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Sexual attitudes and body dissatisfaction among Chinese women with disabilities: The mediating role of body esteem and sexual esteem

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Abstract

Body dissatisfaction is prevalent among women with disabilities and exerts impacts on reproductive health, with sexual attitudes considered an influential factor. Based on social comparison theory and self-objectification theory, a survey was conducted with a valid sample of 406 adult women with disabilities in China. Data were collected using the BSAS, NPSS, PDSBE. A parallel mediation model of body esteem and sexual esteem between sexual attitudes and body dissatisfaction was constructed. Path relationships were tested and the results indicated that: (1) sexual attitudes exhibit a significant negative impact on body dissatisfaction. (2) body esteem and sexual esteem play parallel mediating roles between sexual attitudes and body dissatisfaction. (3) the mediating effect of body esteem is greater than that of sexual esteem. It is recommended that sexual attitudes, body dissatisfaction, sexual esteem and body esteem should be taken into consideration when intervening in reproductive health of women with disabilities. (*Afr J Reprod Health* 2025; 29 [11]: 29-46).

Keywords: sexual attitudes; body dissatisfaction; body esteem; sexual esteem; women with disabilities

Résumé

La insatisfacción corporal es frecuente entre las mujeres con discapacidad y tiene repercusiones en su salud reproductiva, siendo las actitudes sexuales un factor influyente. Basándose en la teoría de la comparación social y la teoría de la autoobjetivación, se realizó una encuesta con una muestra válida de 406 mujeres adultas con discapacidad en China. Los datos se recogieron mediante las escalas BSAS, NPSS y PDSBE. Un modelo de mediación paralelo de l'estime de soi corporelle et de l'estime de soi sexuelle entre les attitudes sexuelles et la dissatisfaction corporelle a été construit. Les relations de chemin ont été testées et les résultats ont indiqué que : (1) las actitudes sexuales tienen un efecto negativo significativo sobre la insatisfacción corporal; (2) la autoestima corporal y la autoestima sexual median de forma paralela la relación entre actitudes sexuales e insatisfacción corporal; (3) el efecto mediador de la autoestima corporal es mayor que el de la autoestima sexual. Il est recommandé de prendre en compte les attitudes sexuelles, la dissatisfaction corporelle, l'estime de soi sexuelle et l'estime de soi corporelle lors de l'évaluation de la santé reproductive des femmes handicapées. (*Afr J Reprod Health* 2025; 29 [11]: 29-46).

Mots-clés : actitudes sexuales; insatisfacción corporal; autoestima corporal; autoestima sexual; mujeres con discapacidad

Introduction

With the global transformation of the medical model of disability perception to the social model, the mainstream culture's definition of disability has shifted from individual pathology to social structural barriers. Conventional mainstream culture characterizes physical and mental disabilities as defects or deficiencies that require remediation to align with normative standards. Gradually, disability is considered to be engendered from social and physical structures, discourses, and relationships

that make it challenging to exist in the world whilst inhabiting a body configured as different.¹

Against this backdrop, urgent attention needs to be given to the sexual and reproductive health rights of 44.7 million women among China's 85 million disabled population. Despite they share the same human need for affectionate and intimate relationships as most other people,² however, as a vulnerable population, on the one hand, women with disabilities experience a lack of social recognition, while discrimination and exclusion are the main barriers that prevent them from fully enjoying their

sexual rights.³ For instance, society is replete with stereotypes such as "the union of two disabled individuals is detrimental to the reproduction and education of their offspring" and "disabled individuals have no sexual desires and do not need to reproduce." On the other hand, women with disabilities encounter more intricate sexual roles due to adverse body image and functional disparities, which culminate in elevated health risks when compared to the general female population, even with heightened prevalence of sexual violence, assault, and exploitation. Collectively, these existing issues can be attributed to the combined effects of internal factors (e.g., individual constructs of knowledge, psychology, and attitudes), and external factors (e.g., stigmatization, gender roles, economics, and education).⁴ The sexual and reproductive health of women with disabilities has long been marginalized, yet this issue remains insufficiently researched.

Existing research on the reproductive and sexual health of persons with disabilities predominantly focuses on exploring the impact of disability on the performance and well-being in areas related to reproductive and sexual health, primarily concentrating on two aspects: One is reporting on the equity and rights of individuals with disabilities regarding reproductive health;⁵ the other is providing and disseminating reproductive health knowledge and services to them.⁶ There is relatively limited attention paid to other aspects that may potentially have an impact. However, existing research has confirmed the association between sexual attitudes and body image with reproductive health and sexual health. As Nemčić emphasized the importance of assessing sexual attitudes as a factor related to the sexual and reproductive health of young women.⁷ Similarly, body image is relevant to sexual health, and the ways in which women perceive their bodies can significantly impact sexual health outcomes.⁸ It can be seen from these that there is a research gap in the studies on the reproductive and sexual health of people with disabilities, focusing on the aspects of body image and sexual attitudes, which needs to be further addressed. Among them, body image concerns can impede sexual functioning and satisfaction,⁹ the relationship between sexual attitude and body image is worthy of further exploration.

More crucially, the interaction between the two may influence women with disabilities through body esteem and sexual esteem. Recent studies on sexual esteem have predominantly explored the causal relationship between female sexual esteem and eating disorders.¹⁰ Some have also addressed the unique experiences of sexual violence and stigmatization faced by women with disabilities.¹¹⁻¹² Current research on body esteem primarily focuses on its role as a variable influencing various domains of disability, such as clinical medicine,¹³ behavioral science,¹⁴ public health,¹⁵ and psychology.¹⁶ Within this paradigm, individuals with disabilities' subjective evaluations and judgments regarding sexuality and their bodies constitute a critical psychological mechanism in sexual and reproductive health research. Consequently, the mediating roles of body esteem and sexual esteem in the relationship between disability-related body image and sexual attitudes require further empirical verification.

Compared with international research, indigenous studies in China have explored the challenges faced by rural women with disabilities in marriage and childbearing. Additionally, some studies have examined the relationship between body image (disability type, disability severity), self-esteem, and life satisfaction among people with disabilities. In summary, conducting in-depth research in the field of reproductive and sexual health among people with disabilities requires establishing the correlation between sexual attitudes and body image, as well as identifying the mechanisms of body esteem and sexual esteem.

To address this critical issue, this study introduces social comparison theory and self-objectification theory to explain the internalization of social aesthetic standards and clarify how external stigmatization drives body monitoring, with disabled women in China as the research subjects. It collected data on sexual attitudes, body satisfaction, sexual esteem, and body esteem with the aim of revealing the following questions: How do sexual attitudes of disabled women influence body image? What influences may body esteem and sexual esteem exert in this process?

