

The relationship between breast size and aspects of health and psychological wellbeing in mature-aged women

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Abstract

Objectives: Increases in breast size with age are common but have not been widely examined as a factor that could affect the health and psychological wellbeing of mature-aged women. The purpose of this study was to examine the relationships between breast size and aspects of health and psychological wellbeing in mature-aged women.

Methods: This was a cross-sectional study of mature-aged women (≥ 40 years). Breast size (breast size score) was determined from self-reported bra size and was examined against health-related quality of life (Medical Outcomes Study Short-Form 36 and BREAST-Q), body satisfaction (numerical rating scale), breast satisfaction (BREAST-Q), physical activity levels (Human Activity Profile), the presence of upper back pain and breast and bra fit perceptions.

Results: Two hundred sixty-nine women (40–85 years) with bra band sizes ranging from 8 to 26 and bra cup sizes from A to HH participated. The mean (standard deviation) breast size score of 7.7 (2.7) was equivalent to a bra size of 14DD. Increasing breast size was associated with significantly lower breast-related physical wellbeing ($p < 0.001$, $R^2 = 0.043$) and lower ratings of body ($p = 0.002$, $R^2 = 0.024$) and breast satisfaction ($p < 0.001$, $R^2 = 0.065$). Women with larger breasts were more likely to be embarrassed by their breasts (odds ratio: 1.49, 95% confidence interval: 1.31 to 1.70); more likely to desire a change in their breasts (odds ratio: 1.55, 95% confidence interval: 1.37 to 1.75) and less likely to be satisfied with their bra fit (odds ratio: 0.84, 95% confidence interval: 0.76 to 0.92). Breast size in addition to age contributed to explaining upper back pain. For each one-size increase in breast size score, women were 13% more likely to report the presence of upper back pain.

Conclusion: Larger breast sizes have a small but significant negative relationship with breast-related physical wellbeing, body and breast satisfaction. Larger breasts are associated with a greater likelihood of upper back pain. Clinicians considering ways to improve the health and psychological wellbeing of mature-aged women should be aware of these relationships.

Keywords

breast size, health, mature-aged women, psychological wellbeing, upper back pain

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Introduction

Good health and psychological wellbeing are attracting growing attention as desirable and closely related constructs that encompass more than simply the absence of illness and disease.¹ Physical, mental, social and behavioural aspects of these constructs together with the burden of any illness, injury, pain or disability are important considerations in the study of health and psychological wellbeing. Factors with the potential to affect directly or indirectly on the health and psychological wellbeing of mature-aged (middle age and

older) women are important to identify, not least because these women represent an expanding proportion of the general Australian population² but also because with advancing

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age, health and psychological wellbeing become increasingly prominent and interdependent.¹

The physical changes that affect a woman's body as a result of ageing have the potential to affect health and psychological wellbeing and should be considered more than inevitable changes. For many women, breasts contribute to their personal sense of attractiveness³ and femininity⁴ throughout their lifetime. The physiological changes that occur in breasts with ageing are well described⁵⁻⁸ and are typically reported by women as an increase in breast size and ptosis.⁴ Menopause is also a transitional period that influences a range of breast characteristics.⁷ The increase in breast size⁹ and the increase in the fat content of breasts¹⁰ following menopause have been associated with increases in body weight around the same time.

Several qualitative studies have captured how the physical changes of breasts, with ageing, affect women.^{3,4,11} The majority of mature women surveyed about these changes report being unhappy about them.⁴ Up to 70% of older women report dissatisfaction with their breasts and the physical changes observed in breasts fuel this dissatisfaction.³ Middle-aged women participating in a large survey study considered the physical changes in their breasts to be distressing and, together with the increases in body weight as they age, led to lower overall levels of body satisfaction and a reluctance to engage in physical activity.¹¹ Collectively, these studies provide some indication that the physical changes occurring in the breasts of women with age have wider implications. In addition to the discontentment and negative feelings these changes may arouse, they may also affect health and psychological wellbeing by perturbing important health behaviours such as physical activity. These findings of qualitative research have not yet been explored in quantitative research.

