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ORIGINAL RESEARCH

From Intention to Action: A Grounded Theory Study on the Staged Mechanisms of Postoperative Exercise Behavior Among Breast Cancer Patients

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Background: Exercise is widely recommended for postoperative breast cancer patients due to its benefits for functional recovery and symptom management. However, real-world participation and long-term adherence remain consistently low. Existing research has largely focused on participation rates or perceived barriers, offering limited insight into the behavioral mechanisms that govern how exercise is initiated and sustained over time, particularly within specific cultural contexts.

Objective: To explore the mechanisms underlying the initiation and maintenance of postoperative exercise behaviors among breast cancer patients, with particular attention to the interaction among behavioral capability, motivation, and cues across different stages of recovery.

Methods: A qualitative study informed by grounded theory was conducted. Fifteen patients (n = 15) who had undergone unilateral mastectomy were purposively recruited from a tertiary hospital in Foshan, China. Semi-structured, in-depth interviews were carried out and analyzed using open, axial, and selective coding procedures.

Results: Postoperative exercise behavior was shaped by the dynamic interaction of three interrelated domains: capability, motivation, and cues. Capability—encompassing physical condition, exercise-related knowledge, and self-regulatory skills—functioned as a threshold condition for behavior initiation. Notably, the capability threshold evolved across the disease trajectory: in the early postoperative phase, it was primarily constrained by acute physical symptoms such as pain and limited mobility, whereas in the long-term recovery phase, it increasingly depended on patients' self-regulatory capacity and ability to integrate exercise into daily life. Motivation acted as a fluctuating driver influenced by perceived benefits, emotional responses, and external support. Cues, including professional guidance and family reminders, functioned as both behavioral triggers and a key maintenance mechanism. In the absence of sustained cues, behavioral discontinuity frequently occurred, even among patients with adequate motivation and capability.Cultural beliefs regarding rest and activity, rooted in the Chinese context, influenced patients' perceptions of exercise safety and timing, thereby shaping motivation and responsiveness to cues.

Conclusion: Postoperative exercise behavior among breast cancer patients follows a staged mechanism characterized by capability-dependent initiation, motivation-driven fluctuation, and cue-dependent maintenance. These findings highlight the need for nurse-led, continuous, and context-sensitive interventions, rather than one-time education, to support long-term exercise adherence, particularly in cultural contexts where beliefs about rest and activity may shape patients' exercise behaviors.

Implications for Nursing Practice: Nursing interventions should move beyond information delivery and adopt a system-based behavioral support approach that strengthens exercise capability, by incorporating structured exercise prescriptions, continuous nurse-led follow-up, digital reminder systems, and family-supported cueing strategies into routine care.

Keywords: breast cancer, exercise behavior, grounded theory

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Introduction

Breast cancer remains one of the most prevalent malignancies among women worldwide, with surgery continuing to serve as a central component of curative treatment.[1] Despite advances in diagnostic techniques and therapeutic strategies, many patients experience persistent postoperative symptoms, including upper-limb dysfunction, pain, stiffness, and fatigue. These symptoms not only interfere with daily activities and physical recovery but also exert a lasting impact on psychological well-being and overall quality of life.[2]

A substantial body of evidence supports the role of exercise in improving postoperative functional outcomes, alleviating treatment-related symptoms, and promoting long-term health among breast cancer survivors.[3,4] Nevertheless, actual engagement in exercise remains limited. Previous studies have reported that only approximately 30%–50% of breast cancer patients meet recommended levels of physical activity after surgery, with even lower participation rates observed during the early postoperative period.[5] During the early postoperative period, patients often restrict physical activity due to pain, fear of injury or recurrence, and uncertainty regarding safe movement.[6] As recovery progresses, inadequate professional guidance, insufficient social support, and the absence of strategies to sustain long-term behavior further undermine adherence.[7] In the context of behavior change, the "maintenance" phase is generally understood as the period during which a behavior is sustained beyond its initial adoption, often operationalized as lasting for at least 6 months after initiation.[8] However, in the postoperative recovery of breast cancer patients, this phase may begin earlier and is closely intertwined with ongoing physical and psychosocial adaptation.[9] While previous studies have documented participation rates and described perceived barriers,[10] the processes through which exercise behaviors are initiated, interrupted, or maintained—particularly during the transition into the maintenance phase—remain insufficiently understood.

