

Systematic Review

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A systematic review on embodiment and breast reconstruction: a patient-centered framework for evolving breast outcome measures

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How to cite this article: Chin MG, Eftekari SC, Moura SP, Donnelly DAT, Shaffrey EC, Sears L, Dingle AM. A systematic review on embodiment and breast reconstruction: a patient-centered framework for evolving breast outcome measures. *Plast Aesthet Res* 2023;10:52. <https://dx.doi.org/10.20517/2347-9264.2023.44>

Received: 22 May 2023 **First Decision:** 26 Jul 2023 **Revised:** 8 Aug 2023 **Accepted:** 28 Aug 2023 **Published:** 16 Sep 2023

Academic Editors: Raffaele Rauso, Tine Engberg Damsgaard, Gordon Kwanlyp Lee **Copy Editor:** Dan Zhang **Production Editor:** Dan Zhang

Abstract

Embodiment describes the sense of one's own body, encompassing dimensions of being, having, and using a body. Regarding breast reconstruction, embodiment can be understood as how effectively the reconstructed breast replaces the patient's missing breast. While there has been increasing attention in recent decades on understanding and measuring embodiment in the prosthetic limb, there is limited literature applying embodiment to the context of breast reconstruction. We posit that the literature on prosthetic embodiment can be applied to evolving discussions on breast reconstruction outcomes and patient satisfaction. As breast reconstruction techniques continue to evolve, such as advances in nerve coaptation and reinnervation of the breasts, the concept of embodiment may help broaden the scope of how patient outcomes can be more holistically evaluated. This systematic review examines existing literature on embodiment after breast reconstruction, summarizes embodiment and its subcomponents, and discusses how embodiment can be a helpful framework for the future of breast reconstruction outcome measures.

Keywords: Embodiment, breast reconstruction, prosthetic embodiment



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INTRODUCTION

Advances in postmastectomy breast reconstruction techniques have led to increasingly nuanced methods of assessing reconstructive outcomes^[1-3]. While historically breast cancer surgery centered solely on successful resection of malignancy, rising survival rates of breast cancer patients have led to increased attention to quality of life metrics following breast reconstruction^[4-6]. While alloplastic interventions have been the most common form of reconstruction over the past twenty years, developments in tissue-based, autologous approaches have led to the possibility of a softer, more natural-appearing breast mound and, in turn, improved long-term patient satisfaction^[7-10].

In the context of breast reconstruction, the BREAST-Q is the current gold standard patient-reported outcome measures (PROMs) instrument^[11]. The BREAST-Q measures physical, psychosocial, and sexual well-being, in addition to patient satisfaction with breasts, outcome, and overall care. The BREAST-Q has evolved considerably since its inception in 2004, notably with the recent addition of a sensation module^[12]. However, as breast reconstruction techniques continue to evolve, investigating patient outcomes utilizing research approaches from reconstruction and prosthetic replacement of other areas of the body may be useful. Within the prosthetic limb literature, the advancement of neural interfaces that allow improved control and sensory feedback from prostheses has spurred new outcome measures centered on dimensions of embodiment^[13-15].

Embodiment describes the sense of one's own body, or with respect to prostheses, how effectively the prosthesis replaces a patient's absent or altered body part^[13]. The primary domains of embodiment for prosthetic limbs are motor, sensory, postural, and psychosocial domains. These domains shape a sense of ownership and agency, which facilitate the embodiment of the prosthesis. Regarding breast reconstruction, we suggest that embodiment encapsulates existing quality-of-life measures, including psychosocial well-being, sexual well-being, and sensation, and expands on them to offer a more holistic and personal framework for understanding one's sense of self post-reconstruction.

Given the extensive literature on prosthetic embodiment, we propose its incorporation into discussions on improving and evaluating breast reconstruction outcomes^[13-15]. This systematic review aims to summarize existing literature on breast reconstruction and embodiment, and discuss how embodiment can be a helpful framework for the future of breast reconstruction outcome measures.

METHODS

This literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines^[16]. To review existing literature on breast reconstruction and embodiment, we queried the PubMed/MEDLINE, Web of Science, Embase, and Cochrane databases with relevant search terms, including combinations of “embodiment” and “breast reconstruction,” “breast implant,” or “breast” [Figure 1]. Our search strategy included all articles published in the years 1977 to August 2023. Studies not available in the English language were excluded.

