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"Breasts are getting bigger". Where is the evidence?

Nicola Brown[1] & Joanna Scurr[2]

1) School of Sport, Health & Applied Science, St. Mary's University, Waldegrave Rd, Twickenham, TW1 4SX, UK

e-mail: nicola.brown@stmarys.ac.uk

2) Research Group in Breast Health, University of Portsmouth, Cambridge Rd, Portsmouth, PO1 2ER, UK

Background

Concerns over breast size have gained prominence as progressively more research points to an association between increased breast size and negative health implications. Larger breast sizes are associated with a higher incidence of breast pain (Brown *et al.*, 2014), postural issues (Findikcioglu *et al.*, 2007) and body image dissatisfaction (Sarwer *et al.*, 1998). It has been widely reported in the popular press that female breast size is increasing, however, empirical evidence for this assertion is limited, with support for this notion stemming primarily from bra sales. For example, a 2010 media article reporting an increase in British women's breast size cited best-selling bra size statistics from retailer John Lewis, increasing from a 34B in 2008 to a 32D in 2010 (Fisher, 2010). Similarly, media articles in the United States of America (USA) report that the average bra cup size is now a 36DD, increasing from an average 34B 10 years ago (Holson, 2009; Hadley, 2012), with these statistics again obtained from lingerie retailers.

We argue that bra sales data cannot be used to document breast size, or change in breast size over time, as this data is confounded by a lack of industry sizing standards and the high proportion of women reportedly wearing the incorrect bra size. Size charts and grading methods differ between bra companies resulting in inconsistencies in bra sizes produced by different manufacturers (McGhee & Steele, 2006). Therefore, whilst women may be one bra size in one brand, they may be a different size in another which may impact bra sale statistics. It is also recognised that up to 100% of women are wearing the wrong-sized bra (Greenbaum *et al.*, 2003). There is currently no objective, empirical evidence of secular increases in breast size.

Review of available data

In an attempt to investigate the evidence of a secular increase in breast size, we conducted a comprehensive literature search to identify all published bust circumference data, defined as the horizontal circumference taken at the level of the nipple. Direct techniques employed to measure breast size include volume determinations using water displacement techniques, sophisticated imaging techniques and casting techniques (Kayar *et al.*, 2011). However, due to high costs, technical difficulties and patient discomfort, no method has gained acceptance as a routine measurement tool. In contrast, bust circumference has been inherent in breast size measurement since the early 1900's and the equipment required is portable and inexpensive allowing for routine use (Brown & Scurr, 2012). It is acknowledged that bust circumference gives an indication of chest and breast size amalgamated, and therefore gives an identification of increases in chest circumferences as well as breast size. However, bust circumference was reported as a key dimension for all female upper body garments (Chun-Yoon, 1996), and in a review of forty USA size charts

for women's clothing dating from 1873 to 2000, Schofield & LaBat (2005) found that bust circumference was used as the size designation in all charts.

Despite a comprehensive search of electronic databases and grey literature, only 31 articles met our key inclusion criteria which were; (1) they reported objective chest or bust circumference measurement of adult females, (2) they used calibrated instruments and trained personnel to obtain circumference data, (3) the study had a minimum sample size of 50 to ensure that the results were sufficiently representative, and (4) the study showed no obvious bias in bust circumference measurement (e.g. did not include pregnant females, or females who had undergone breast surgical procedures). Studies reporting chest or bust circumference were included in the initial search to ensure no relevant data were missed, as these terms are often used synonymously. The chest and bust circumference definitions provided in the 31 articles were reviewed and in total 15 studies provided a circumference definition that reflected a measurement taken at the nipple level or area of breast fullness, thus were deemed to have reported a bust circumference measure. These studies included data from 10 countries; China, Greece, India, Italy, Korea, the Netherlands, Poland, Sri Lanka, the UK and the USA. Data spanned from 1940 to 2008, comprising 48,651 participants (Appendix). The smallest mean bust circumference (81 cm) was observed in India in 2007 and the largest mean bust circumference (109 cm) was observed in a Hispanic population in 2008 (Fig. 1).