Postoperative exercise behavior is inherently contextual and dynamic.[11] However, existing studies rarely distinguish how the nature of behavioral constraints evolves across different stages of recovery. In particular, the "capability" required to initiate and sustain exercise may shift from being predominantly limited by acute physical symptoms in the early postoperative phase to being shaped by long-term self-regulation and habit formation in survivorship. This stage-dependent transformation remains insufficiently understood.It is shaped by fluctuating physical capacity, emotional responses, perceived risks, fragmented information sources, and uneven access to and utilization of supportive tools, including emerging digital health technologies such as mobile applications, wearable devices, and telehealth platforms, which are increasingly used to promote physical activity but remain inconsistently implemented and insufficiently tailored to postoperative breast cancer patients.[12–14] Moreover, the extent to which these digital tools effectively support the long-term maintenance of exercise behavior in real-world clinical settings remains unclear.

Within the Chinese cultural context, additional factors—including family involvement, interpretations of medical advice, and beliefs about postoperative rest and activity—further influence behavioral decision-making.[15] For example, traditional beliefs that emphasize rest and energy conservation after surgery may discourage early mobilization and structured exercise, while strong family involvement may lead to overprotection, thereby limiting patients' autonomy in engaging in physical activity.[16] In addition, patients may interpret medical advice conservatively, prioritizing safety over activity, which can further reduce exercise participation.[17]

These complexities underscore the need for qualitative inquiry to capture how patients interpret exercise recommendations and translate them into daily practice during recovery.These culturally embedded factors suggest that some aspects of postoperative exercise behavior may be context-specific, while others may reflect more generalizable behavioral mechanisms.

Guided by grounded theory, a qualitative methodology aimed at generating theory inductively from data through iterative data collection and analysis,[18] the present study sought to elucidate the mechanisms underlying postoperative exercise behavior among breast cancer patients. Specifically, data were analyzed using constant comparative methods with open, axial, and selective coding to identify key categories and their relationships.[18] By examining how capability, motivation, and cues interact across recovery stages, this study seeks to inform the development of theory-informed, system-based nursing interventions to support sustained exercise engagement.

In addition to the inductive grounded theory approach, this study was informed by existing behavior change frameworks, particularly the COM-B model[19] and the theory of planned behavior.[20] These frameworks provided theoretical sensitivity during data interpretation, offering a conceptual lens to understand how capability, motivation, and contextual triggers influence the translation of intention into action. Rather than serving as rigid analytical structures, these theories were used to support higher-level abstraction and interpretation of emerging categories.

Unlike prior studies that primarily describe barriers or rely on predefined behavioral frameworks, this study seeks to generate a process-oriented and stage-sensitive theoretical explanation grounded in patients' lived experiences. Specifically, it aims to (1) reconceptualize capability as a threshold condition for behavior initiation, (2) capture the temporal instability of motivation across recovery stages, and (3) identify cues as proximal triggers that translate intention into sustained action. These contributions extend existing behavior change theories by introducing a dynamic and staged perspective on postoperative exercise behavior.Specifically, this study introduces a staged and conditional behavioral mechanism, highlighting that behavior initiation, fluctuation, and maintenance are governed by different dominant factors over time, rather than a static interaction of components.

Participants and Methods

Participants

This study was approved by the Ethics Committee of the Sixth Affiliated Hospital of South China University of Technology (Ethics No. NYKY-2025-366-01) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

Patients who had previously undergone unilateral mastectomy at a tertiary hospital in Foshan were recruited through purposive sampling for interviews conducted between September and October 2025.

Prior to data collection, participants received detailed information regarding the study's purpose and procedures. Written informed consent was obtained from all participants. Confidentiality and anonymity were ensured, and participants were informed of their right to withdraw at any time without consequences.