Increasing breast size, noted by women as they get older, may be particularly problematic for women's health and psychological wellbeing if the burden associated with large breasts that has been suggested in prior work is considered. Increased breast size has previously been related to reduced health and psychological wellbeing in studies of women undergoing reduction mammoplasty surgery where a range of negative physical¹²⁻¹⁴ and psychological characteristics¹³⁻²² have been attributed to having large or excessively large (hypertrophic) breasts. Characteristics that have been most widely examined and which show improvement following reduction mammoplasty include low quality of life,^{16,17,19,21,23} body dissatisfaction,¹⁵ low breast satisfaction,^{16,19,24} depression,^{18,20} upper back pain^{14,25} and physical activity limitations.²⁵ The work undertaken in surgical studies suggests that these characteristics could be measurable aspects of health and psychological wellbeing related to larger breast sizes. However, these characteristics have had limited exploration in women not seeking reduction mammoplasty across a broad range of breast sizes.

Outside the reduction mammoplasty literature, there is growing evidence of the potential impact of larger breast sizes on aspects of physical health including perceptions of pain and physical activity. Pain felt in the thoracic spine^{26,27} and upper back and torso^{28,29} has been observed more commonly in women with large breasts across a range of ages who are not seeking reduction mammoplasty. Total time spent in physical activity and participation in vigorous physical activity have also been noted to be significantly lower among women (aged 18-75 years) with hypertrophic breasts compared to women with small breasts.³⁰ In addition, women with large breasts commonly cite their breast size as a barrier to physical activity participation.^{30,31} With the health benefits of physical activity for mature-aged women well recognized,³² but with only half of women at this age reported to be adequately active,³³ the negative impact of increasing breast size on physical activity levels could be an important burden on physical health that needs further consideration.

Consideration of body mass index (BMI) and bra-related factors that may also be a source of influence is necessary to progress understanding of the relationship between breast size and physical activity levels that may be particularly applicable to mature-aged women. Body size has been reported to have an important role in determining the physical activity levels of mature women¹¹ and this was alluded to, but not controlled for, in prior work that reported the negative trends in physical activity with increasing breast size.³⁰ In addition, the value of a correctly fitted bra may also be important to explore as a variable related to breast size affecting physical activity participation.³⁴⁻³⁶ Mature-aged women with large breasts consider the comfort and fit of their bra as important,⁴ and how satisfied they are with their bra fit may influence their willingness to participate in physical activity. Although women with large breasts commonly wear ill-fitting bras^{27,37-40} and avoid having their bra professionally fitted,³⁸ it is unclear whether breast size per se contributes to these problems in mature-aged women.

To confirm whether increasing breast size has implications for health and psychological wellbeing in mature-aged women, the relationships between breast size and variables that reflect aspects of health and psychological wellbeing need to be more fully examined. In this study, we explored relationships between breast size and aspects of health and psychological wellbeing with the aim of identifying how increasing breast size may affect a woman in her mature years, while also examining the roles that age, BMI and menopausal status may have. The null hypothesis tested in this study was that larger breast sizes would not contribute to explaining negative changes in quality of life, body and breast satisfaction; physical activity levels and breast and bra fit perceptions; or the presence of upper back pain, beyond what can be explained by differences in age, menopausal status or BMI.

Table 1. Measured variables.

Variables	Type of variable	Measure
Predictors		
Breast size		
Breast size score	Continuous	Participant information questionnaire
Participant characteristics		
Age (years)	Continuous	Participant information questionnaire
Body mass index	Continuous	Participant information questionnaire
Menopausal status (premenopausal/postmenopausal)	Categorical	Participant information questionnaire
Outcomes		
Health-related quality of life		
Physical component summary score	Continuous	SF-36
Mental component summary score	Continuous	SF-36
Breast-related psychosocial wellbeing	Continuous	BREAST-Q
Breast-related physical wellbeing	Continuous	BREAST-Q
Satisfaction		
Body satisfaction	Continuous	Numerical rating scale
Breast satisfaction	Continuous	BREAST-Q
Physical activity		
Average physical activity levels	Continuous	Human Activity Profile
Upper back pain		
Upper back pain presence (yes/no)	Categorical	Participant information questionnaire
Breast and bra fit perceptions		
Breast embarrassment (yes/no)	Categorical	Participant information questionnaire
Desire to change breasts (yes/no)	Categorical	Participant information questionnaire
Professional bra fit (yes/no)	Categorical	Participant information questionnaire
Satisfaction with bra fit (yes/no)	Categorical	Participant information questionnaire

SF-36: Medical Outcomes Study Short-Form 36 Health Survey.

Methods

Participants

This was a cross-sectional questionnaire-based study conducted as part of a large project exploring the effects of increasing breast size on mature-aged women (defined as ≥ 40 years). It was approved by the Human Research Ethics Committee at Curtin University (RDHS-267-15).