RESULTS AND DISCUSSION

Breast embodiment framework

The literature search on embodiment in the context of breast cancer surgery yielded 320 articles, of which 21 were ultimately included [Figure 1]. The majority of these studies applying “embodiment” to assessments of patients' experiences following breast reconstruction utilized qualitative methodologies, predominantly semi-structured patient interviews [Table 1]. Many of these patient interviews centered on the broad research question of how women experience oncoplastic breast surgery, and then “embodiment” served as a

Table 1. Summary of included articles on breast embodiment

Author (year)	Assessment methods	Domain(s)	Key findings/embodiment definitions
Adams et al. ^[53] (2011)	Literature review 17 qualitative studies included	PSYCH	This review article examined the experiences and concerns of women under the age of 45 diagnosed with breast cancer. Key issues identified included feeling 'out of sync' and fear of recurrence. These articles were analyzed with a framework of altered embodied subjectivity. Beyond visual changes, the participants underscored the <i>feelings of being</i> in an altered body
Cheng et al. ^[20] (2018)	Qualitative 8 semi-structured interviews	PSYCH	This study interviewed women who decided to undergo delayed breast reconstruction. Four embodiment themes were highlighted: losing a sense of self, living with an altered body, reclaiming the body/self, and rebuilding the body/self
Chuang et al. ^[19] (2018)	Qualitative 8 interview participants, 20 transcripts	PSYCH	This study evaluated perceptions of the body from women diagnosed with breast cancer and treated with a mastectomy more than 5 years prior. Main themes from the interviews included abandoning objectification, restoring body image, and redefining the self
Boer et al. ^[40] (2015)	Qualitative 10 women, 26 interviews at different stages of reconstruction	PSYCH + SENS	This study interviewed women prior to undergoing breast reconstruction regarding their expectations of their body post-reconstruction. The women were also interviewed after reconstruction. In the analysis, their expectations were categorized as dealing with their "gazed body," their "capable body," and their "felt body." After reconstruction, these expectations had to be reconfigured and many had to adjust to the unexpected, namely altered feeling of the reconstructed breast
Esplen et al. ^[52] (2020)	Review	PSYCH	This review summarized various body image interventions for women with breast cancer, with a particular focus on online interventions. The authors outlined a construct of "embodied body image" in cancer in which body image is multifaceted and linked to patients' early history, self-identity, and self-worth
Graham et al. ^[60] (2018)	Qualitative 4 semi-structured interviews, 5 online forums, 3 online newspaper articles	PSYCH	This article explored women's decision processes for risk-reducing mastectomy, highlighting social and political factors that shape the process. The analysis highlights how a sense of "embodied selves" is often gendered and culturally shaped by conceptions of womanhood and femininity
Greco ^[59] (2015)	Qualitative 12 interviews, analyses of policy documents of French/EU regulatory agencies, medical literature, and an online forum	PSYCH + SENS	This article examined the 2010 controversy in France regarding the use and eventual recall of silicone breast prostheses. The mixed methods article includes interviews with patients who received these breast implants during post-mastectomy reconstruction. The article analyzed the patients' experiences of both physical and psychological pain utilizing the concept of "embodied risk," insofar as the risks derived from prostheses and implants are literally embodied by patients
Hansen et al. ^[18] (2022)	Qualitative 7 women, 14 interviews	PSYCH	This article assessed women's experiences of oncoplastic breast surgery and how treatment affected body image. Participants discussed how the reconstructed breast restored a sense of normalcy, in particular with maintaining interpersonal relationships. The findings were framed by a theory of embodiment defined by philosopher Merleau-Ponty, insofar as the altered body is an essential part of the subjective being, and time and transition are needed before the altered body is integrated into an individual's embodiment
Holmberg ^[21] (2014)	Qualitative Interviews with 17 first-time breast cancer patients, 4 oncologists, and 10 nurses	PSYCH	This article examined the nature of persistent worry that women may experience after breast cancer treatment, particularly mistrust towards their own bodies. The authors described how cancer diagnoses impact a patient's sense of embodiment, given these diagnoses are often received before a physical sense of illness, therefore leading to an experience of shock. The authors conceive of post-treatment worry as an "embodied sense of risk"
Hopwood et al. ^[17] (2019)	Review	PSYCH	This article offers a novel framework for embodied body image in cancer patients. The approach consists of three dimensions of embodiment: "being a body, having a body, using a body." Applications of the framework were illustrated through three case examples of breast cancer patients
Lende et al. ^[58] (2009)	Qualitative 15 semi-structured interviews	PSYCH	This article examines the decision-making of African-American women regarding breast cancer screening. The article describes an "embodied approach," which highlights the significance of subjective experience and of understanding the body as relational and meaningful
Lindau et al. ^[38] (2020)	Review	SENS + PSYCH	This article describes bionic technologies for the restoration of sensation in the nipple-areolar complex. The authors highlight that mastectomy often leads to numbness of the chest, which can impact sexual well-being and lead to the "disembodiment" of the breasts. The authors discuss their sensor technologies, which can be placed under the skin of the nipple-areolar complex, to detect touches
Loaring et al.	Qualitative	PSYCH	This study focused on couples' experiences of mastectomy with