Inclusion criteria were: pathologically confirmed breast cancer; completion of unilateral mastectomy; age ≥18 years; intact cognitive function and ability to communicate; ability to recall and describe postoperative exercise experiences; and voluntary participation. To enhance sample homogeneity and ensure comparability of postoperative experiences, this study focused exclusively on patients who had undergone unilateral mastectomy. Women who had undergone bilateral mastectomy were not included, as the greater surgical extent and associated differences in functional impairment and recovery trajectories could introduce additional heterogeneity in exercise behavior patterns.Patients who were unable to complete the interview due to severe fatigue, emotional distress, or early withdrawal were excluded, as were interviews that failed to achieve sufficient depth for theoretical saturation.The determination of insufficient depth was based on predefined criteria, including limited narrative detail, lack of experiential description, and inability to contribute new conceptual insights during coding. This assessment was conducted jointly by two researchers during the initial coding phase.

Data saturation was assessed concurrently with data collection. After the 13th interview, no new codes or categories emerged, and two additional interviews were conducted to confirm saturation.

Methods

Research Team

Given the central role of researchers as instruments in qualitative inquiry, the composition of the research team was carefully considered.[21] The team included one qualitative research expert (professor and master's supervisor), two senior oncology nurses with over 20 years of clinical experience, and three master's students with formal training in qualitative methods. The team's clinical expertise and cultural familiarity with oncology care facilitated rapport-building and enhanced the depth of data collection.

Given the researchers' clinical backgrounds in oncology nursing, reflexivity was actively considered throughout the study. The researchers were aware that their prior experiences and assumptions regarding postoperative exercise might influence data interpretation. To mitigate this, reflexive discussions were conducted within the team, and researchers

consciously bracketed preconceptions during data collection and analysis. The involvement of multiple researchers with different roles also helped to provide diverse perspectives and reduce individual bias.

Prior to the interviews, no prior relationship was established between the researchers and participants. The interviewers were not involved in the clinical care of the participants, thereby minimizing potential power imbalances. Participants were informed about the researchers' professional background and the purpose of the study before the interviews.

Development of the Interview Guide

The semi-structured interview guide was developed through literature review, team discussions, and pilot interviews (see Supplementary Material).Key areas included postoperative physical changes and exercise-related challenges, expectations and goals related to exercise, sources of exercise information, perceived barriers across recovery stages, and preferences regarding reminders, supervision, and support for long-term exercise maintenance.In this study, two theoretical frameworks were used to enhance interpretative depth. The COM-B model[19] proposes that behavior is influenced by three interacting components: capability (physical and psychological capacity), opportunity (external factors that enable or prompt behavior), and motivation (reflective and automatic processes driving behavior). The theory of planned behavior[20] suggests that behavioral intention is shaped by three constructs: attitudes toward the behavior, subjective norms, and perceived behavioral control, which together influence actual behavior.

Data Collection

One-on-one, in-depth interviews were conducted by two trained researchers in a quiet, private hospital setting. Interviews lasted approximately 40–60 minutes and were extended as needed. Audio data were recorded using two devices to ensure completeness. Field notes documenting non-verbal cues and contextual observations were taken concurrently. All interviews were transcribed verbatim within 24 hours, cross-checked for accuracy, anonymized, and incorporated into the analytical dataset.

The use of two researchers during the interview process was intended to enhance data quality and methodological rigor. One researcher (Lihua Shan), who had formal training in qualitative interviewing, led the interview, facilitated rapport-building, and guided the conversation using the semi-structured interview guide. The second researcher (Xiaoyun Li) served as a non-participant observer, responsible for taking detailed field notes, capturing non-verbal cues, and monitoring the flow of the interview. This arrangement helped ensure completeness of data collection, reduced the risk of missing key information, and supported reflexivity during the interview process.

This collaborative approach also facilitated reflexivity, allowing the researchers to reflect on how their interactions and positionality might shape the data collection process.

Data Analysis

Data analysis followed the three-step grounded theory approach: open coding, axial coding, and selective coding.