This study makes the following theoretical contributions: First, it enriches the theoretical framework on body image, and offers a novel

perspective by focusing on the sexual and reproductive health among disabled women through the lens of body image. Second, it expands the applicability of objectification theory and social comparison theory to the population of disabled women. Third, sexual attitudes were identified as a key antecedent of body dissatisfaction among women with disabilities. Fourth, the introduction of body esteem and sexual esteem as parallel mediators broadens the theoretical discourse on the role of individual cognition in enhancing body satisfaction.

Theoretical analysis and hypothesis

Sexual attitudes and body dissatisfaction

Body dissatisfaction is a sub-field of body image research, also known as body image disturbance, referring to an individual's negative, subjective evaluation of their own body, as well as the discrepancy between their perceived body and their ideal body.¹⁷ Previous research on it has mainly focused on two aspects: one is the mechanisms of formation, which primarily explored how body image is continuously formed and reformed through the constitutive interchange of sensory, psychological, and social-relational factors;¹⁸ the other is the gender differences, where body image issues among girls and women largely center around weight concerns while boys and men may be more concerned with muscularity.¹⁹ For example, a low waist-to-hip ratio signals reproductive viability among women.²⁰

Social comparison theory posits that the process of social comparison is an important component of body image interference.²¹ It is an innate process whereby individuals gather information regarding certain features or attributes. Specifically, disabled women are rarely portrayed in the media as objects of beauty and sensuality, and often be excluded from mainstream definitions of “sexiness” due to physical differences (such as limb loss or mobility impairments), yet they still live in a society that values able-bodied bodies as the aesthetic standard. This will lead to the perception of a lack of “sexual attractiveness and charm” when compared with non-disabled women, thereby exacerbating body dissatisfaction. Similarly, self-objectification theory suggests that

sexual objectification is a specific form of self-objectification. In interpersonal encounters, women are gazed at more than men. As Karen Horney noted, “the socially sanctioned right of all males to sexualize all females, regardless of age or status.”²² The internalization of society’s external observer perspective compels individuals to perceive their own bodies as objects of sexualized evaluation, precipitating a progressive dissolution of corporeal subjectivity. This sociocognitive process perpetuates chronic body surveillance and severe disruption of phenomenological flow, generating patterned subjective experiences (e.g., hypervigilance toward perceived bodily “flaws”) that systematically culminate in body shame and dissatisfaction.²³ As such, women's thoughts and feelings regarding sexuality are closely associated with their body image. Therefore, for women with disabilities, sexuality-related issues may critically contribute to body dissatisfaction through the dual mechanisms of social comparison process and self-objectification dynamics.

Additionally, sexual attitudes and sexual behaviors are often linked and multidimensional.²⁴ Sexual attitudes serve as value indicators for individuals' evaluations of sexual-related issues which do not emerge solely as personal or individual constructs but evolve from interactions with others within a specific sociocultural environment²⁵ As highlighted in existing literature that judgments pertaining to sexuality can often serve as a mirror, reflecting the cultural norms and values of a specific country or region.²⁶Error! Reference source not found. Divergent from Western hegemonic norms, Chinese sociocultural attitudes toward sexuality remain markedly regulated, specific dimensions ranging from accuracy of sexual knowledge to sexual experience, and sex guilt may be one mechanism impacting their sexual desire.²⁷Error! Reference source not found.

From this, it can be inferred that in the process of developing intimate relationships, disabled women typically assume the sexual role of giving rather than taking, with their focus lies on attracting and satisfying sexual partners while responding to male sexual demands. This dynamic often results in the neglect of their own bodily sensations and physiological functions. Concurrently, physical disabilities and appearance-

related pressures become amplified, ultimately leading to heightened levels of body dissatisfaction. Based on this, the present study proposes Hypothesis 1: Disabled women's sexual attitudes significantly and negatively predict body dissatisfaction.

Sexual attitudes and body esteem and sexual esteem

While few empirical studies have directly investigated the relationship between sexual attitudes and self-esteem, indirect evidence suggests a potentially significant association close between the two. For instance, higher body esteem has been demonstrated to be significantly positively related to sexual desire.²⁸ Body esteem refers to the overall positive or negative evaluation of the body, moreover, it is related to self-perceived attractiveness.²⁹Error! Reference source not found. Women's physical attractiveness indirectly signals reproductive value, and so evaluating women's physical attributes has become an important criterion in men's mate selection.

Within the conceptual framework of traditional Chinese culture, sexuality, marriage, and procreation are intrinsically interconnected and often conflated into a tripartite construct, a phenomenon deeply embedded with critical notion of *mianzi* (social face) as both a regulatory mechanism and cultural performative practice.³ To minimize the opportunity of losing one's face, one of the common strategies is to behave according to the social norm.²⁵ While from the social comparison theoretical lens, the possession of an able-bodied physique constitutes a foundational element in constructing mainstream standards of bodily attractiveness and aesthetic desirability with mate selection and marital fertility contexts. This imperative systematically marginalizes women with disabilities beyond the boundaries of social-cultural recognition and normative frameworks, culminating in the internalization of negative sexual self-perceptions and diminished body esteem. Empirical investigations have substantiated that women with spinal cord injuries frequently develop heightened body estrangement through sexual avoidance behaviors, culminating in clinically significant reductions in body esteem.³⁰

This analysis demonstrates that the sexual attitudes of women with disabilities are correlated with their body esteem, shaped by sociocultural norms and

social comparison processes. Based on this, the present study proposes Hypothesis 2(a): The sexual attitudes of women with disabilities have been shown to have a significant and positive influence on body esteem.

Sexual esteem has been defined as positive regard for and confidence in an individual's capacity to experience his or her sexuality in a satisfying and enjoyable way.³¹ The sexual attitudes of women with disabilities are structurally shaped by mechanisms of sexual objectification, wherein their sexual esteem is systematically eroded through the dual processes of stigmatization and categorical labeling. In a general way, sexual objectification tends to socialize women to view and value themselves based on how their bodies look to men, and can manifest in various forms, ranging from sexual evaluations to sexual violence. On this basis, for women with disabilities, on the one hand, they are stigmatized through the perpetuation of dehumanizing narratives that frame them as "sexually incompetent", "presumed asexual", "devoid of sexual agency", and "biologically obligated to refrain from reproduction to prevent hereditary defect transmission". On the other hand, they are frequently subjected to labeling as "perpetual care-recipients" and "deficient in sexual allure". This phenomenon aligns with the aforementioned standpoint of "*mianzi*". As evidenced by a representative survey that non-disabled men unconsciously resist choosing women with disabilities as potential partners or romantic interests when seeking a spouse or entering an intimate relationship.³

All above often lead disabled women to internalize these societal perceptions as negative, avoidant sexual attitudes, which eventually form internal views of self-worth and significantly impact their sexual esteem. This consistent with previous research findings. Taleporos, G. found that disabled women, due to internalizing societal stigma, exhibit negative sexual attitudes and significantly lower sexual esteem compared to non-disabled groups;¹⁶ Esmail's research indicated that neglecting sexual needs in medical settings exacerbates sexual attitude suppression and harms sexual esteem.³² Therefore, influenced by the process of self-objectification, women with disabilities develop negative sexual attitudes due to insufficient identification with their sexual identity, with sexual shame and cultural taboos further contributing to diminished sexual

esteem. Based on this, the present study proposes Hypothesis 2(b): Sexual attitudes significantly and positively influence sexual esteem among women with disabilities.