It is acknowledged that a secular trend generally refers to the attainment of a larger size over several generations. Data were only available from two countries (UK and USA) that allowed assessment of change over time, highlighting the lack of published literature available on bust circumference. The rate of change in bust circumference (in cm per year) was calculated from the time spanned by the studies and the total observed change in bust circumference. This method assumes that changes in bust circumference have occurred linearly over time. In the UK bust circumference increased by 6.3 cm from 1951 to 2002, at an annual rate of change of +0.12 cm per year. The USA data indicates a similar pattern with bust circumference data increasing by +0.09 cm per year in White American females from 90.5 cm in 1940 to 96.9 cm in 2008. Previous research has identified that breast size is related to body composition, with larger-breasted women having significantly greater fat mass than smaller-breasted counterparts (Brown *et al.*, 2012). As the breast is composed primarily of fat and glandular tissue, and obesity rates in developed countries such as the UK and the USA have continued to rise since the 1970s (Wang *et al.*, 2013), it is plausible that the increase observed in White British and White American females bust circumference could be related to the current obesity epidemic.

Future Directions

Our literature search identifies that there is a lack of available data on bust circumference and with the exception of the UK and the USA it is difficult, if not impossible, to provide evidence to confirm or reject the notion that there has been a secular increase in breast size. Emphasis should be placed on obtaining reliable and representative measurements of the female breast at frequent intervals to allow evidence based projection of future trends and between county comparisons. Furthermore, as physical changes occur in the body due to the natural process of ageing, and there is a relationship between breast size and body composition (Brown *et al.*, 2012), larger data sets stratified by age and body size should be considered to accommodate the full range of variation observed in the population. Additionally, it is important that standards of reporting anthropometric data are improved to ensure clear identification of measurement procedures and definitions used. In the articles reviewed, less than a third provided a measurement definition directly and eight failed to define the measurements taken or cite any specific protocols that were followed. Additionally, 50% of

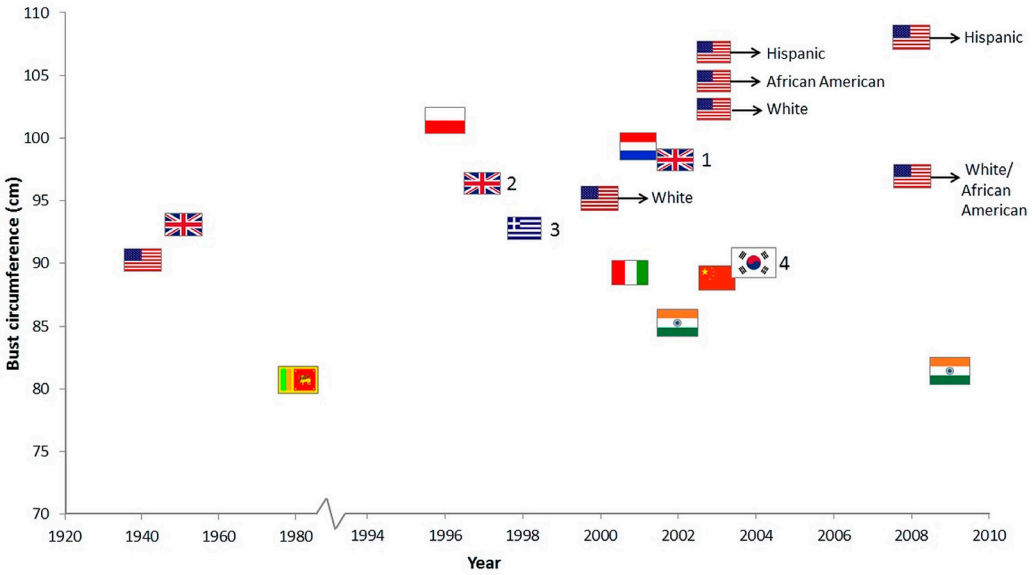

Fig. 1 - Mean bust circumference (cm) by country and year of data collection.
1 where 2002 UK data is stratified by age summary data from Wells* et al., *(2008) is presented only (n = 4710).
2 where 1997 UK data is stratified by BMI (Park et al., 2012) data from the BMI group 25.6 to 26.5 kg.m-2(n = 2252) is presented as this most closely matches the average BMI presented in the Wells* et al., *(2008) UK data set.
3 where 1998 data is available for low (n = 665) and high breast cancer risk groups (n = 236), data is presented for the low-risk group only.
4 where 2004 scanned and manual data is available for Korea (Han* et al., *2010), scanned data is presented only (n = 1794).
The colour version of this figure is available at the JASs website.