In the open coding phase, transcripts were examined line by line to identify discrete concepts, which were labeled and grouped based on similarities and differences. Initial codes were generated inductively from the data without imposing predefined categories.During axial coding, related codes were compared and organized into higher-level categories and subcategories. Relationships among categories were explored by examining conditions, interactions, and consequences, allowing for the development of a structured framework.In the selective coding phase, a core category was identified, and all categories were systematically integrated around this central theme. The relationships between categories were refined to construct a coherent theoretical explanation of postoperative exercise behavior.

Two researchers independently coded the transcripts, with discrepancies resolved through discussion. NVivo 15.0 software was used to facilitate data organization and maintain an audit trail. While analysis was inductive, theoretical sensitivity was informed by established behavior change frameworks, including the COM-B model[19] and the theory of planned behavior,[20] to support higher-level conceptual integration.

Data analysis was conducted following the grounded theory approach proposed by Barney G. Glaser and Anselm L. Strauss,[18] involving three iterative stages: open coding, axial coding, and selective coding. All transcripts were imported into NVivo 15.0 software to facilitate data management and maintain a transparent audit trail.

To enhance analytical rigor, two researchers independently coded the data and met regularly to compare coding results. Discrepancies were resolved through discussion until consensus was reached, and, when necessary, a third senior researcher was consulted. Analytic memos were recorded throughout the process to document coding decisions and category development.

Although the initial coding process followed an inductive grounded theory approach, the COM-B model[19] and the theory of planned behavior[20] were applied during the axial and selective coding stages.

Specifically, categories and subcategories derived from the data were mapped onto the COM-B components (capability, opportunity, and motivation)[19] to better understand the determinants of postoperative exercise behavior. For example, patients' physical limitations and knowledge gaps were interpreted as aspects of capability, while environmental constraints and social support were categorized under opportunity. Motivational factors, including beliefs and emotional responses, were analyzed within the motivation domain.

In parallel, constructs from the theory of planned behavior[20] were used to further interpret patients' intentions and decision-making processes. Attitudes toward exercise, perceived social expectations (subjective norms), and perceived behavioral control were identified within the data and used to explain variations in exercise adherence.

These frameworks were not used as predefined coding schemes but as sensitizing concepts to support the organization, interpretation, and integration of findings.

Transcripts or preliminary findings were returned to a subset of participants for verification, and no major discrepancies were identified.

Results

Participant characteristics are presented in Table 1. The study included 15 breast cancer patients with a wide age range (35–60 years), varying educational levels, and different tumor stages (eg., stages I–III). All participants were married. This diversity provided a comprehensive perspective on postoperative exercise experiences.

Three main themes and several subthemes were identified from the data: (1) Motivation as a fluctuating amplifier of exercise behavior, (2) Capability as a threshold condition for exercise initiation, and (3) Cues as triggers translating intention into action. These themes reflect the dynamic interplay between psychological, physical, and environmental factors influencing postoperative exercise behavior.These themes collectively illustrate a staged behavioral mechanism in

Table 1 Demographic Characteristics of Participants (n = 15)

Variable	Category	n (%)/Mean ± SD
Sex	Female	15 (100%)
Age(years)	Range	35–60
	Mean±SD	47.2±7.1
Education level	Primary school	2 (13.3%)
	Secondary school	8 (53.3%)
	Technical secondary school	1 (6.7%)
	College diploma	1 (6.7%)
	Bachelor's degree or above	3 (20.0%)
Marital status	Married	15 (100%)
Occupation	Employed	8 (53.3%)
	Unemployed	4 (26.7%)
	Retired	2 (13.3%)
	Self-employed	1 (6.7%)
Tumor stage	Stage 0–I	5 (33.3%)
	Stage II	6 (40.0%)
	Stage III–IV	4 (26.7%)
Disease duration (years)	Mean ± SD	1.9 ± 2.7
	Range	0.3–11

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which exercise behavior evolves from initial capability constraints to long-term maintenance dependent on cues. Representative quotations are provided to illustrate how themes were grounded in participants' experiences.