The role of body esteem

While sexual attitudes may influence body dissatisfaction, focusing solely on the relationship between the two factors cannot reveal the “how” of this influence. It is essential to comprehensively incorporate factors related to self-perception among individuals with disabilities to thoroughly investigate the underlying mechanisms, and it seems to be related to self-esteem.³³

Previous research has shown that physical attractiveness is often accompanied by social evaluation, which influences body satisfaction by arousing and altering levels of esteem. As Singh argues, men's initial assessments of female physical attractiveness involve visual evaluations of female body shape, with low waist-to-hip ratios being evaluated most favorably.³⁴ Physical attractiveness has been found to correlate more strongly with popularity, dating experience, and marriage opportunities for women than for men.³⁵

In other words, attractiveness functions as a prime currency for women's social and economic success, enabling them to “exchange” their relative attractiveness for favorable treatment in relationships. This also implies that external pressures encouraging women's preoccupation with their own physical appearance are widespread.²² For example, compared to men, obesity has a greater negative impact on women's social mobility. Obese women and those perceived as unattractive are more likely to face discrimination and negative evaluations in the workplace. As such, when individuals engage in social evaluations of their own physical appearance, their self-acceptance of their physical appearance is lower, leading to negative self-identity and low self-esteem, which in turn result in dissatisfaction with body image. Generally speaking, the lower the body esteem, the higher the level of body dissatisfaction. A multitude of experiments have demonstrated that, in social comparison situations, individuals report elevated levels of body dissatisfaction in comparison to neutral or natural states.³⁶ This pertains to the regulation of body-related self-perception within the procedural mechanism. From an intrinsic

mechanistic perspective, the relationship between social comparison and sexual attitudes is actually the manifestation of the relationship between personal motives and social mechanisms in sexual issues. The disparities in the distribution and differentiation of resources among disparate groups exert a significant influence on sexual interactions. However, as a disadvantaged group, disabled women encounter significant barriers in accessing structural social resources (e.g., education, career opportunities, and income growth environments) and individual resources (e.g., personal charm and social interaction frequency), which can hinder the development of positive personal motives (e.g., sexual attitudes).

From a latitude perspective, disabled women must not only compare themselves with able-bodied women on a parallel level, but also engage in upward body image comparisons, i.e., comparisons with individuals considered to better meet ideal standards. The mass media's broad dispersion pervasive of these idealized images of women's bodies has all but universalized them.²⁵ Additionally, Heinberg and Thompson conducted an experiment comparing participants with peers, family members, and celebrities, while assessing the perceived importance of these comparative targets. The results show that for women, not for men, there were significant positive associations among target importance ratings and body dissatisfaction. From an outcome perspective, individuals tend to attribute their short-comings globally to the self in its totality rather than narrowly to their specific actions.²¹ Simultaneously, the outcomes of these comparisons concomitantly engendering feelings of inferiority and loss, diminishing body esteem, and escalating body dissatisfaction.

Thus, within social comparison contexts, personal attitudes exert impact on body esteem via the internalization of social appraisals, subsequently influencing the degree of body dissatisfaction. Based on this, the present study proposes Hypothesis 3: Body esteem mediates the relationship between sexual attitudes and body dissatisfaction among women with disabilities.

The role of sexual esteem

Existing research has empirically established correlational linkages between sexual esteem and

body image, with manifestations observed across both sexual health behaviors and clinical intervention contexts. For instance, findings revealed that sexual esteem played a serial mediating role in the relationship between body image (body appreciation and body image self-consciousness during sexual intimacy) and sexual function.¹⁸ Similarly, individuals who underwent cosmetic surgery reported higher sexual esteem and greater satisfaction with their body image.³⁷ Furthermore, it is imperative to acknowledge that bodies exist within the intricate web of social and cultural contexts, while the construction of bodies is not merely a biological phenomenon but is also shaped by sociocultural practices and discourses. The interactive process between sexual esteem and body image is mediated by appearance-based social comparisons and by appearance-ideal internalization.²⁸ Notably, this dynamic mirrors the interactive mechanisms between body esteem and body image delineated in preceding analyses.

In summary, it can be inferred that in social-interpersonal contexts, individuals with heightened sexual esteem exhibit greater intentionality toward intimate relationship engagement and enhanced relational confidence, which mediates positive embodiment perceptions. Conversely, those with compromised sexual self-worth experience diminished perceived sexual attractiveness and intimacy avoidance, consequently exacerbating body dissatisfaction. Generally speaking, the higher the sexual esteem, the lower the level of body dissatisfaction.

To better elucidate the influence of disabled women's sexual esteem on body imagery in this investigation, a rigorous analysis is warranted regarding the dynamics of their sexual esteem states embedded within the self-objectification paradigm. Cross-cultural investigations of able-bodied cohorts demonstrate a robust inverse correlation between elevated self-objectification tendencies in Western women and compromised self-esteem states.⁵ This perspective receives indirect empirical corroboration from converging evidence in extant literature, investigations have documented that in heterosexual relationships, women are more likely than men to experience sexual dissatisfaction and sexual

dysfunction,³⁸ particularly orgasm issues. Building upon this foundation, more rigorous researches targeting disabled populations demonstrate that when applied specifically to physical disability, the social and physical challenges that individuals with disabilities face in their sexual expression have also been related to their sexual esteem.³⁹ Subsequently, sexual esteem encompasses the desire to hide the disability and beliefs that the disability interferes with finding a sexual partner and with sexual expression and enjoyment.²⁵ This demonstrated that sexual esteem in women with disabilities significantly contributes to body image dissatisfaction.

Therefore, sexual attitudes among women with disabilities may mediate body dissatisfaction through sexual esteem. Specifically, individuals with positive sexual schemas may demonstrate reduced body dissatisfaction via heightened sexual self-worth, whereas those holding restrictive sexual scripts potentially experience exacerbated dissatisfaction through diminished sexual esteem. Based on this, the present study proposes Hypothesis 4: Sexual esteem mediates the relationship between sexual attitudes and body dissatisfaction among women with disabilities. Based on the above Hypotheses 1 to 4, the following theoretical model is constructed, as shown in Figure 1.