[42] (2015)	8 semi-structured interviews, with 4 long-term heterosexual couples		reconstruction, and its impact on sexual intimacy and body image. The results highlighted how heteronormative sexual scripts and gendered coping styles may influence couples' intimacy after an experience of 'altered embodiment'. The authors stressed how the altered body involved both <i>personal</i> adjustment, and <i>relational</i> adaptation in the context of these intimate relationships
Parton et al. ^[56] (2016)	Qualitative 16 semi-structured interviews	PSYCH	This study examined how women understand their own bodily experiences and sexuality in the context of cancer, as well as their sexual relationships. A dominant theme was describing the "abject body" after cancer, outside of normality and ideal femininity
Piot-Ziegler et al. ^[41] (2010)	Qualitative 19 women, 3 semi-structured interviews each	PSYCH + SENS+ POST	This study examined the impact of mastectomy on women's identity. Participants discussed how breast reconstruction is often viewed as a potential restoration of altered body integrity and physical symmetry. Many described how grieving the past body and having to accept a new body can lead to an identity crisis. Modified touch and sensation, altered postural balance, and impact on relationships were discussed
Quixadá et al. ^[51] (2022)	mixed methods: -likert questionnaires on pain, self-esteem, fatigue, depression, anxiety, stress, and exercise self-efficacy -posture: vertical spine and vertical head angles 21 women included	POST + PSYCH + SENS	This study evaluated the practicality of measuring posture objectively, and explored the correlation between posture and affect in patients with breast cancer-related postsurgical pain who underwent a 12-week course of Qigong mind-body training. The majority of participants who improved in fatigue and anxiety scales had better vertical head values. Pain severity decreased when vertical spine angle improved
Reid-de Jong ^[55] (2022)	Qualitative 6 women interviewed	PSYCH	This study evaluated the experiences of women who underwent post-mastectomy tattoos. Many women described feelings of being damaged following mastectomy. The tattoos often served as an embodied representation of self, and helped women regain confidence in a symbolically meaningful way
Slatman ^[25] (2014)	Review	PSYCH	This review explored various understandings of embodiment from a patient's perspective, focusing on experiences after breast surgery. The author proposes that an analysis of embodiment requires including both individual-level and social group-, or societal-level
Slatman et al. ^[39] (2016)	Qualitative multiple interviews with 19 female breast cancer patients	PSYCH + SENS	This study addressed how women give meaning to their bodies' scars after breast cancer surgery. Beyond the physical marking of scars, women also highlighted experiences of pain/functional impairment and changes in sensation
Thomas-MacLean ^[54] (2005)	Qualitative 12 women, interviewed twice each	SENS + PSYCH	This study explored women's experiences of bodily changes and subsequent embodiment after breast cancer, utilizing a feminist perspective. Key themes that impacted the altered sense of embodiment included altered or loss of sensation and the management of appearances (e.g., wearing prostheses)
Trachtenberg et al. ^[57] (2022)	Likert questionnaires 4 measures of gender socialization: gender role socialization scale, mental freedom scale, objectified body consciousness scale, and silencing the self scale 2 measures of psychosocial well-being: experience of embodiment scale and functional assessment of cancer therapy-breast 113 women included	PSYCH	This study examined the correlation between gender socialization and psychosocial well-being in young women treated for breast cancer. Women who reported more normative gender socialization were associated with poor well-being scores. Women who described greater resistance towards gender-role expectations and objectification pressures correlated with greater well-being scores. Body shame, body surveillance, and mental freedom were significant predictors of variance within a regression analysis of the Experience of Embodiment Scale scores

PSYCH: Psychosocial; POST: postural; SENS: sensation.

key framework for interpreting their findings.