Motivation as a Fluctuating Amplifier of Exercise Behavior

Participants' motivation to engage in postoperative exercise was dynamic rather than stable, shaped by both internal expectations and external influences.

Expectation of Health Improvement

Most participants regarded exercise as an integral component of recovery, particularly for improving upper-limb mobility, reducing discomfort, and alleviating fatigue. However, the clarity and strength of these expectations varied.

Some participants perceived exercise as essential for recovery:"I think if I do not move my arm, it will get stiff, and recovery will be slower, so I try to do the exercises every day." (P3)

However, some participants expressed ambivalence, perceiving exercise as beneficial but not urgent:"I know it's probably good for recovery, but I do not feel it's something I must do every day." (P7)

In contrast, others expressed uncertainty about its long-term benefits:"I know exercise might help, but I am not sure how much it really makes a difference." (P11)

External Support as a Motivational Driver

Support from healthcare professionals and family members played a central role in motivating exercise initiation. Professional reassurance increased confidence in movement safety, whereas family encouragement facilitated routine formation.

"When the nurse told me it was safe to move, I felt more confident to start exercising." (P6)"My family keeps reminding me to do the exercises, otherwise I might just forget or feel too lazy." (P9)

In contrast, the absence of external reminders often resulted in reduced activity:"If no one tells me or reminds me, I probably will not do it regularly." (P2)

Some participants also reported that excessive reminders could be perceived as pressure, reducing their intrinsic motivation:"If my family keeps pushing me too much, I sometimes feel stressed and less willing to do it." (P10)

In the Chinese cultural context, family involvement often extends beyond emotional support to active supervision and daily behavioral prompting.[22]

Reinforcement Through Positive Experience

Short-term improvements, such as reduced stiffness or improved mood, reinforced participants' belief in exercise effectiveness and strengthened motivation.'After doing the exercises for a few days, my arm felt less tight, so I became more willing to continue." (P5)

However, when benefits were not immediately perceived, motivation declined:"I did not feel much change at the beginning, so I was not very motivated to keep going." (P12)

Others described a delayed reinforcement process, where motivation increased only after sustained effort:"At first, I did not notice much change, but after sticking with it for a while, I started to feel the benefits." (P6)

Monitoring and Reward Mechanisms

Some participants reported that progress monitoring, digital logs, or structured supervision enhanced adherence by fostering accountability and a sense of achievement.

"I record my exercise on my phone, and when I see the progress, I feel a sense of accomplishment." (P8)"If someone checks on me or gives me feedback, I feel more responsible to complete it." (P14)

However, some participants indicated that such monitoring tools were not consistently used:"I tried using an app at the beginning, but I did not keep using it after a few days." (P3)

Limited Perceived Value of Exercise

Participants with mild symptoms or limited awareness of long-term risks often underestimated the importance of exercise.

"I feel okay now, so I don't think exercise is that necessary." (P1)"The surgery is already done, and I am taking medicine, so I think that should be enough." (P10)

This perception was particularly evident among those with minimal symptoms:"Since I do not feel much discomfort, I do not think exercise is necessary right now." (P4)

Capability as a Threshold Condition for Exercise Initiation

Participants' accounts indicated that the capability required for exercise was not static but evolved across the recovery trajectory. The threshold for initiating and maintaining exercise shifted from being primarily constrained by physical symptoms in the early postoperative phase to being increasingly influenced by self-regulatory capacity in the later stages.

Early-Stage Capability: Dominance of Physical Limitations

In the early postoperative phase, capability was primarily constrained by acute physical symptoms such as pain, fatigue, and restricted range of motion.