Methods

Sample and data

The study employed simple random sampling to select 720 eligible women with disabilities from municipal and county-level registries of the China Disabled Persons' Federation. Initial contact was established with 586 participants, yielding 472 consenting respondents. Data collection spanned October 2024 to February 2025 using dual-mode (online/offline) questionnaires refined through iterative pretesting. Of 445 returned surveys, 39 were excluded due to incompleteness, resulting in 91.2% validity rate. Participants were geographically distributed as Liaoning (n=73), Shandong (n=58), Jiangsu (n=116) and Hebei (n=159), all female aged 20-44 years.

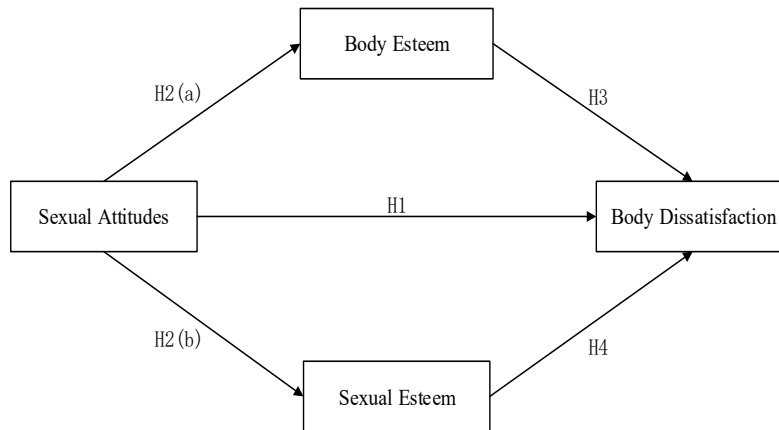


Figure 1: Hypothesized mediated model

To control disability-type effects on body image perception, the sample exclusively included five impairment categories: visual, auditory, speech, physical, and multiple disabilities (≥ 2 concurrent impairments). Disability severity was stratified as mild/moderate/severe per government-issued certification. Demographic characteristics demonstrated sufficient contextual variability for analytical requirements.

Variables and measurements

This study utilized 5-point Likert scales derived from mature scales. While preserving original semantic integrity, item wording was contextually adapted to align with the research framework. To ensure content validity, a dual verification process was implemented: 1) cognitive interviews with disability community members to confirm item comprehensibility, and 2) iterative refinement through expert consultations with research team members

Socio-demographic variables

Personal and socio-demographic data regarding the disabled women's age, types of disabilities and handicapped degree were collected using as hoc questions.

Sexual attitudes

The sexual attitudes of disabled women in China were assessed using the Brief Sexual Attitudes Scale (BSAS). To enhance participants' engagement and

willingness to respond, while ensuring the reliability and validity of the scale, 12 items were removed from the questionnaire. The measurement consists of 11 items divided into four factors: permissiveness; birth control (formerly called sexual practices); communion; and instrumentality. The permissiveness subscale (4 items) measures the proactive and open attitude toward sexual relationships (e.g., "I do not need to be committed to a person to have sex with him/her" or "It is possible to enjoy sex with a person and not like that person very much"). The birth control subscale (3 items), measures the degree of responsibility and responsibility sharing regarding contraception and birth control in sexual behavior (e.g., "Birth control is part of responsible sexuality" or "A woman should share responsibility for birth control"). The communion subscale (4 items) refers to the conceptual construction and value evaluation of sexual behavior in intimate relationships between the sexes (e.g., "Sex is the closest form of communion between two people" or "At its best, sex seems to be the merging of two souls"). The instrumentality subscale (4 items) refers to perceptions of the function and purpose of sex (e.g., "The main purpose of sex is to enjoy oneself" or "Sex is best when you let yourself go and focus on your own pleasure"). Scores range from 1: Strongly disagree; 2: Moderately disagree; 3: Neutral; 4: Moderately agree; 5: Strongly agree. The validity indicators of this scale fit well, $\chi^2/df=1.048$, RMSEA=0.011, TLI=0.998, CFI=0.998, SRMR=0.026. The Cronbach's α coefficient of the scale is 0.871.

Body and sexual esteem

The Physical Disability Sexual and Body Esteem (PDSBE) scale was developed to assess respondents' capacity to feel positive about their sexuality and their body while living with a physical impairment. The measurement consists of 10 items divided into three factors: Sexual Esteem; Attractiveness to Others; and Body Esteem. At this stage, the study does not provide an assessment of the dimension of attractiveness to others. The first subscale, sexual esteem (4 items), refers to the self-identification and value judgments regarding sexual identity among persons with disabilities (e.g., "I feel that my disability interferes with my sexual enjoyment" or "My sexual expression is limited by my disability"). The second subscale, body esteem (3 items), refers to the self-perception and evaluation of body image among people with disabilities (e.g., "I would like to hide my disability as much as possible" or "I envy people with normal bodies"). Scores range from 1: Strongly disagree; 2: Moderately disagree; 3: Neutral; 4: Moderately agree; 5: Strongly agree. This scale employs reverse scoring, with higher scores indicating greater levels of body esteem and sexual esteem. The validity indicators of this scale fit well, $\chi^2/df=1.235$, RMSEA=0.024, TLI=0.996, CFI=0.998, SRMR=0.018. The Cronbach's α coefficient of the scale is 0.857.

Body dissatisfaction

Body dissatisfaction among Chinese disabled women was measured using the Negative Physical Self-Scale (NPSS), developed by Chen Hong et al. (2006). The scale consists of 48 items across five dimensions: overall, appearance, weight, height, and thinness. To enhance research efficiency, this study extracted only three dimensions: "overall," "weight," and "appearance." The "Overall" dimension describes the overall perception and evaluation of one's body image (e.g., "I am proud of my body" or "I like my body very much"), which has been reversed to a negative description. The "Obesity" dimension measures the degree of concern about weight gain and body shape changes (e.g., "People I like think I am fat" or "I am very distressed when I think about my weight"). The "appearance" dimension assesses the level of appreciation and confidence in one's facial features

(e.g., "I am depressed about how my face looks" or "If possible, I will have cosmetic surgery"). Scores range from 1: Strongly disagree; 2: Moderately disagree; 3: Neutral; 4: Moderately agree; 5: Strongly agree. The validity indicators of this scale fit well, $\chi^2/df=1.315$, RMSEA=0.028, TLI=0.993, CFI=0.992, SRMR=0.026. The Cronbach's α coefficient of the scale is 0.860. The operationalized measurement items for each variable, along with their corresponding reliability and validity metrics, are comprehensively detailed in Table 1.