Participants were recruited via word-of-mouth and radio, newspaper and online advertising. Advertising was designed carefully to attract women of all breast sizes and minimize recruitment bias. Volunteers were excluded if they resided outside Australia; were unable to read and understand English; or were younger than 40 years. Volunteers were also excluded if they had undergone previous breast surgery or if they had a history of thoracic spine surgery, a systemic inflammatory condition, a neurodegenerative disorder or a known pathology of the breast, lung or thoracic spine or cancer involving the bones. Volunteers who had long-term and recent ongoing use of steroid or pain medication were also excluded for the purposes of an unbiased assessment of upper back pain within the larger project.

Procedure

Self-report data were collected using an online survey platform (Qualtrics, version June 2016, Provo, Utah, USA). The survey was made accessible electronically through a specifically designed study website or via an emailed URL link. Hard copies of the survey were available on request and returnable in a postage-paid envelope. The survey had a continuous structure and incorporated specifically designed questions (participant information questionnaire) and standardized questionnaires to assess breast size and the aspects of health and psychological wellbeing listed as outcome variables in Table 1. The survey had an estimated completion time of 20 min and participants indicated informed consent on the questionnaire. The survey flow function on electronic versions of the survey allowed customization of what a participant saw and which questions were asked based on the responses given. Complete answers were encouraged in electronic versions of the survey by imposing a forced response condition on all questions. Any questions left blank by respondents using paper formats of the survey were omitted and defined as a missing value.

Breast size. A breast size score (BSS), derived from participants' self-reported bra size, was used as a measure of breast

size. The BSS is an ordinal value (0–18) determined using numerical bra band sizes and alphabetical cup sizes (see Supplementary Material) which is similar in concept to the sizing system for unilateral breast prostheses⁴¹ and has been used in prior research.^{26,42} The BSS increments follow a numeric pattern, increasing sequentially relative to bra sizes, providing it with face validity. Using Australian bra sizes, a 14C is equivalent to a 12D or 16B; these each have a BSS of 6. A one-cup size increase (e.g. C to D) on the same band size (under bust, e.g. size 12) is equivalent to a 1-point increase in BSS. Alternatively, a one-band size increase (e.g. 12–14) with no change in cup size is also a 1-point increase in BSS. In a subset of 119 participants,⁴² BSSs derived from self-reported bra size data correlated significantly ($r=0.8$, $p<0.001$) with BSSs derived from investigator measured under and over bust circumferences.⁴³

Participant characteristics. Participants' self-reported height and weight were used to calculate BMI (kg/m^2). Women were classified as postmenopausal if they had not menstruated in the past 12 months. Breast changes following menopause (not itemized in Table 1) were recorded in a multiple-choice question (as applicable) and answers were used for descriptive purposes only.

Health-related quality of life. The Medical Outcomes Study Short-Form 36 version 2.0 (SF-36) Health Survey^{44,45} was used as a generic measure of health-related quality of life (HRQoL). This 36-item instrument comprises eight subscales: physical functioning (10 items); social functioning (2 items); role limitations due to physical problems (4 items); role limitations due to emotional problems (3 items); mental health (5 items); energy/vitality (4 items); bodily pain (2 items) and general health perceptions (5 items). A physical component summary score and mental component summary score were calculated according to the developer guidelines.⁴⁵

In addition to this, a breast-specific measure was used to better characterize the impact of breasts on quality of life. The BREAST-Q (version 1.0 Reduction/mastopexy module)⁴⁶ is a patient-reported outcome measure that is used widely in breast-related research and can be administered at a single time-point in a cross-sectional survey to assess the breast-related themes.^{46,47} Physical wellbeing and psychosocial wellbeing are two breast-related quality of life themes measured by BREAST-Q. Breast-related physical wellbeing (14 items) captures the physical problems caused by breast size, including pain; rashes; energy levels; and sleeping problems. Breast-related psychosocial wellbeing (9 items) captures the emotional problems caused by breast size including effects on self-esteem; confidence in social settings; and perceptions of body image. Stand-alone scores between 0 and 100 are generated for each theme, with higher scores indicating greater wellbeing.⁴⁸ The validity and reliability of the BREAST-Q in evaluating these constructs have been previously reported to be good.⁴⁶

Satisfaction. A numerical rating scale (NRS) of body satisfaction was used as simple measure of body satisfaction. The NRS captured a single score between 0 (completely unsatisfied) and 10 (completely satisfied) in response to the question 'How satisfied are you with your body shape?' Similar numerical scales have been used in previous research on self-perceptions of mature women.⁴

Breast satisfaction was another breast-related theme that was measured using BREAST-Q. The breast satisfaction theme uses responses to 11 items that cover aspects of breast appearance clothed and unclothed, to give a score between 0 and 100 (higher scores indicating greater satisfaction) which can be used as a standalone scale.^{46,48}

Physical activity levels. The Human Activity Profile,⁴⁹ a 94-item questionnaire that produces a score to indicate a participant's typical daily activity level (*adjusted activity score (AAS)*), was used to assess physical activity levels. Scores range from 0 to 94 with higher scores indicating higher average levels of activity.