Embodiment encompasses the dimensions of "being, having, and using a body," and has been measured through sensation, posture, and psychosocial outcomes^[17]. These subcomponents of embodiment can be articulated by patients and evaluated independently; however, they all contribute to an overall sense of being and belonging in one's body. A recurring theme from the literature was that alterations to these dimensions require both personal and relational adaptations. Another over-arching theme was embodiment post-reconstruction requires time and transition. One patient described the breast reconstruction experience,

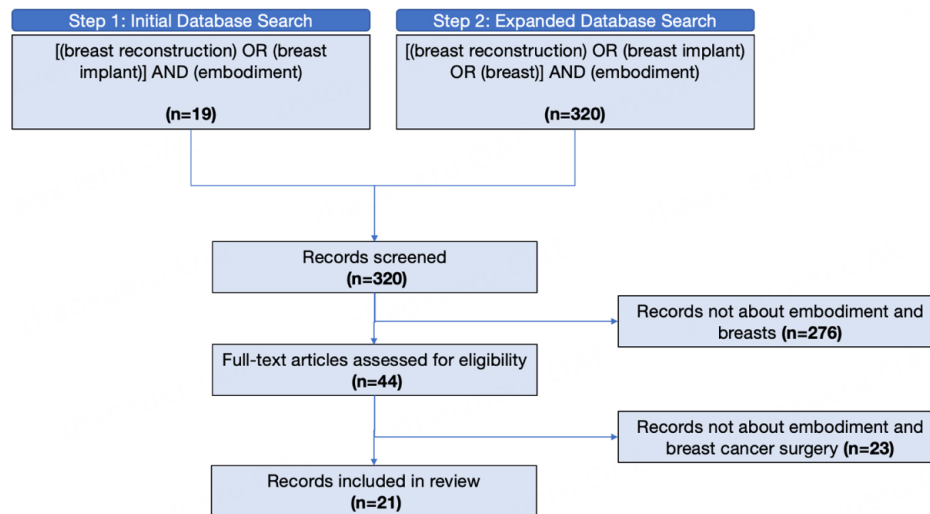


Figure 1. Diagram of the literature review process.

saying, “I think it is comparable to giving birth...the body is a completely different universe until it is healed^[18].” Given that embodiment describes the sense of one’s body, the process of embodiment post-reconstruction is a process of acceptance of a new, altered body. Embodiment post-reconstruction can include a redefinition of self in the context of the altered body and abandoning self-objectification of the body^[19-21]. In patients’ descriptions of seeking and undergoing reconstruction, they linked the physical reconstruction to the process of striving to redefine the self, amongst their cancer diagnoses^[18,20].

These studies offer a starting point for outlining a framework for breast embodiment. However, there is more extensive literature on measurements of prosthetic limb embodiment compared to breast embodiment^[13,14,22]. While breast reconstruction, autologous or implant-based, is not universally described as a “prosthesis”, the prosthetic embodiment framework can be extended to breast reconstruction to describe how effectively the reconstructed breast replaces a patient’s missing breast. There are parallels between these contexts, insofar as alloplastic implants are analogous to prostheses, while autologous breast reconstruction represents a reconstructive approach similar to limb salvage with bone allograft or vascularized composite allotransplantation of the limb. In both contexts, “prosthesis” and reconstructive approaches are intended to restore the normal form and functions of the missing body part. Therefore, we sought to merge the themes from this literature review with established embodiment conceptions outlined in the prosthetics literature to suggest a framework of “breast embodiment”.

PRIMARY DRIVERS OF EMBODIMENT

Within existing frameworks of *prosthetic* embodiment, two primary drivers of embodiment are ownership and agency^[13,14,22]. The proposed outline for understanding *breast* embodiment overlaps considerably with prosthetic embodiment. However, there are a few key distinctions given their anatomic and functional differences. We propose that “ownership” and “body representation” are the two main drivers of breast embodiment, both of which are influenced by three domains of embodiment: sensation, posture, and psychosocial [Figure 2].

Ownership is the sense that an implant or prosthetic belongs to oneself, or is “part of my body” or “part of me^[14,23,24].” Ownership includes explicit and implicit subcomponents. Explicit ownership describes a patient’s conscious sense of the implant/prosthesis as instinctively part of their own body. A decreased sense of