Procedure

This study strictly adhered to the ethical guidelines stipulated in the Helsinki Declaration and has obtained approval from the Ethics Review Board of the Faculty of Humanities and Law at Northeastern University. Data collection was conducted following informed consent procedures involving participants themselves, legal guardians (where applicable), parents, and local community administrators. Psychological examiners received standardized training on the administration and interpretation of assessment instruments. Data acquisition occurred in participants' homes or workplaces during non-working hours, implemented under standardized conditions to ensure consistency in informational context, motivational factors, and time allocation (mean duration: 25 minutes).

Data analysis

The analytical procedure commenced with descriptive statistics (means and standard deviations) of study variables computed using SPSS 26.0. Subsequently, bivariate relationships were examined through Pearson correlation coefficients. Measurement models were evaluated via confirmatory factor analysis (CFA) in Mplus 8.3, with construct validity assessed against established fit indices: χ^2/df ratio <3, CFI >0.90, TLI >0.90, RMSEA <0.08. Upon achieving satisfactory model fit, path analysis was conducted to examine: 1) Direct effects of sexual attitudes on body dissatisfaction 2) Mediating roles of body esteem and sexual self-esteem. Mediation hypotheses were tested using bias-corrected bootstrapping with 5,000 resamples (95% CI). Effects were deemed statistically significant if confidence intervals excluded zero.

Table 1: Variable measurement items and reliability and validity analysis

Scale	Variables	Items	Std.fl
BSA Cronbach's a : 0.871	Permissiveness AVE : 0.545 CR : 0.828 Cronbach's a : 0.827	I do not need to be committed to a person to have sex with him/her	0.735
		It is okay to have ongoing sexual relationships with more than one person at a time	0.745
		Sex as a simple exchange of favors is okay if both people agree to it	0.736
		It is possible to enjoy sex with a person and not like that person very much	0.738
	Birth Control AVE : 0.631 CR : 0.837 Cronbach's a : 0.836	Birth control is part of responsible sexuality	0.802
		A woman should share responsibility for birth control	0.761
		A man should share responsibility for birth control	0.819
	Communion AVE : 0.550 CR : 0.830 Cronbach's a : 0.830	Sex is the closest form of communication between two people	0.728
		A sexual encounter between two people deeply in love is the ultimate human interaction	0.751
		At its best, sex seems to be the merging of two souls	0.737
		Sex is a very important part of life	0.751
		Sex is best when you let yourself go and focus on your own pleasure	0.718
		Sex is primarily the taking of pleasure from another person	0.737
	Instrumentality AVE : 0.531 CR : 0.819 Cronbach's a : 0.819	The main purpose of sex is to enjoy oneself	0.734
Sex is primarily physical		0.726	
I feel that my disability interferes with my sexual enjoyment		0.758	
I feel sexually frustrated because of my disability		0.800	
I feel that my disability is likely to prevent me from satisfying a sexual partner		0.822	
My sexual expression is limited by my disability		0.790	
PDSBE Cronbach's a : 0.857	Sexual Esteem AVE : 0.629 CR : 0.872 Cronbach's a : 0.871	I would like to hide my disability as much as possible	0.788
		I envy people with "normal" bodies	0.763
	Body Esteem AVE : 0.611 CR : 0.824 Cronbach's a : 0.825	I would do a body swap with an able-bodied person if I could	0.794
		I am shame of my body	0.785
NPSS Cronbach's a : 0.860	Overall AVE : 0.583 CR : 0.849 Cronbach's a : 0.848	I do not like my body very much	0.761
		Generally, I am dissatisfied with my body	0.762
		There is something for me to be sorry about regarding my body	0.746
		I am very distressed when I think about my weight	0.719
	Obesity AVE : 0.541 CR : 0.780 Cronbach's a : 0.779	When I weigh myself, I feel depressed	0.745
		People, who I like, think I am fat	0.743
		I am depressed about how my face looks	0.844
	Appearance AVE : 0.683 CR : 0.896 Cronbach's a : 0.896	If possible, I will have cosmetic surgery	0.836
		I am worried about my facial appearance	0.778
		If there is some way I can improve my face, I will keep trying to do it	0.846

Results

Descriptive statistics and correlation analysis

Table 2 presents descriptive statistics (means, standard deviations) and intercorrelations for all study variables. Mean scores were as follows: sexual attitudes ($M=2.589$), sexual self-esteem ($M=2.251$), body esteem ($M=2.205$), and body dissatisfaction ($M=3.025$), with body dissatisfaction demonstrating the highest mean score, followed by sexual attitudes and sexual self-esteem, while body esteem showed the lowest mean. These patterns indicate relatively negative body perceptions and suboptimal sexual attitudes, and low levels of sexual or body esteem among participants. Pearson correlation analyses revealed significant bivariate associations: Sexual attitudes negatively correlated with body dissatisfaction ($r=-0.382$, $p<0.01$). Sexual attitudes positively correlated with sexual self-esteem ($r=0.405$, $p<0.01$) and body esteem ($r=0.357$, $p<0.01$). Sexual self-esteem negatively correlated with body dissatisfaction ($r=-0.357$, $p<0.01$). Body esteem exhibited the strongest inverse association with body dissatisfaction ($r=-0.413$, $p<0.01$). These findings empirically substantiate the theoretical foundation for subsequent mediation hypothesis testing.

Path analysis

Path analysis employing Mplus 8.0 examined the mediating roles of sexual esteem and body esteem in the relationship between sexual attitudes and body dissatisfaction. As presented in Table 3, results demonstrated:

- 1) Significant negative direct effect of sexual attitudes on body dissatisfaction ($\beta=-0.418$, $p<0.001$), supporting Hypothesis 1.
- 2) Positive predictive effects of sexual attitudes on sexual esteem ($\beta=0.570$, $p<0.001$) and body esteem ($\beta=0.506$, $p<0.001$), confirming Hypotheses 2a and 2b.

Upon inclusion of mediators, the direct effect remained significant ($\beta=-0.250$, $p<0.001$), with both sexual self-esteem ($\beta=-0.111$, $p<0.01$) and body esteem ($\beta=-0.208$, $p<0.001$) exerting negative effects on body dissatisfaction, confirming their mediating roles. Notably, after incorporating age (K1), disability type (K2), and disability severity

(K3) as control variables into the model, no significant impact was observed on the core path. The specific manifestations are as follows:

- 1) The predictive effects of the control variables on sexual esteem (β ranged from -0.055 to -0.006 , $p>0.05$) and body esteem (β ranged from -0.043 to 0.010 , $p>0.05$) did not reach a significant level.
- 2) The direct effects of the control variables on the body dissatisfaction (β ranged from -0.041 to 0.014 , $p>0.05$) were also not significant.

This result indicates that age, disability type, and disability severity did not significantly interfere with the core mechanism through which sexual attitude affects body dissatisfaction via body esteem and sexual esteem.