articles reporting a chest circumference measurement referred to this at the level of the nipple, which may be more accurately reflected by the term bust circumference. Inconsistencies in such terminology could result in errors when interpreting data and limits comparisons of anthropometric data. Furthermore, respiration has been documented as a potential source of error in bra sizing (McGhee & Steele, 2006). Less than half of the articles provided description regarding participants breathing patterns during the course of the bust circumference measurement. It is acknowledged that a number of scientific disciplines use anthropometry of which varied dimensions are of interest to researchers, making standardization difficult. However, at the minimum, a standardized and explicit definition of bust circumference is recommended for future research. It is also recommended that this is further supplemented by documenting measurement procedures, including participant's positioning and respiratory state, when the measurement is taken.

Conclusion

Increased breast size is associated with negative health implications and although bra fit is a significant problem, studies on the fit of bra apparel are limited and there has been little resolution. The overall picture that emerges from this analysis is that in White British and White American females a secular increase in bust circumference has occurred and this may potentially

be attributed to the current obesity epidemic. However, further data collection, with improved reporting standards is needed to investigate the secular trend in other countries and allow cross-country comparison. Knowledge of the range of variation in bust circumference could aid the development of improved sizing standards, leading to improved bra fit and customer satisfaction, ultimately resulting in long-term business success for manufacturers and retailers of breast support apparel.

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Appendix - Country, data collection period, sample size, population characteristics, age and bust circumference of the 15 included studies (some studies have multiple results).

AUTHORS, (YEAR)	COUNTRY	DATA COLLECTED	N	POPULATION CHARACTERISTICS	AGE (YEARS)	BUST CIRCUMFERENCE
Zheng (2006)	China	2003	456	Adult Chinese females participating in AIMER HEC-BICTs measuring survey	20 to 39	88.8 ± 7.3
Riza *et al*. (2009)	Greece	1997 to 1998	901	Postmenopausal females categorised as high (n = 236) and low (n = 665) breast cancer risk based on parenchymal patterns	56.7 ± 5.9 (high-risk) 59.4 ± 5.9 (low-risk)	90.0 ± 8.0 (high risk) 93.5 ± 8.6 (low risk)
Dewangan *et al*. (2008)	India	2002*	400	Adult female agricultural workers from two North-Eastern states of India; Arunachal Pradesh and Mizoram. Categorised as < 25 years (n = 136), 25 to 35 years (n = 140), > 35 years (n = 124)	30.6 ± 7.1 (18 to 54)	85.0 ± 6.4 (all) 84.2 ± 5.7 (< 25 years) 85.2 ± 6.9 (25 to 35 years) 85.7 ± 6.7 (> 35 years)
Agrawal *et al*. (2010)	India	2000 to 2007*	757	Adult female healthy agricultural workers from six agro-climatic zones of Madhya Pradesh (Central India) state.	33.7 ± 8.2	81.0 ± 7.2
Fullenkamp *et al*. (2008)	Italy	1999 to 2001	388	Adult females from Civilian American and European Surface Anthropometry Resource database	18 to 65	89.0 ± 8.0
Han *et al*. (2010)	Korea	2003 to 2004	1794	Adult females participating in the fifth Size Korea survey	20 to 75	88.8 (manual) 90.4 (scanned)
Fullenkamp *et al*. (2008)	Netherlands	2000 to 2001	700	Adult females from Civilian American and European Surface Anthropometry Resource database	18 to 65	99.8 ± 11.9
Jarosz (1999)	Poland	1996	106	Elderly females of normal health and activity	60 to 96	101.7 ± 10.0

*denotes data collection period confirmed via author correspondence

Appendix - Continued.