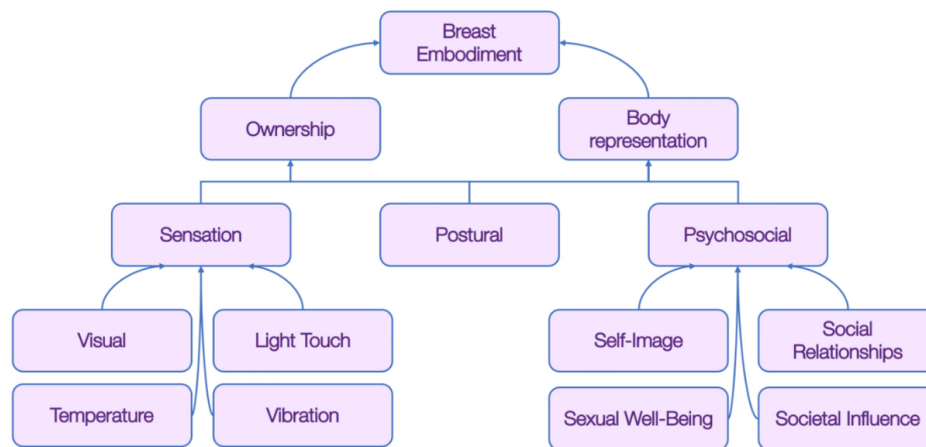


Figure 2. Breast embodiment framework.

ownership, or feeling of estrangement from one's own body post-reconstruction, can lead to decreased embodiment. One patient who underwent breast reconstruction noted, "At least there is something to fill in the bra, so I guess people will never notice that the breast is *not mine*" (emphasis added)^[18]. In contrast, implicit ownership represents a patient's unconscious behaviors towards the implant/prosthesis. In the context of breast prostheses or reconstruction, sometimes forgetfulness of the breast prosthesis can promote a sense of ownership, insofar as if the person is constantly cognizant of the prosthesis, by feeling pain or constantly feeling, these sensations may highlight the foreignness of the prosthesis^[25]. Thus, these subconscious behaviors facilitate a sense of ownership.

While "ownership" applies to both prosthetic and breast embodiment, the driver of "agency" is less pertinent to the context of breast reconstruction. In regards to prosthetic limbs, agency refers to a patient's capacity to start and terminate their actions to control their prosthesis in a deliberate manner^[14], which is outside the scope of breast embodiment given the lack of motor actions as a primary function. Instead of agency, we suggest that body representation is a second key driver of breast embodiment. Previous literature has included body representation as a major component of embodiment, alongside ownership and agency^[13,26,27]. The integration of a reconstructed breast into one's body representation facilitates embodiment, in so far as the foreign object or reconstructed tissue becomes part of the neural structures that guide awareness and perception of the body^[14].

Body representation encompasses the experiences, understandings, and knowledge of the physical structure of one's body^[13,28]. Similar to ownership, there are explicit and implicit subcomponents of body representation. Explicit body representation refers to conscious experiences of the body, which include its shape, size, location, and physical properties. "Body image" is often defined as these explicit experiences of "body representation^[13,28,29]". Whereas implicit body representation is often referred to as "body schema^[29]". Body schema refers to the body's spatial properties, and the subconscious or unconscious mechanisms that direct posture and movement. At this implicit level of body representation, an object becomes embodied if its properties are cognitively processed similar to the properties of biological body parts^[30]. In the context of breast reconstruction, the integration of a reconstructed breast into one's body representation supports the sense of embodiment.

THE THREE EMBODIMENT DOMAINS

The established domains that shape and create the drivers of *prosthetic* embodiment are motor, sensory, postural, and psychosocial^[22]. These domains are integral to *breast* embodiment, with the exception of the motor domain. Embodiment outcome measures typically assess one of these three domains-sensation, posture, or psychosocial. In embodiment research, these domains are the interface for assessing how an intervention can alter a patient's embodiment level, given that these domains act as a gateway to influence the higher drivers of embodiment.

The sensory domain encompasses the visual, tactile, vibratory, and temperature inputs that allow a patient to receive feedback from the implant/prosthesis^[31-33]. The postural domain describes the proprioceptive features of an implant/prosthesis and the positioning a patient develops following reconstruction. The psychosocial domain includes the self-image and social integration of an implant/prosthesis into a patient's life. A key difference in breast embodiment compared to prostheses is the emphasis on sexual well-being within the psychosocial domain. Sexuality is more commonly addressed in breast embodiment, which may be attributed to societal roles in gender identity and breast sensation as it relates to sexual function, which underscores the overlapping nature of the embodiment domains. Thus, the proposed framework of breast embodiment offers a conceptual schema, rather than a rigid outline [Figure 2]. While sensation and motor domains of embodiment are the most prevalent domains discussed within the current literature on limb prosthetics, the psychosocial domain (including sexual function) is underrepresented^[22,34]. Conversely, many breast reconstruction outcomes focus on the psychosocial domain, with more recent increasing attention to the sensation domain given advances in neurotization during breast reconstruction^[35-37]. We identified the relevant domains for each article included in our literature review on embodiment and breast reconstruction [Table 1]. All included articles assessed psychosocial dimensions, while one-third included sensation, and two articles included impacts on posture [Figure 3].