Bootstrap analyses with 5,000 resamples (Table 4, Figure 2) revealed:

- 1) Sexual self-esteem mediation: Indirect effect= -0.063 , 95% CI $[-0.122, -0.019]$
- 2) Body esteem mediation: Indirect effect= -0.105 , 95% CI $[-0.162, -0.062]$

Both bias-corrected confidence intervals excluded zero, providing robust support for Hypotheses 3 and 4. Meanwhile, by comparing the indirect effects of body esteem and sexual esteem, it is concluded that the mediating effect of body esteem is greater than that of sexual esteem.

Discussion

This study integrates self-objectification theory and social comparison theory to examine the impact of body esteem and sexual esteem as critical mental health factors on body image among Chinese women with disabilities. It elucidates the mechanisms through which sexual attitudes influence body dissatisfaction via self-esteem levels.

By investigating the relationships among these four variables, the research addresses the question of how sexual attitudes shape body image perceptions in disabled women. These findings provide theoretical foundations for developing targeted interventions and therapeutic strategies to enhance the physical and psychological well-being of this population.

The study revealed that sexual attitudes in women with disabilities directly and significantly negatively predict body dissatisfaction levels. Specifically, holding open and positive sexual attitudes was found to mitigate body dissatisfaction.

Table 2: Descriptive statistics and correlation analysis table

	M	SD	1	2	3	4	5	6	7
AGE1	3.079	1.286	1						
Disability Type2	2.256	1.303	-0.012	1					
Diability Severity3	1.803	0.829	-0.002	0.070	1				
Sexual Attitudes4	2.589	0.628	-0.012	-0.068	0.042	1			
Sexual Esteem5	2.251	0.885	-0.065	-0.056	-0.025	0.405**	1		
Body Esteem6	2.205	0.896	-0.083	-0.032	0.024	0.357**	0.465**	1	
Body Dissatisfaction7	3.025	0.693	-0.023	0.056	-0.037	-0.382**	-0.357**	-0.413**	1

Note: N=121, *p<0.05, **p<0.01(double-tailed test) the control variables in the table and subsequent analyses are age, disability type, and disability severity

Table 3: Path analysis results

Variables	Body Dissatisfaction		Sexual Esteem		Body Esteem		Body Dissatisfaction	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Control Variable								
K1	-0.015	0.026	-0.041	0.030	-0.055	0.033	-0.031	0.024
K2	0.017	0.023	-0.018	0.029	-0.006	0.031	0.014	0.023
K3	-0.019	0.040	-0.043	0.050	0.010	0.051	-0.022	0.038
Independent Variable								
X	-0.418***	0.065	0.570***	0.078	0.506***	0.083	-0.250***	0.064
Mediating Variable								
M1							-0.111**	0.043
M2							-0.208***	0.043

Note: * p<0.05, ** p<0.01, *** p<0.001

Table 4: Mediation effect test

Mediating variable	Indirect Effect	SE	95% Confidence Interval	
			Lower limit	Upper limit
Sexual Esteem	-0.063	0.026	-0.122	-0.019
Body Esteem	-0.105	0.025	-0.162	-0.062

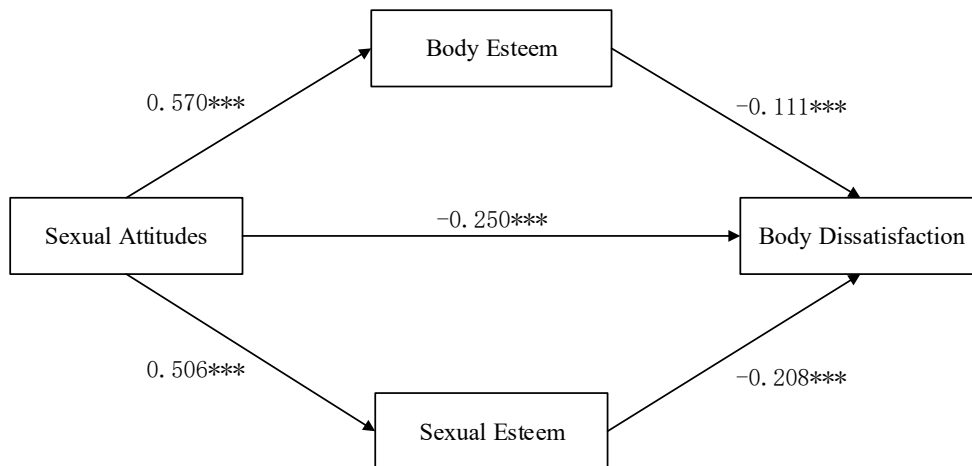


Figure 2: Parallel intermediary model diagram.

These findings suggest that greater acceptance and tolerance of sexual behaviors, coupled with perceiving sexual activity as a source of psychosomatic fulfillment, may enhance functional body appreciation while attenuating preoccupation with physical discrepancies and associated negative affect. This pattern aligns with prior findings observed in non-disabled female cohorts. As indicated by Dilek's findings, an increase in positive attitudes toward sexuality among pregnant women was associated with a decrease in body image dissatisfaction.⁴⁰ Concurrently, studies examining sexual function and satisfaction in general demonstrate a robust correlation with overall well-being and body image.⁴¹ Additionally, among European and American college women, a more positive attitude towards one's body has been associated with greater comfort with their sexual identity.⁴²

From the perspective of physical differences, for women with disabilities, self-evaluations of body satisfaction cannot be separated from the objective defects that may affect physical appearance and function. As demonstrated in previous studies, the physical consequences of the disease, including disability, pain, and difficulty with balance, have the potential to result in a new body image. This new body image, when associated with low self-perception, has been shown to lead to reduced functioning in activities of daily living and a deterioration in quality of life.⁴³

However, the trajectory of life adaptation, whether for congenital or acquired disabilities, is critically mediated by an individual's degree of disability acceptance.³⁹ Lower acceptance levels predict diminished self-esteem, underscoring the necessity of constructing an affirmative disability identity to transform entrenched psychosocial outcomes. This pattern aligns with core tenets of feminist materialist disability theory, which offers a reinterpretation of difference through an affirmative lens, conceptualizing body image as relational and processual.⁴⁴ Furthermore, a materialist perspective on disability posits that disabilities do not originate in the physical body itself, but rather in the dynamic interaction between the body and its world. In a similar vein, difference is fundamental to the world, yet it is not a deficiency or a problem. Rather, it is associated with people's social and physical environments, as well as their actual bodily

changes.⁴⁵ Consequently, subsequent research endeavors may delve deeper into the impact of perceptions toward disability on the body image of individuals with disabilities.