AUTHORS, (YEAR)	COUNTRY	DATA COLLECTED	N	POPULATION CHARACTERISTICS	AGE (YEARS)	BUST CIRCUMFERENCE
Abeysekera & Shahnavaz (1987)	Sri Lanka	1981 to 1982	288	Adult Sri Lankan females from working establishments across all 24 districts of the 7 provinces of Sri Lanka	21 to 51	80.8 ± 5.8
Kemsley (1957)	United Kingdom	1951	4995	Adult females largely comprised of working women. Categorised as 18 to 29 years, 30 to 44 years and 45 to 64 years.	18 to 64	92.7 ± 8.9 (all) 89.4 (18 to 29 years) 93.0 (30 to 44 years) 98.6 (45 to 64 years)
Wells *et al.* (2008)	United Kingdom	2001 to 2002	4710	White adult females from across 8 UK cities participating in Size UK survey	18 to ≥ 66	99.0 ± 10.3
Wells *et al.* (2007)	United Kingdom	2001 to 2002	5278	White adult females from across 8 UK cities participating in Size UK survey	17 to 76 categorised as:	
					< 21 years (n = 742)	94.0 ± 7.9 (< 21 years)
					21 to 30 years (n = 1329)	95.1 ± 8.8 (21 to 30 years)
					31 to 40 years (n = 900)	98.6 ± 10.8 (31 to 40 years)
					41 to 50 years (n = 728)	101.4 ± 11.5 (41 to 50 years)
					51 to 60 years (n = 743)	102.4 ± 10.4 (51 to 60 years)
					61 to 70 years (n = 578)	103.3 ± 10.1 (61 to 70 years)
					≥ 71 years (n = 258)	100.7 ± 9.9 (≥ 71 years

*denotes data collection period confirmed via author correspondence

Appendix - Continued.

AUTHORS, (YEAR)	COUNTRY	DATA COLLECTED	N	POPULATION CHARACTERISTICS	AGE (YEARS)	BUST CIRCUMFERENCE
Park *et al*. (2012)	United Kingdom	1993 to 1997	11055	Adult females grouped into BMI quintiles: BMI < 22.7 (n = 2315)	55.5 ± 9.5 (BMI < 22.7)	87.3 ± 4.7 (BMI < 22.7)
				BMI 22.7 to 24.5 (n = 2271)	57.0 ± 9.2 (BMI 22.7 to 24.5)	92.7 ± 4.6 (BMI 22.7 to 24.5)
				BMI 24.6 to 26.5 (n = 2252)	58.8 ± 9.1 (BMI 24.6 to 26.5)	96.7 ± 5.0 (BMI 24.6 to 26.5)
				BMI 26.6 to 29.3 (n = 2180)	59.8 ± 9.1 (BMI 26.6 to 29.3)	101.6 ± 5.8 (BMI 26.6 to 29.3)
				BMI > 29.4 (n = 2037)	58.9 ± 8.8 (BMI > 29.4)	111.0 ± 8 (BMI > 29.4)
O'Brien & Shelton (1941)	United States of America	1939 to 1940	10042	Adult white civilian females	≥ 18	90.5 ± 9.8
Fullenkamp *et al*. (2008)	United States of America	1998 to 2000	1264	Adult females from Civilian American and European Surface Anthropometry Resource database	18 to 65	95.8 ± 12.4
Wells *et al*. (2008)	United States of America	2002 to 2003	5274	White (n = 3329), African American (n = 1106) and Hispanic American (n = 839) females participating in Size USA survey	18 to ≥ 66	103.0 ± 12.3 (White)
						107.4 ± 14.4 (African American)
						105.1 ± 11.9 (Hispanic American)
Doukky *et al*. (2012a)	United States of America	2007 to 2008	148	Predominantly White and African-American adult outpatient females (author correspondence)	56.6 ± 14.1	96.9 ± 9.3
Doukky *et al*. (2012b)	United States of America	2007 to 2008	95	Predominantly Hispanic adult outpatient females (author correspondence)	55.8 ± 12.5	109.0 ± 12.7

*denotes data collection period confirmed via author correspondence