Upper back pain. *Upper back pain* was assessed as present or not within the previous month (yes/no) to examine upper back pain prevalence.⁵⁰ Participants were provided with a body diagram where the upper back had been highlighted as the region above the base of the ribcage and below the neck.

Breast and bra fit perceptions. Closed questions of the participant information questionnaire asked whether participants were embarrassed about their breasts (yes/no); whether they would like to change their breasts (yes/no); whether they had their bra professionally fitted (yes/no); and whether they were satisfied with their bra fit (yes/no).

Data analysis

The sample size of 269 participants, determined for a concurrent study, was adequate to detect an odds ratio (OR) of 1.37 in any of the binary outcome variables (upper breast point (UBP) and breast and bra fit perceptions) and an R^2 of 0.011 in linear regression models fitting five covariates for continuous outcomes (HRQoL, satisfaction, physical activity) at 80% power, $\alpha=0.05$.⁵¹

Associations between continuously measured predictors breast size and other relevant participant characteristics (age, BMI) with continuously measured outcome variables (HRQoL, satisfaction, physical activity) were initially examined using Pearson product-moment correlation coefficients (r).

The relationship between predictors (breast size, age, BMI and menopausal status) with each outcome variable was examined using multivariable linear and logistic regression models for continuous and categorical outcome

Table 2. Summary of participants' outcome data.

Outcome variable (possible score range)		<i>n</i>	Mean (SD)
Health-related quality of life			
Physical component summary score (0–100)		269	47.4 (8.5)
Mental component summary score (0–100)		269	51.1 (8.2)
Breast-related psychosocial wellbeing (0–100)		269	60.8 (20.2)
Breast-related physical wellbeing (0–100)		269	68.2 (14.3)
Satisfaction			
Body satisfaction (0–10)		268 ^a	5.3 (2.4)
Breast satisfaction (0–100)		269	47.6 (17.7)
Physical activity			
Adjusted activity score (0–94)		269	71.5 (13.2)
Upper back pain			
Upper back pain presence	Yes	269	165 (61.0)
	No		104 (39.0)
Breast and bra fit perceptions			
Breast embarrassment	Yes	269	62 (23.0)
	No		207 (77.0)
Desire to change breasts	Yes	269	123 (46.0)
	No		146 (54.0)
Professional bra fit	Yes	267 ^b	179 (67.0)
	No		90 (33.0)
Satisfaction with bra fit	Yes	267 ^b	148 (55.0)
	No		119 (45.0)

SD: standard deviation.

^aOne missing value; ^b Two missing values.

variables, respectively. Results of linear regression models were reported as beta coefficients, corresponding 95% confidence intervals (CIs) and coefficients of determination (R^2) which explain proportion of variance attributable to predictors. Results of logistic regression models were reported as ORs and corresponding 95% CIs.

Model assumptions were checked (linearity, homoscedasticity, normality of residuals and multicollinearity), and sensitivity analyses were conducted, wherein outliers (z -residuals > 2.5) were identified and removed and the resulting model estimates compared against original estimates.

Data were analysed using SPSS version 24 (IBM; Chicago, IL), and statistical significance was set at $p < 0.05$.

Results

Two hundred and sixty-nine women between the ages of 40 and 85 years were recruited for this study. The mean (standard deviation (SD)) age, height, weight and BMI were 58.2 (9.1) years; 162.8 (7.1) cm; 73.3 (15.8) kg and 27.6 (5.6) kg/m², respectively. Bra band sizes ranged from 8 to 26 and bra cup sizes from A to HH. BSSs ranged from 2 to 16. The mean (SD) BSS of 7.7 (2.7) was equivalent to a bra size of 14DD. The majority (75%) of the sample were postmenopausal and of those, half (52%) reported a change in their breasts following menopause. An increase in size (61% of the participants)

and breast sensitivity (31% of participants) together with a change in breast shape (20% of participants) were the most common changes reported. Participants' outcome data are summarized in Table 2.