This study found that sexual attitudes in women with disabilities positively influence sexual esteem, with sexual esteem mediating the relationship between sexual attitudes and body dissatisfaction. Aligning with self-objectification theory, the results support its core premise that internalized observer perspectives and objectification pressures compromise women's bodily self-evaluations, amplify body-related shame, and diminish sexual esteem. These findings indicate that self-objectification, as a sociocultural phenomenon, not only shapes negative and passive sexual attitudes through distorted self-perception but also reduces sexual esteem via appearance anxiety, ultimately exacerbating body dissatisfaction. This pattern corroborates prior research demonstrating that women who internalize sexual objectification for male gratification tend to develop detrimental attitudes toward their sexual identity and self-worth.⁴⁶ Furthermore, Weaver and Byers demonstrated that high body dissatisfaction was associated with lower sexual self-esteem across a variety of social and non-social situations.³⁴

This study further indicates that, on one hand, it is essential to shift the direction of self-objectification from other-oriented identification to self-identification. The degree to which women like themselves as sexual beings, value their own sexuality, and accept their sexuality as part of their self-concept is another direct consequence of self-objectification.⁴⁷ On the other hand, this appears to create a new possibility for replacing aesthetic pressures through body functionality appreciation. Specifically, individuals living with physical disabilities may encounter a tendency to focus on their bodies in a negative way. This is due to the fact that such a focus can draw attention to the decreases in organ function that are related to their disability.⁴⁸ The concept of functionality, which is defined as "everything the body is capable of doing," has been incorporated into reviews of positive body image approaches and has been included in measures of positive body image.⁴⁹ Simultaneously, this perspective aligns with feminist materialist disability theory, which conceptualizes the body as dynamic and future-oriented, always in the process

of "becoming." A multitude of studies have previously demonstrated that prioritizing bodily functionality over aesthetic concerns can enhance women's body image. Thus, this concept is extremely beneficial for comprehensively understanding and transforming the body dissatisfaction experienced by women with disabilities. When disabled women focus on their physical functions, they can acquire specialized skills, showcase the capabilities of people with disabilities to the outside world, and transform from "service recipients" to "service providers." The handicrafts handmade by 150 disabled women from China made a stunning appearance at the 2024 Paris Paralympic Games, enabling the whole world to witness the brilliance of disabled women. A French person commented, "With your hands, you are weaving the common courage of humanity." For another real case, in a cable workshop in China, a deaf and mute female employee, unable to judge the equipment status by hearing, independently developed the "vibration perception method". This method involves accurately identifying equipment abnormalities by sensing the differences in the vibration frequencies of the equipment's outer casing. Subsequently, this method has been incorporated into the enterprise's training system for new employees, benefiting a larger number of individuals. Consequently, subsequent research endeavors may delve deeper into the substantial influence of body functionality on the enhancement of body image among women with disabilities.

This study found that sexual attitudes among women with disabilities positively predict body esteem, with body esteem mediating the relationship between sexual attitudes and body dissatisfaction. Viewed through the lens of social comparison theory, these findings can be coherently explained. Social comparison theory posits that appearance ideals and pressures communicated through media, peers, and family contribute to negative body image. Concurrently, heightened comparison levels have been linked to body image disturbances, yet this association is exclusively observed among female subjects.¹⁰ Thus it can be seen that in comparative contexts with the general population, women with disabilities experience dual processes. On one hand, persistent reinforcement of "nonconformity to mainstream sociocultural norms" perpetuates the concealment and suppression of sexual needs and

desires, cultivating negative sexual attitudes. On the other hand, perceived discrepancies between physical characteristics and dominant aesthetic standards systematically reduce body esteem.

The findings of this study are consistent with existing research, individuals with physical disabilities have reported a perception of diminished sexual desirability in comparison to their able-bodied counterparts.⁵⁰ Consequently, societal attitudes regarding dating and sexual activity for individuals with disabilities may result in decreased body and sexual esteem.⁵¹ Notably, certain findings in this investigation diverge from established research outcomes. Suzanne's research examined the mediating role of body self-esteem in interpersonal relationships among people with disabilities, including intimate relationships. The findings indicated that the hypothesized mediating role of body self-esteem was not substantiated in either male or female samples.⁵² The observed discrepancies in research outcomes may stem from variations in conceptual frameworks and cultural contexts across studies.

This study further posits that body esteem levels are influenced by both the direction and content of social comparisons. On one hand, comparative orientations can be shifted from upward comparisons to downward or within-group comparisons. Strategic exposure to positive representations of women with disabilities and other marginalized groups via social media platforms and real-world interpersonal networks may effectively guide perceptions by proactively showcasing bodily aesthetics and life optimism within this population. On the other hand, comparative frameworks should transition from appearance-based evaluations to functionality-focused appraisals. Focusing on functionality offers a positive approach to sex, as most people can find at least one thing about how their body works in the world that they feel good about. Furthermore, the act of reshaping perceptions of disabled bodies as beautiful and sexy has the potential to challenge prevailing notions of ideal beauty and narrow conceptions of femininity.¹⁶ By doing so, individuals with disabilities can develop a higher level of self-acceptance and achieve greater self-esteem. The shifts in the sexual attitudes of the Chinese populace can be attributed to the subconscious influence of traditional Chinese culture and the shaping effects of modernity.

Building upon these findings, future research could investigate how shifts in sociocultural norms and conceptual paradigms may enhance body esteem levels among women with disabilities.

It is worthy of separate mention that the relationships among all the aforementioned variables remain unaffected by the control variables. That is to say, despite the samples encompassing different age groups, disability types, and disability severities, the formation mechanism of body dissatisfaction still exhibits consistency and robustness. This indicates that the impacts of social comparison and self-objectification on the body image of disabled women are universal.

This study demonstrates that sexual attitudes among Chinese women with disabilities negatively influence body dissatisfaction through the parallel mediating roles of body esteem and sexual esteem. The independent mediation effects of these two variables establish a parallel mediation model. Comparative analysis of indirect effect coefficients reveals that the mediating effect of body esteem surpasses that of sexual esteem. This discrepancy may be interpreted through sociocultural and measurement perspectives.

From a sociocultural standpoint, sexual esteem levels are intrinsically linked to self-objectification processes. Recent studies have indicated that the socio-demographic characteristics of women can qualify the extent to which self-objectification.⁵³ Specifically, body dissatisfaction exhibits a marked increase from childhood through adolescence into adulthood, demonstrating significant positive associations with chronological age.⁵⁴ Moreover, a study on objectification among women in seven countries found that women in India, Japan, and Pakistan exhibited lower levels of self-objectification compared to those in Australia, Italy, the United Kingdom, and the United States.⁵⁵ This finding aligns with the results of another study, which indicated that girls from low-income groups reported higher levels of body satisfaction compared to those from high-income groups. Notably, the study also found that as a woman's educational attainment increased, her dissatisfaction with her appearance and body shape also increased. Furthermore, McLaren and Kuhb's research revealed that middle-aged women from upper-class backgrounds exhibited higher levels of body dissatisfaction compared to their counterparts from

lower-class background.⁵⁵ Drawing upon existing empirical evidence and considering the sociodemographic profile of the study cohort, Chinese women with disabilities predominantly exhibit low-income status, limited educational attainment, and substantial representation of rural household registration. Compared to other sociostratified female groups, these socioeconomic constraints appear to demonstrate attenuated self-objectification tendencies.