"When I move my arm, it hurts, so I'm afraid it might make things worse." (P4)"I feel very tired after treatment, and I just do not have the energy to exercise." (P7)

Some participants avoided movement entirely due to fear of harm:"I was afraid that moving too much would affect the wound, so I preferred to stay still." (P2)

Insufficient Knowledge and Skills

Across different stages, uncertainty regarding appropriate exercise types, intensity, and progression remained a persistent barrier."I do not really know what kind of exercise I should do or how much is enough." (P13)

Conflicting information further reduced confidence:"I searched online, but different sources say different things, which makes me confused." (P6)

This confusion sometimes led to inaction:"When I am not sure what is correct, I'd rather not do anything at all." (P11)

Long-Term Capability: Challenges in Self-Regulation and Routine Integration

Time constraints, lack of routine, and limited self-regulatory strategies hindered regular exercise. Uncertainty about appropriate duration and intensity contributed to either under-engagement or avoidance.

In the longer-term recovery phase, as physical limitations became less dominant, capability was increasingly shaped by challenges in self-regulation, including time constraints, lack of routine, and difficulty integrating exercise into daily life.

"I'm busy with work and family, and I don't know when to fit exercise into my day." (P9)"Sometimes I plan to do it, but then I forget or postpone it." (P15)

Some participants also described a gradual loss of routine over time:"At the beginning I followed the plan, but later I became less disciplined and skipped more often." (P8)

Together, these findings suggest a transition in the nature of the capability threshold across the disease trajectory—from being primarily limited by physical symptoms in the early stage to being increasingly constrained by self-regulatory capacity in long-term recovery.

Cues as Triggers Translating Intention into Action

Professional Guidance

Clear and timely instructions from healthcare providers acted as decisive triggers for exercise initiation.

"I only started exercising after the doctor clearly told me what to do." (P3)"If there are no specific instructions, I hesitate because I am afraid of doing it wrong." (P11)

Without clear guidance, participants often delayed action:"If no one tells me exactly what to do, I just wait and do not start." (P1)

Family-Based Reminders

Family members functioned as proximal cues through reminders and emotional support.

"My family reminds me every day, which helps me stick to the routine." (P5)

"When someone checks on me, I feel encouraged to keep going." (P8)

However, reliance on family cues varied depending on personal preferences:"Sometimes I prefer to manage it myself rather than being reminded all the time." (P12)

This form of family-based prompting may be particularly prominent in collectivist cultural contexts such as China.

Lack of Embedded Daily Cues

Many participants lacked routine-linked or environmental cues, resulting in forgotten or postponed activity.

"If it's not part of my daily routine, I easily forget to do it." (P2)"Sometimes I remember, but then I delay it and eventually skip it." (P12)

This absence of cues often resulted in discontinuity even among motivated individuals:"I know I should do it, but without reminders, I just keep postponing it." (P6)

Together, these findings suggest a staged behavioral mechanism in which capability determines whether exercise can be initiated, motivation shapes the intensity and persistence of engagement, and cues act as proximal triggers that sustain behavior over time. These components interact dynamically rather than independently, forming a process that evolves across recovery stages.

Discussion

Capability as a Potential Prerequisite for Exercise Initiation

Rather than functioning as one of several equally weighted determinants, capability appears to operate as a gatekeeping condition that constrains whether exercise behavior can occur at all.

Importantly, our findings further suggest that the nature of this capability threshold is not static but evolves across the disease trajectory. In the early postoperative phase, the threshold is primarily defined by acute physical limitations, such as pain and restricted mobility, which directly constrain patients' ability to initiate exercise. In contrast, during long-term recovery, as physical barriers diminish, the threshold becomes increasingly determined by self-regulatory capacity, including the ability to establish routines, manage competing demands, and sustain behavior over time. This shift suggests that the nature of behavioral constraint evolves over time, transitioning from externally imposed physiological limitations to internally mediated self-regulatory challenges.