Correlations were interpreted as weak ($r < 0.3$), moderate ($r = 0.3–0.5$) or strong ($r > 0.5$).⁵² Increasing BSS was strongly correlated with higher BMI ($p < 0.001$) and lower body satisfaction ($p < 0.001$; Table 3). Increasing breast size was moderately correlated with lower breast-related physical wellbeing ($p < 0.001$), lower physical component summary scores ($p < 0.001$), lower levels of breast-related psychosocial wellbeing ($p < 0.001$), lower breast satisfaction ($p < 0.001$) and lower levels of physical activity ($p < 0.001$; Table 3).

In addition, there were strong correlations between the following: physical activity and physical component summary scores ($r = 0.70$); breast-related psychosocial wellbeing and breast satisfaction ($r = 0.68$); and BMI and body satisfaction ($r = -0.58$; Table 3).

Breast size. Increasing BSS was significantly associated with lower breast-related physical wellbeing ($p < 0.001$, $R^2 = 0.043$), lower body satisfaction ($p = 0.002$, $R^2 = 0.024$), lower breast satisfaction ($p < 0.001$, $R^2 = 0.065$) and a higher odds of upper back pain ($p = 0.014$). For each one-size increase in BSS, participants were 13% more likely to report the presence of upper back pain. Increasing BSS was significantly associated with higher odds of breast

Table 3. Correlations between all variables measured on a continuous scale.

	Age	BMI	Physical component summary score	Mental component summary score	Breast-related psychosocial wellbeing	Breast-related physical wellbeing	Body satisfaction	Breast satisfaction	Physical activity (HAP)
Breast size (BSS)	0.099	0.753***	-0.393***	-0.093	-0.320***	-0.420***	-0.534***	-0.446***	-0.392***
Age (years)		0.082	-0.136**	0.182**	0.190**	0.115	0.048	0.110	-0.318***
BMI (kg/m ²)			-0.475***	-0.108	-0.380***	-0.383***	-0.581***	-0.376***	-0.459***
Physical component summary score (SF-36)				0.211***	0.317***	0.566***	0.357***	0.338***	0.702***
Mental component summary score (SF-36)					0.452***	0.394***	0.287***	0.295***	0.196**
Breast-related psychosocial wellbeing (BREAST-Q)						0.555***	0.575***	0.679***	0.238***
Breast-related physical wellbeing (BREAST-Q)							0.426***	0.592***	0.445***
Body satisfaction (NRS)								0.566**	0.275***
Breast satisfaction (BREAST-Q)									0.288***

BSS: breast size score; BMI: body mass index; kg/m²: Kilogram per metre squared; SF-36: Medical Outcomes Study Short-Form-36 Health Survey; NRS: numerical rating scale; HAP: Human Activity Profile.

Correlations were interpreted as weak ($r < 0.3$), moderate ($r = 0.3-0.5$) or strong ($r > 0.5$).⁵⁰

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

embarrassment ($p \leq 0.001$) and a desire to change breasts ($p \leq 0.001$). For each one-size increase in BSS, participants were 49% more likely to be embarrassed by their breasts and 55% more likely to desire a change in their breasts. Participants with larger breasts were more likely to have their bra professionally fitted ($p = 0.002$) but were less likely to be satisfied with their bra fit ($p = 0.010$). For each one-size increase in BSS, participants were 27% more likely to have their bra professionally fitted but 16% less likely to be satisfied with their bra fit (Table 4).

Age. Increasing age was significantly associated with higher mental component summary scores ($p = 0.045$, $R^2 = 0.013$); higher breast-related psychosocial wellbeing ($p = 0.001$, $R^2 = 0.028$); higher breast-related physical wellbeing ($p = 0.027$, $R^2 = 0.010$); higher breast satisfaction ($p = 0.033$, $R^2 = 0.009$) and lower physical activity levels ($p < 0.001$, $R^2 = 0.043$). Increasing age was significantly associated with lower odds of upper back pain ($p < 0.001$) and breast embarrassment ($p = 0.031$). For each 1-year increment in age, participants were 5% less likely to report upper back pain and breast embarrassment (Table 4).

BMI. Increasing BMI was significantly associated with lower physical component summary scores ($p < 0.001$, $R^2 = 0.214$); lower breast-related psychosocial wellbeing ($p < 0.001$, $R^2 = 0.157$); lower body satisfaction ($p < 0.001$, $R^2 = 0.344$); and lower physical activity levels ($p < 0.001$, $R^2 = 0.188$). Participants with a higher BMI were less likely to have their bra professionally fitted ($p = 0.014$; Table 4).