From a measurement standpoint, this discrepancy may also relate to conceptual and operational variability in measuring sexual esteem.⁵⁶ As a multidimensional construct, sexual esteem encompasses distinct facets. The current measurement approach prioritized global sexual self-worth rather than domain-specific dimensions tied to partner-acquisition efficacy. Relevant research has confirmed that women's sexuality is often defined as being for the purpose of attracting a sexual partner, and thus is heavily appearance focus.⁴⁶ Which means women's global evaluations of sexual self-worth are predominantly associated with perceptions of sexual desirability rather than agentic sexual experiences, sexual competence, or performance efficacy. Therefore, future investigations should prioritize identifying additional subcomponents of sexual esteem, such as others-directed attractiveness (which may enhance relational confidence), as these dimensions could foster more robust associations with sexual attitudes. Such granular conceptual differentiation warrants systematic exploration in subsequent research.

Implications

Based on the findings of this study and in consideration of the actual situation, management and practical strategies for interventions targeting the sexual and reproductive health of disabled women can be proposed at different levels.

Firstly, at the level of individual psychological intervention, recent research indicates that many clinicians make assumptions that women with disabilities cannot communicate at the level that is needed to understand, a completely false assumption.⁵⁷ Consequently, this study further corroborates the notion that experts and counselors in the healthcare and mental health sectors can adopt cognitive behavioral therapy (CBT) to enhance awareness of women's sexual health, with a

particular emphasis on assessing individual sexual attitudes and self-esteem levels. These assessments can then be integrated into the treatment priorities of mental health, reproductive health, and sexual health for individuals with disabilities.

Secondly, at the level of organizational service provision, this study contributes actionable insights for individual and collective efforts to redefine sociocultural meanings ascribed to female embodiment through recognizing this as an ongoing process. The transition from negative to positive body image involves two critical inflection points: First, the pursuit of novel community support systems that provide unconditional acceptance and belonging, that is to say, participation in culturally validated and valued collectives can enhance self-esteem through identity reaffirmation. Second, the cultivation of agency and empowerment via vocational or educational advancement, where earned respect extends to positive bodily appraisals.⁹ Based on these, this study proposes dual intervention pathways for practice reform. In cultural practice, visual media should actively restructure social norms through regulated content production that promotes value-driven narratives, thereby enhancing disabled women's confidence in their bodily distinctiveness. The utilization of media has been demonstrated to facilitate the establishment of a conducive environment, thereby enabling individuals to adopt a receptive stance toward their bodily experiences. In educational practice, transformative efforts could encompass both formal schooling systems and informal educational platforms including family education, community-based initiatives, and NGO-led public health campaigns. Systematic integration of critical knowledge frameworks will empower women with disabilities to recognize the psychological ramifications of self-objectification mechanisms and cultivate resilience strategies against their detrimental effects.

Furthermore, given the demonstrated influence of sexual attitudes on body satisfaction among women with disabilities, it is imperative to expand and promote comprehensive sexual and reproductive health education programs tailored to this population. These initiatives should address, but not be limited to: sexual tolerance and acceptance, contraceptive responsibility, and the instrumental versus relational dimensions of sexuality. Such

education will facilitate the development of healthy value systems and foster positive sexual attitudes.

Lastly, at the level of the socio-cultural environment, public health authorities and stakeholders should strive to foster supportive social environments that mitigate social comparison, actively promote public acceptance of physical impairments among individuals with disabilities, and affirm body functionality. Concurrently, efforts should be made to reduce objectification and acknowledge the sexual identity and desirability of the disability community. By enhancing both sexual and bodily esteem, the overall quality of life for women with disabilities can be significantly improved.

Limitation

This study also has several limitations. First, although the cross-sectional design was grounded in theoretical and empirical research, it inherently carries methodological constraints that preclude causal inferences. Future studies should employ longitudinal data to establish causal relationships.

Second, both body esteem and sexual esteem are contextually constructed perceptions rather than absolute givens. Subsequent research could adopt experience sampling or case-study methods to conduct dynamic investigations, enabling deeper exploration of the factors influencing body image among women with disabilities.

Third, while the sample represents Jiangsu, Liaoning, Shandong and Hebei, the cities where the study was conducted, the findings are unlikely to be applicable to all regions of China. Future research should replicate this study at a national or international level. For instance, in most African countries, the coverage rate of reproductive health services for the disabled population is relatively low. Disabled women also face issues such as body image concerns and the marginalization of sexual health, and are significantly influenced by sociocultural norms. This shares commonalities and cross-cultural relevance with the core topic of this study. Meanwhile, the social comparison theory and the self-objectification theory are applicable and can be used to explain the psychological mechanisms of the local population. Therefore, replicating this study can provide data support for formulating targeted

intervention measures and has policy and social value.

Lastly, sexuality remains a sensitive topic in China. This study relied on self-reported data to minimize bias. Although women with disabilities are considered capable of providing reliable information about their internal states and behavioral expressions, incorporating objective measures of both independent and dependent variables would strengthen future investigations.

Conclusion

Chinese women with disabilities generally exhibit relatively conservative and negative sexual attitudes, reporting high levels of dissatisfaction with their subjective bodily evaluations. Both their body esteem and sexual esteem remain at notably low levels. Specifically, their sexual attitudes negatively influence their body dissatisfaction levels: those who hold more positive and open sexual attitudes tend to report significantly lower body dissatisfaction. Additionally, both body esteem and sexual esteem function as parallel mediators between sexual attitudes and body dissatisfaction among women with disabilities, with body esteem demonstrating a stronger mediating effect than sexual esteem. Notably, Chinese women with disabilities can improve their body esteem and sexual esteem by reducing social comparison and self-objectification, which would benefit multiple dimensions of their sexual health and psychological well-being.

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Conflict of interest

The authors declare no conflicts of interest.

Contribution of authors

Xinyuan Zhang: Conceptualization, methodology, formal analysis, writing-original draft, writing-review&editing; Wanbing Shi: Data curation, supervision, writing-review&editing. All authors mentioned in article approved the manuscript.

Data availability statement

The complete de-identified datasets used and analysed during the current study are available from the corresponding author on reasonable request.

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