While previous studies have identified physical limitations and knowledge deficits as barriers to exercise, they have largely conceptualized capability as a static determinant. The present findings extend this view by demonstrating that capability operates dynamically across recovery stages and may function as a threshold that must be met before behavior can be enacted.[23,24] However, unlike prior research that often treats capability as a static construct,[25] our findings suggest that capability evolves across recovery stages and may function as a threshold condition for behavior initiation. This extends existing literature by introducing a temporal and hierarchical perspective on capability within behavior change processes.Insufficient physical readiness, limited exercise knowledge, and weak self-regulatory skills often prevented action, even in the presence of motivation, aligning with behavior change theory emphasizing capability as a necessary condition for behavior enactment.[19]

Motivation as a Dynamic and Unstable Driver

Motivation in this context appears to function less as a stable driver of behavior and more as a context-sensitive regulator that responds to fluctuating symptom experiences and perceived outcomes.[26] This challenges the common assumption underlying many intervention designs that motivation can be sufficiently enhanced through single-point education or counselling, suggesting instead that sustained behavioral engagement requires ongoing reinforcement mechanisms.

Although prior research has acknowledged the instability of motivation in health behavior,[27] the present findings further demonstrate that such fluctuations are closely coupled with stage-specific recovery experiences, indicating that motivation should be conceptualized as temporally dynamic rather than inherently unstable.

Cues as the Critical Switch Between Intention and Action

Cues appear to function as a proximal activation mechanism that bridges the well-documented intention–behavior gap, rather than merely serving as a facilitating condition. The persistence of behavioral discontinuity despite adequate

capability and motivation suggests that these components alone are insufficient for sustained action in the absence of triggering mechanisms.[28,29] Current nursing practices often overlook cue design, focusing primarily on education and encouragement.[30]

While previous studies have acknowledged the role of environmental and social support,[31] cues as immediate behavioral triggers have received relatively limited attention. Our findings highlight cues as a proximal and indispensable mechanism that bridges intention and action, thereby extending existing literature by emphasizing their operational role in real-world behavioral maintenance.

Theoretical Contributions to the COM-B Model

This study provides a context-specific interpretation of the COM-B model by providing a process-oriented and stage-sensitive understanding of postoperative exercise behavior among breast cancer patients.

First, our findings suggest that capability operates not merely as one component of behavior, but as a threshold condition for behavior initiation. While the COM-B model conceptualizes capability, opportunity, and motivation as interacting components,[19] our data indicate that insufficient capability can entirely prevent behavior enactment, even when motivation is present. This suggests a potentially hierarchical relationship in this specific context.

Second, motivation was found to be dynamic and unstable, fluctuating across recovery stages in response to symptom experience and perceived outcomes. This adds nuance to the understanding of motivation within the COM-B framework and suggests the need to incorporate temporal variability and feedback loops into the model when applied to recovery-based behaviors.

Third, this study identifies cues as a distinct and critical mechanism translating intention into action. Although cues are implicitly embedded within the "opportunity" component in COM-B, our findings demonstrate that they function as proximal triggers that directly activate behavior. The absence of sustained cues led to behavioral discontinuity, even among patients with sufficient capability and motivation. This suggests that cues may deserve greater attention in practical applications of the COM-B framework or greater emphasis within the COM-B framework.

Finally, our findings highlight the staged nature of behavior change in postoperative contexts, characterized by capability-dependent initiation, motivation-driven fluctuation, and cue-dependent maintenance. This process-oriented perspective complements the COM-B model by introducing a temporal dimension that may enhance its applicability in clinical rehabilitation settings.

Taken together, these findings move beyond static representations of behavior by proposing a dynamic, staged mechanism that integrates threshold conditions, temporal fluctuations, and triggering processes. This framework provides a more process-oriented understanding of how intention is translated into sustained action in real-world clinical contexts.

Together, these findings contribute to a more nuanced understanding of behavior change and support the adaptation of the COM-B model for use in dynamic, recovery-oriented healthcare contexts.

Beyond the specific context of postoperative exercise, these findings contribute to the broader behavior change literature by suggesting that behavior enactment may follow a staged and conditional process rather than a purely interactional model. This perspective may inform the refinement of existing theoretical frameworks to better accommodate temporal dynamics and real-world complexity.