Menopausal status. Menopausal status was not significantly associated with any of the outcome variables (Table 4).

Discussion

The findings of this study have confirmed that, in healthy mature-aged women, increasing breast size is negatively associated with a number of variables which may relate more broadly to their health and psychological wellbeing. Our results indicate that larger breast sizes are associated with small but important negative changes in breast-related physical wellbeing and lower ratings of body and breast satisfaction. In addition, our findings show that mature-aged women with larger breasts are significantly more embarrassed by the size of their breasts, are expressing a desire to change their breast size and are significantly less satisfied with their bra fit. This indicates, for the first time, that in mature-aged women, who are not seeking breast reduction, increasing breast size is negatively associated with aspects of psychological wellbeing. Our study also confirms the potential for increased breast size to affect physical health by showing that women with larger breast sizes are more likely to experience upper back pain, and this supports previous research examining mature-age women.^{26,42} Ascertaining that breast size has a significant role in explaining negative changes in at least some of the aspects of health and psychological wellbeing that we have examined, allows us to partially reject our null hypothesis.

The quality of life of women with large breasts undergoing reduction mammoplasty has been well researched.^{16,17,21,23,53-55} In women other than those with very large or hypertrophic breasts seeking reduction mammoplasty, there has been no direct examination of quality of life against differences in breast size. Our findings show that mature-aged women with larger breasts have significantly lower quality of life measured by both generic and breast-related measures. The correlations generated in our

Table 4. Relationships between predictors and outcomes: summary of multivariable regression models.

Outcome variable	n	Model components (linear regression)				Menopausal status		Total model summary	
		Breast size	Age	BMI	Menopausal status	R ²	p value		
Health-related quality of life									
Physical component summary score (SF-36)	269	-0.22 (-0.73 to 0.29)	-0.01 (-0.15 to 0.12)	-0.63 (-0.87 to -0.39)***	-2.36 (-5.16 to 0.44)	0.25 ^c	<0.001		
Mental component summary score (SF-36)	269	-0.13 (-0.69 to 0.42)	0.15 (0.00 to 0.29)*	-0.14 (-0.40 to 0.13)	0.88 (-0.22 to 3.91)	0.05 ^c	0.008		
Breast-related psychosocial wellbeing (BREAST-Q)	269	-0.73 (-1.97 to 0.52)	0.56 (0.23 to 0.88)**	-1.17 (-1.77 to -0.58)***	-1.64 (-8.48 to 5.19)	0.20	<0.001		
Breast-related physical wellbeing (BREAST-Q)	269	-1.70 (-2.57 to -0.82)**	0.26 (0.03 to 0.49)*	-0.41 (-0.83 to 0.02)	-0.26 (-5.08 to 4.56)	0.21 ^c	<0.001		
Satisfaction									
Body satisfaction (NRS)	268 ^a	-0.21 (-0.34 to -0.08)**	0.02 (-0.01 to 0.05)	-0.18 (-0.24 to -0.12)***	0.18 (-0.53 to 0.90)	0.37 ^c	<0.001		
Breast satisfaction (BREAST-Q)	269	-2.56 (-3.63 to -1.50)***	0.31 (0.03 to 0.58)*	-0.30 (-0.82 to 0.21)	0.01 (-5.88 to 5.90)	0.23 ^c	<0.001		
Physical activity									
Physical activity (HAP)	269	-0.40 (-1.16 to 0.37)	-0.37 (-0.57 to -0.17)***	-0.89 (-1.26 to -0.52)***	-1.29 (-5.51 to 2.92)	0.29 ^c	<0.001		
Upper back pain									
Upper back pain presence (yes/no)	269	1.13 (1.02 to 1.25)*	0.95 (0.92 to 0.98)***	1.03 (0.96 to 1.10)	1.20 (0.96 to 1.10)	0.09	<0.001		
Breast and bra fit perceptions									
Breast embarrassment (yes/no)	269	1.49 (1.31 to 1.70)***	0.95 (0.91 to 0.98)*	1.02 (0.94 to 1.10)	0.93 (0.35 to 2.42)	0.25	<0.001		
Desire to change breasts (yes/no)	269	1.55 (1.37 to 1.75)***	0.96 (0.93 to 1.01)	0.97 (0.90 to 1.04)	1.21 (0.51 to 2.87)	0.30	<0.001		
Professional bra fit (yes/no)	267 ^b	1.27 (1.09 to 1.48)**	0.98 (0.95 to 1.02)	0.91 (0.85 to 0.98)*	0.77 (0.34 to 1.73)	0.05	0.006		
Satisfaction with bra fit (yes/no)	267 ^b	0.84 (0.76 to 0.92)***	1.01 (0.97 to 1.05)	1.01 (0.94 to 1.08)	1.47 (0.67 to 3.22) [^]	0.07	<0.001		

B: beta coefficient; BMI: body mass index; SF-36: Medical Outcomes Study Short-Form 36 Health Survey; NRS: numerical rating scale; HAP: Human Activity Profile; CI: confidence interval.