Sensation

The complete or partial desensitization of the chest following mastectomy and breast reconstruction is a common phenomenon and contributing factor to altered embodiment^[38,39]. Altered embodiment refers to the disruption of one's sense of self, or the experience of self-alienation from one's body^[25]. However, expectations for loss of breast sensation after mastectomy may not be clearly set for patients during their course of care, which can lead to distressing outcomes^[38,40]. Sensation was often tied to influencing ownership and, in turn, embodiment. One patient described, "It seems as though [the breast] was not yours, because, first of all, you have no sensations anymore^[41]".

Furthermore, a few articles highlighted the impact of altered sensations on intimate relationships^[38,42]. In response to numbness of the breasts following mastectomy, some women report aversion towards sex or a feeling of frustration or detachment during sexual interactions^[38,42]. Lindau *et al.* proposed leveraging technology utilized in restoring sensation in bionic hands to restore sensation to the nipple-areolar complex^[38]. They posit that providing sensation to the reconstructed breast fosters its embodiment and may reduce post-mastectomy sexual dysfunction^[38]. Additionally, these relational impacts of altered sensation extend beyond intimate partners. In one study, patients discussed the fear of modified touch and sensations before undergoing mastectomy; however, they reported that modification of sensitivity and sensuality was seldom discussed in medical contexts^[41]. This literature on the sense of touch in relational contexts, such as hugging one's child or partner, highlights how sensation is a crucial domain of breast embodiment.

Posture

Postural changes following breast reconstruction also impact embodiment. Particularly for patients

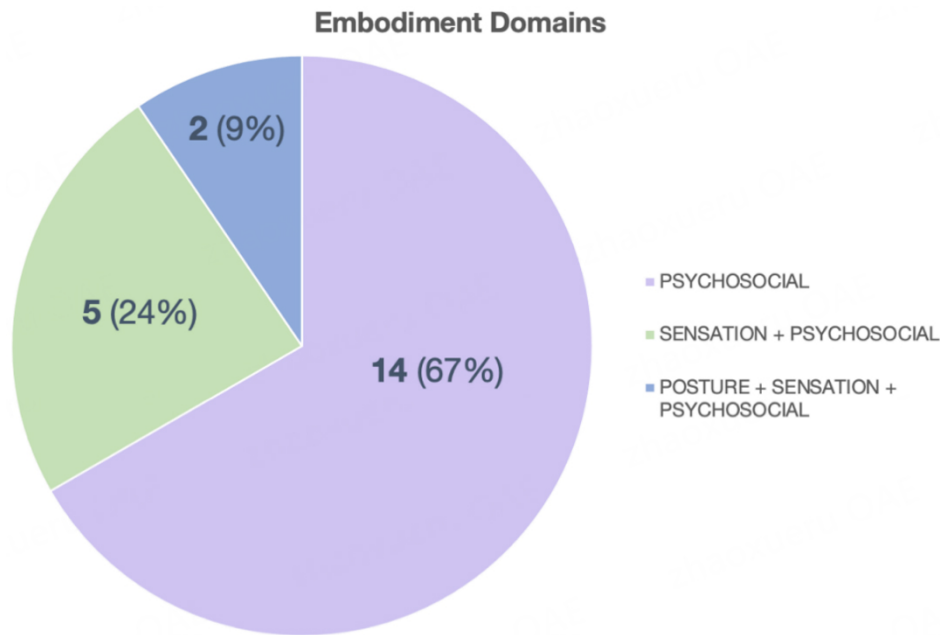


Figure 3. Domain analysis of included articles in embodiment and breast reconstruction literature review.

undergoing unilateral mastectomy, postural control and balance can be altered^[43-46]. In evaluations of mastectomy-induced spinal deformities, several studies have reported on the correlation between immediate breast reconstruction and the prevention of spinal postural changes^[47-49], though delayed breast reconstruction has not demonstrated significant improvement in this regard^[50]. In our review, some women reported postural imbalance following mastectomy, thus highlighting the integral role of immediate reconstruction in attempting to restore postural symmetry^[41]. Quixadá *et al.* objectively measured posture through vertical spine and vertical head angles in a 3D motion capture system and examined the correlation between posture and affect in breast cancer survivors who underwent a therapeutic course of Qigong mind-body training^[51]. Notably, patients who improved in fatigue and anxiety scales had better vertical head values, suggesting a connection between posture and affect within an embodied paradigm^[51]. Overall, the postural domain was the least captured within this embodiment literature review, which suggests future work is needed to assess the influence of measurements of posture on embodiment.

