has been the attributed to a flexion torque on the thoracic spine created by excessive breast mass (Findikcioglu et al., 2007; McGhee et al., 2013). Although the size of this flexion torque is yet to be reported, vertebral column radiographs of women with large breasts (D + cup bra size) have revealed significantly greater thoracic kyphosis compared to women with small breasts (A cup bra size) (Findikcioglu et al., 2007). Thoracic kyphosis has also been found to be significantly reduced post-breast reduction surgery (Berberoğlu et al., 2015; Findikcioglu et al., 2013; Karabekmez et al., 2014), although other researchers found no relationship between thoracic kyphosis and breast size in post-menopausal women (mean age 69 years) (Spencer and Biffa, 2013). Unfortunately, the researchers in this study did not screen for osteoporosis, which might have masked the effects of breast size on thoracic kyphosis. Two studies that recruited only young women as participants (Coltman et al., n.d.; Wood et al., 2008) found no relationship between breast size and thoracic pain, suggesting that increased thoracic kyphosis and thoracic pain are likely to be long-term rather than immediate consequences of having large breasts. It should be noted, however, that the cohort numbers in these two studies was relatively small and that the breasts of the participants were not very large when comparing their bra sizes to objectively calculated breast volumes (Coltman et al., 2017).

Increased thoracic kyphosis has been linked to a forward head and shoulder posture, and altered scapulae alignment, which in combination have been associated with reduced shoulder flexion range-of-motion (Goh et al., 1999; Kebaetse et al., 1999; Lewis et al., 2005). Poor mobility of the upper thoracic spine has also been identified as a predictor of neck and shoulder pain (Lau et al., 2010). Therefore, decreased mobility in the upper thoracic spine and shoulder complex secondary to an increased thoracic kyphosis, might also contribute to musculoskeletal pain suffered by women with large breasts. The effect of large breasts on shoulder range-of-motion, however, is yet to be investigated.

Thoracic extensor muscle length and, in turn strength, can also be affected by increased thoracic kyphosis (Kebaetse et al., 1999; Wood et al., 2008). Reduced thoracic extensor muscle strength is one of the factors thought to contribute to age-related hyper-kyphosis (Roghani et al., 2017), and has been found in older, estrogen-deficient women with hyper-kyphosis (Kebaetse et al., 1999). Reduced thoracic extensor muscle strength has also been found in breast reduction mammoplasty candidates who displayed increased thoracic kyphosis (Benditte-Klepetko et al., 2007; Chao et al., 2002) and was found to increase six months post-breast reduction surgery (Chao et al., 2002). Women with large breasts might also adapt to the greater load generated by their breasts and increase their thoracic extensor muscle strength. Although back extensor muscle strength and endurance is very important for maintaining normal postural alignment (Roghani et al., 2017), it is not known whether a decrease in the capability of the thoracic extensor muscles to generate extension torque and control anterior shear force leads to an increase in kyphosis angle (Greig et al., 2008) or whether the increased compression and shear forces imposed on spinal functional units by an increased thoracic kyphosis angle compromises the thoracic extensor muscles force generation capacity (Mika et al., 2005) and length-tension relationship (O'Sullivan et al., 2002). We speculated that the combination of an increased flexion torque on the thoracic spine (due to the weight of large breasts) and weaker muscles in the posterior region of the thoracic spine might alter both the posture and the tissue loading in the thoracic region of the vertebral column and, in turn, contribute to musculoskeletal pain experienced by women with large breasts. No previous research, however, has objectively measured and compared thoracic muscle strength and endurance in women with and without large breasts.

A greater understanding of differences in the upper torso musculoskeletal structure and function between women with large breasts and women with small breasts would provide evidence for physical therapists to develop effective health care strategies to treat and prevent symptom progression in female patients with large breasts. Therefore, we aimed to identify differences in the upper torso pain and musculoskeletal structure and function of women with large breasts and women with small breasts. We hypothesized that women with large breasts would report significantly more frequent and severe occurrences of musculoskeletal pain in the upper torso, and would display significantly greater thoracic kyphosis and flexion torque, less shoulder and thoracic spine range-of-motion, and less scapular retraction muscle strength and endurance compared to women with small breasts.

2. Methods

2.1. Participants and ethical issues

Fifty-three women (mean 44.8 y SD 10.3 y) were recruited as participants through local community advertising. Inclusion criteria were aged 18–60 years, not currently seeking breast reduction surgery, and wearing either a large bra cup size (DD or larger) or a small bra cup size (A or B). The upper age was set at 60 years to allow for the accumulated effect of breast hypertrophy on the upper torso (Benditte-Klepetko et al., 2007), while reducing the likelihood of complications associated with age-related diseases (Raisz, 2005). Exclusion criteria were current pregnancy or breast-feeding; previous breast or spinal surgery; any other musculoskeletal condition that affected shoulder, cervical, or thoracic spine range-of-motion or that prevented participants assuming the positions required for data collection; a current diagnosis of osteoporosis or epilepsy (due to flashing lights associated with the scanning system described below); or current menstrual-related breast pain.

Twenty-seven of the women self-reported a large bra cup size and 26 self-reported a small bra cup size. The breast size of each participant was then objectively classified by calculating their breast volume following procedures described in detail elsewhere (Coltman et al., 2016). In brief, each breast was scanned (Artec Studio 9, Artec Eva, USA; 16 Hz) while the participants lay prone with their breasts freely suspended between two tables. The volume of the three-dimensional scanned breast structure was calculated using Geomagic Studio® software (Three D Systems, South Carolina, USA) (Coltman et al., 2016). Women with bilateral breast volumes > 1200 ml were allocated to the participant group with large breasts (Ikander et al., 2014; McGhee et al., 2013; Sigurdson and Kirkland, 2006), whereas women with bilateral breast volumes < 800 ml were allocated to the participant group with small breasts (McGhee and Steele, 2010; McGhee and Steele, 2011). The mean breast volumes of the two participant groups were significantly different (mean volume of the group with large breasts was five times that of the group with small breasts; Table 1).

The two participant groups were matched for age, height, and physical activity level (Table 1), which was assessed using the International Physical Activity Questionnaire (levels 1–3; 1 = low

Table 1
Characteristics of the participant group with large breasts and with small breasts.

Variable	Large breasts (n = 27)	Small breasts (n = 26)	Mean difference (95% CI)	*P*-value
Age (years)	45.9 (9.9)	43.8 (10.9)	1.97 (− 3.8–7.7)	0.494
Height (m)	1.65 (0.05)	1.63 (0.08)	0.15 (− 0.21–0.52)	0.412
Body mass (kg)	*78.7 (11.8)	61.9 (9.9)	16.7 (10.7–22.8)	< **0.001**
Body mass index (kg/m^2)	*29.0 (3.8)	23.3 (2.9)	5.74 (3.87–7.61)	< **0.001**
Physical activity level (1–3)	2.6 (0.75)	2.8 (0.44)	0.21 (− 0.55–0.13)	0.212
Bilateral breast volume (ml)	*2373 (863)	453 (150)	1921 (1576–2266)	< **0.001**

Values expressed as a mean (SD). Asterisks represent significance (**$P < 0.001$).