^aOne missing value; ^bTwo missing values; ^cSensitivity analysis completed and model unchanged by removing outlier(s).

*p < 0.05; **p < 0.01; and ***p < 0.001.

study confirm the notion of an inverse relationship between breast size and quality of life. However, we also acknowledge that for some aspects of quality of life, particularly those captured by generic measures, such as the SF-36, that differences in BMI, and to a lesser extent age, explain more than breast size and therefore look to be more important. The significant roles that advancing age and a higher BMI have in determining the HRQoL of mature-aged and older populations have been previously documented.^{56,57} In agreement with these reports, our findings confirm that higher BMI, in particular, accounts for a considerable proportion of why mature-aged women perceive their physical health more negatively. In addition, although age and BMI have been identified as significant predictors in their own right, they are also clearly confounders for a range of HRQoL variables. As such age and BMI are important considerations for future work where the role of breast size on HRQoL is being examined.

The role of breast size was prominent in determining breast-related physical wellbeing. In contrast to the SF-36, this measure captures the specific physical problems caused by breast size, including pain, rashes, energy levels and sleeping problems.⁴⁸ Within our sample, breast size had a negative relationship with physical wellbeing which was slightly offset by the positive effects of age. This suggests that the burden of larger breasts is potentially problematic for the physical wellbeing of mature-aged women and that this may be in quite specific ways.

Prior qualitative research involving mature women has clearly stated that the breast changes occurring with age contribute to overall perceptions of body satisfaction.⁴ Our findings add to this by confirming more specifically that increasing breast size is a significant contributor to lower ratings of body satisfaction in mature-aged women. In doing so, we speculate that there could be negative physical and psychological outcomes linked to this such as, the avoidance of physical activity,¹¹ anxiety,⁵⁸ depression,⁵⁹ and low self-esteem.⁶⁰

It was expected that BMI would also be important in determining levels of body satisfaction in the participants of our study since prior qualitative work has reported the dominant role that body weight has in perceptions of body image in women of mature age.^{11,61} Our findings confirm that increasing BMI is clearly related to lower body satisfaction, and the role of BMI in explaining variance in body satisfaction is substantial (34% of total variance). Of note, however, we have been able to distinguish that breast size is equally as important as BMI in the strength of its relationship with body satisfaction. This is notable because our results are drawn from a relatively simplistic measure of body satisfaction. Since the anthropometric data used in our study were also self-reported, future work may look to confirm the relationships we have identified between breast size and body satisfaction using objective measures of height, weight and breast size and a standardised measure of body satisfaction.

Breast satisfaction has been previously discussed as an important factor contributing to perceptions of attractiveness and body satisfaction in mature-aged women.^{3,4} Beyond this, breast size has not been widely examined as a factor related to breast satisfaction that may affect the health and psychological wellbeing of mature-aged women. This has, however, been previously considered in research involving younger women (mean age 19 years)⁶² and women seeking reduction mammoplasty.⁶³

Our results have confirmed that breast size is clearly related to breast satisfaction in mature-aged women. Breast size had its strongest negative relationship with breast satisfaction. This was only slightly offset by increasing age but not by increasing BMI. The negative linear correlation between breast size and breast satisfaction that we measured confirms what is popularly assumed anecdotally, that women with large breasts are less satisfied with them. This is in contrast to what has been found among younger female populations where women with very small and very large breast sizes report lower breast satisfaction which indicates an inverted-U (Kuznets) curve relationship between breast size and breast satisfaction.⁶²

Because increasing breast size is only one of a number of physical changes affecting breasts that may contribute to breast satisfaction in mature-aged women, we acknowledge that other factors, such as increasing ptosis,³ may also be important. Our findings indicate that there is still a large proportion of the variance in breast satisfaction that remains unexplained by our predictors, and future work may examine other breast characteristics, such as ptosis, to explore this further.