Psychosocial

The psychosocial dimensions of embodiment were the predominant focus of the identified literature on breast embodiment. In addition to the impacts on sexual well-being and social relationships discussed previously, much of the literature raised the effect of breast reconstruction on self-image, which included traditional conceptions of body image, as well as a broader sense of self-identity^[52]. Multiple articles discussed how patients undergoing breast cancer surgery are often left in a state of altered embodiment^[18,25,41,42,53,54]. Beyond the visual anatomical alterations, patients' language around self-conceptualization following mastectomy described insecurities related to sexuality, gender identity, beauty, and femininity^[55-57].

These broader questions around self-identity highlight how psychosocial dimensions of breast embodiment include the patient's experience within a given societal context^[58]. While breast reconstruction is a lived experience from within, the impact of its visual representation on others influences body image and, in turn, embodiment. The breast embodiment literature brings attention to how reconstructive breast surgery is

often driven by the desire for a “normal” feminine appearance^[59].” One patient explicitly described how “the breast and shape do imply a femininity which I have always had,” demonstrating how breasts often serve as a cultural symbol for femininity^[18,25]. Thus, embodiment can often be a matter of societal adaptation to gender norms and/or a negotiation of one’s femininity. Women are often situated between individual and cultural perceptions of what it means to be a woman, which further complicates an individual’s negotiation of their own sense of identity^[60].

While many existing outcome evaluations of breast reconstruction focus on the “natural look” of the breasts or how the breast physically “feels to touch” relative to preoperatively, the qualitative results from our literature analysis highlight the patient’s *feeling* of how the implant/prosthesis “fills a void in her chest^[25].” From this perspective, the implant/prosthesis not only restores an empty space but also provides psychological comfort in the face of this recent loss^[25]. Beyond the outward appearance of the breasts, embodiment examines the deeper, inner function of the breast implant/prosthesis as filling a void and fitting into one’s body representation.

This literature review offers insight into how “embodiment” allows for a more capacious understanding of patients’ subjective experience of their bodies following reconstruction. These studies and this proposed framework of breast embodiment provide a foundation for incorporating embodiment into existing evaluations of patients’ quality of life post-reconstruction.

INCORPORATING EMBODIMENT INTO PATIENT-REPORTED OUTCOME MEASURES

The embodiment framework extends the scope beyond current breast reconstruction outcome measures while still centering patients’ experiences and perspectives. In designing and implementing outcome evaluations for breast reconstruction, capturing the first-person perception of the embodied experience is critical to understanding reconstructive goals and the patient’s experience postoperatively. Traditionally, evidence-based medical sciences have given primacy to quantitative data, which, in the case of subjective matters, has given rise to a variety of “quality of life” scales^[25]. These quantitative tools are valuable for the collection of large data samples to offer generalizable outcomes.

Within the field of breast reconstruction, the BREAST-Q is the gold standard patient-reported outcome measurement instrument^[11,61]. The BREAST-Q measures three quality of life domains (physical, sexual, and psychosocial well-being) and three satisfaction domains (satisfaction with breasts, outcome, and care)^[11]. The BREAST-Q questionnaire has demonstrated high reliability and has been independently validated^[11,62].

Since its inception in 2004, the BREAST-Q has evolved considerably, with the addition of multiple new modules and scales to address identified gaps^[12,63-65]. When the content validity was recently re-examined to determine relevance and comprehensiveness, additional scales for breast sensation, cancer worry, fatigue, work impact, and upper extremity lymphedema were developed^[66]. These changes reflect the increasing trend in the literature on functional outcomes, in addition to the traditional paradigms in post-mastectomy breast reconstruction focusing on aesthetic outcomes^[38,67].