Physical activity levels of mature-aged women are an important target for health-related research with the majority of middle-aged women being inadequately active,³³ despite the benefits of being well described.³² We were unable to confirm that breast size is significantly associated with physical activity levels in mature-aged women after accounting for difference in age and BMI. We do, however, highlight that the negative pairwise correlation between breast size and physical activity levels reflects prior findings that women with larger breasts are typically less physically active.³⁰ Our results advance the understanding beyond what has already been described in prior research³⁰ by demonstrating that BMI, relative to breast size, is more important in determining physical activity levels.

Bra fit satisfaction also has relevance to physical activity levels. Our findings illustrate that mature-aged women are less likely to be satisfied with their bra fit as their breast size increases. Since satisfaction with bra fit in mature-aged women is likely to depend on how comfortable and well fitted they perceive their bra to be,⁴ our results suggest that attaining a comfortable well-fitted bra is difficult for the women with larger breast sizes, despite it being more likely that they would have their bra professionally fitted. Exercise-induced breast discomfort as a result of an ill-fitting bra is a widespread problem among women with

large breasts^{34–36} and a primary reason deterring them from participating in physical activity.^{30,31} From the relationships that we have described, the full implications of an ill-fitting bra on the health and psychological wellbeing of mature-aged women warrants further investigation. As a factor that is amenable to change,⁶⁴ improving bra fit could be examined as a strategy to benefit health and psychological wellbeing by improving physical activity levels. The significant relationships identified between physical activity and HRQoL variables that we have reported (Table 3) suggest these benefits could be extensive.

Finally, by showing that women with larger breasts are more likely to experience upper back pain, we provide further evidence that upper back pain is a condition that is distinguishable as a physical health burden related to breast size. This has been previously suggested in prior research involving women who are seeking reduction mammoplasty^{14,25,65} and also among women of varied age in general.^{26,28,29,66} Our results highlight that an increase in breast size, equivalent to a one-cup size increase on the same band, or one-band size increase with the same cup size, leads to a 13% increase in the odds of upper back pain. A relatively small change in breast size, therefore, has the potential to effect health, and this effect remains after taking age into account. Since one in five women reports an increase in their bra size after menopause,⁹ it is possible that upper back pain will be a problem for many mature-aged women. In the absence of prospective work on the topic, we cannot be certain about the scale of the increases in breast size with age nor that these occur independently of increases in body size around the same time.^{8,9,67} Our findings have confirmed that larger breast size alone is sufficient to increase the odds for upper back pain; however, by not examining UBP severity in this study, we cannot be sure how bothersome this could be for mature-aged women. Low back pain deters physical activity participation⁶⁸ and reduces an individual's sense of mental and physical wellbeing.^{69,70} Whether these low back pain findings are transferable to mature-aged women with upper back pain is an avenue for future research.

The results of our study should be considered in the context of its limitations. Our findings were generated from self-report data which are subject to issues of reporting accuracy. Breast sizes were calculated using participants' reported bra size, and it is acknowledged that most women wear an incorrectly fitted and sized bra.^{26,27,38,40} In addition, bra sizes can differ across different brands and styles of bra.⁷¹ These factors may have led to some underestimation or overestimation of actual breast size, but in the absence of more precise self-report measures, bra sizes were chosen as a suitable surrogate for breast size. The conversion of bra sizes into an ordinal BSS, while allowing us to rank participants breast sizes, requires further validation as a method to estimate actual breast size. Despite the limitations of the breast size scoring system, data that we have for a subset of our participants, in whom objective measures of bra size

were taken,⁴² showed that BSSs determined from self-reported bra size were comparable to those scores determined using objective measures of bra size ($r=0.8$, $p < 0.001$). This provided us with some confidence that the self-reported bra sizes of participants in the current study were a reasonable representation of their breast size. Finally, we note the limited ability of cross-sectional data in differentiating cause and effect. Further research is encouraged to confirm the nature and direction of the relationships that have been identified using objective measures of breast size and prospective study design.

In summary, the results of this study suggest that the burden of larger breasts in mature-aged women is subtly reflected in several aspects of health and psychological wellbeing. We have demonstrated that breast size has distinct, albeit small, negative relationships with breast-related physical wellbeing, ratings of body and breast satisfaction, as well as increasing the risk for upper back pain within the study population. Clinicians considering ways to improve the health and wellbeing of mature-aged women should be aware of these relationships.

Declaration of authorship & contributorship

The authors declared criteria for authorship and contributorship have been met.

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Supplemental material

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