As breast reconstruction techniques continue to advance, we believe that embodiment offers a helpful framework for formulating additional questions that can capture patients’ values. The developments in breast neurotization have already been paralleled with evolving sensation measures^[12,35,36,67]. Previous focus on breast sensory outcomes focused on symptomatic complications following surgery, such as pain, burning, or tightness. Numbness, or loss of sensation, was largely overlooked in patient-reported outcome scales. In 2021, the BREAST-Q incorporated new sensation modules to evaluate how the loss of sensation in

the breast area has affected the quality of life and to quantify the amount of sensation felt in the breast during certain activities (i.e., when pressing, bumping something, showering, touched sexually, hugging)^[12]. The concept of embodiment can offer additional dimensions to future iterations of outcome evaluations. Newer tools such as the Prosthesis Embodiment Scale may serve as inspiration^[15]. The Prosthesis Embodiment Scale includes thirteen items that correlate with measurements of embodiment, including ownership [“The prosthesis is my (body part)”], belongingness (“The prosthesis belongs to me”), affiliation (“The prosthesis is part of my body”), and completeness (“My body feels complete”). Other items such as integrity, self-observation, posture, touch, and vividness are also relevant to breast reconstruction outcome measures and could serve to enhance existing BREAST-Q metrics.

This literature search was predominantly comprised of qualitative patient interviews. The BREAST-Q and other patient-reported outcome measure tools are also developed through in-depth qualitative interviews before quantitative field testing. We suggest that embodiment may be a helpful concept for widening and diversifying the scope of conversation during such interviews. Furthermore, it is essential to recognize the limitations inherent to questionnaires and other quantitative measurement tools. These tools are often confined to discrete information about aspects of one’s body at a specific moment and, therefore, can be limited in accounting for the diverse multitude of bodily experiences^[25]. There is growing recognition of the role of qualitative research in the field of plastic and reconstructive surgery^[68-70]. Given the complexity of breast embodiment as a conceptual framework, we suspect qualitative data will continue to play an integral role in eliciting these patient perspectives.

Limitations

There were limitations to this review. Since the concept of embodiment has been sparsely discussed within existing surgical literature, this systematic review utilized a wide inclusion criterion, including articles from outside the field of plastic surgery, primarily psychology and qualitative health journals. Given our aim to introduce the concept of breast embodiment more broadly, this review included literature describing patient experiences with multiple forms of breast reconstruction. We did not elucidate differences in embodiment between the different types of mastectomies (i.e., total, skin-sparing, nipple-sparing, *etc.*) and different forms of reconstruction (i.e., autologous, alloplastic). It is likely that there are embodiment differences between autologous and alloplastic reconstruction, and thus future work analyzing breast embodiment and measurements of its domains within these two different contexts is warranted.

While we mainly focused on breast embodiment in the context of reconstructive surgery, it is worth noting that using an external breast prosthesis, or artificial breast form, remains an option in the United States and worldwide. Future literature review on the embodiment of an external breast prosthesis could also contribute to the overall discussion on breast embodiment.

Lastly, given that the embodiment framework seeks to give space to an individual’s subjective experience, it also opens space for alternative choices and narratives for patients who opt out of the decision to have reconstruction or utilize prostheses. The Going Flat movement has brought attention to the option of mastectomy alone, and outcomes on patient satisfaction have increasingly been explored^[71]. Evaluating embodiment following mastectomy in this patient population warrants further investigation.

CONCLUSION

As advances in breast reconstruction progress, the goals of reconstruction may extend beyond anatomic similarity and restoring sensation; these advances may also further patients’ goals of having an increased sense of being one’s own breast. This review explored how the concept of embodiment can be understood

and applied to patients undergoing breast reconstruction. While qualitative studies have examined embodiment following mastectomy and breast reconstruction, further research is needed to measure the dimensions of breast embodiment, including ownership, body representation, sensation, posture, and psychosocial outcomes. Studies in the prosthetics literature may serve as a guide for applying these measures to breast reconstruction outcomes. The breast embodiment framework builds upon existing patient-reported outcome measures and expands the plastic surgeon's tools for evaluating patients' experiences following reconstruction. Beyond post-mastectomy reconstruction, the embodiment framework may also be useful in outcome evaluations of other reconstructive surgeries, such as gender-affirming surgery.

DECLARATIONS

Author's contributions

Concept and design: Dingle AM, Chin MG, Eftekari SC, Moura SP, Donnelly DAT, Shaffrey EC, Sears L

Literature review and analysis of data: Chin MG

Drafting of the manuscript: Chin MG

Critical revision of the manuscript for important intellectual content: Chin MG, Eftekari SC, Moura SP, Donnelly DAT, Shaffrey EC, Sears L, Dingle AM

Availability of data and materials

Not applicable.

Financial support and sponsorship

None.

Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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