Implications for Intervention Design

Existing exercise interventions for breast cancer survivors have primarily focused on structured exercise prescriptions, supervised training programs, and educational support.[32–34] While these approaches have demonstrated effectiveness in improving physical outcomes, they often assume relatively stable motivation and sufficient capability, and pay limited attention to stage-specific barriers and real-time behavioral triggers.The present findings extend this body of research by highlighting that postoperative exercise behavior is shaped by dynamic interactions among capability, motivation, and cues across recovery stages. These findings suggest that effective interventions should be operationalized as multi-component systems rather than single-point educational strategies. For example, early-stage interventions may include structured, pain-adapted exercise prescriptions and reassurance from healthcare professionals, while long-term strategies may incorporate digitally delivered reminders, routine-based prompts, and family-supported cueing systems embedded

into daily life.For example, early-stage interventions may focus on pain-adapted exercise protocols and reassurance, whereas long-term strategies may incorporate digital reminders, habit formation techniques, and family-supported cue systems integrated into daily routines.

From a nursing perspective, and guided by a system-based and theory-informed approach, these findings suggest that postoperative exercise interventions should be redesigned beyond one-time education as dynamic, stage-sensitive support systems integrated into routine care pathways. This approach reflects a system-based and theory-informed perspective on intervention design. A system-based approach emphasizes that exercise support should not rely on isolated actions, but be embedded within the broader continuum of care, including inpatient education, discharge planning, and ongoing follow-up.[35] At the same time, a theory-informed approach, guided by the COM-B model, suggests that interventions should systematically target capability, motivation, and opportunity (including cues) as interacting components of behavior.[36] In practice, this may involve integrating exercise support across the care continuum, including discharge-based exercise planning, scheduled follow-up through digital platforms (eg., mobile applications or messaging systems), and structured engagement of family members as cue providers.[37]

In this framework, nursing interventions can be conceptualized as targeting different components of the COM-B model, including enhancing physical and psychological capability, stabilizing motivation, and creating supportive opportunities through structured cues and environmental support.

These implications may be relevant not only in the context of breast cancer rehabilitation but also for other chronic conditions requiring long-term self-management, highlighting the broader applicability of stage-sensitive and cue-integrated intervention strategies.

Cultural Context and Transferability

The interpretation of these findings requires careful consideration of the sociocultural context in which they were generated, as cultural norms and family structures may shape not only behavioral preferences but also the mechanisms through which behavior is sustained. In the Chinese sociocultural setting, family members often play an active and sustained role in postoperative care, which may explain the prominent function of family-based cues identified in this study.[15] In addition, cultural beliefs emphasizing rest and caution after surgery may contribute to patients' hesitation toward early exercise initiation.[16]

It is noteworthy that all participants in this study were married, which may have amplified the prominence of family-based cues observed in the findings. For patients who live alone or lack a proximal support system, the form and effectiveness of cue mechanisms may differ substantially. In such contexts, cues may rely more heavily on structured professional follow-up, digital health tools, or self-initiated reminder strategies rather than family-based prompting. Future research is warranted to explore how cue mechanisms function across different living arrangements and support contexts.

At the same time, the underlying mechanisms identified in this study—namely the threshold role of capability, the temporal instability of motivation, and the triggering function of cues—may represent transferable behavioral principles that extend beyond this specific cultural setting. The roles of capability as a prerequisite for action, the dynamic nature of motivation, and the function of cues as triggers for behavior are consistent with established behavior change theories and may be transferable to other populations and healthcare settings.

Therefore, while the specific forms of cues and support systems may vary across cultures, the underlying interaction between capability, motivation, and cues is likely to represent a more generalizable behavioral mechanism.

This observation is consistent with studies conducted in collectivist cultures, where family involvement plays a central role in health behavior, but differs from findings in more individualistic contexts, where self-regulation and professional support may be more dominant.[38] However, the extent to which these mechanisms operate similarly in non-collectivist cultural contexts remains to be further explored.

Limitations

This study has several limitations. First, recall bias may have been present, as participants were asked to retrospectively describe their postoperative exercise experiences across different stages of recovery, with disease duration ranging from 0.3 to 11 years. Their accounts may therefore have been influenced by memory decay or post hoc reinterpretation. To mitigate this issue,

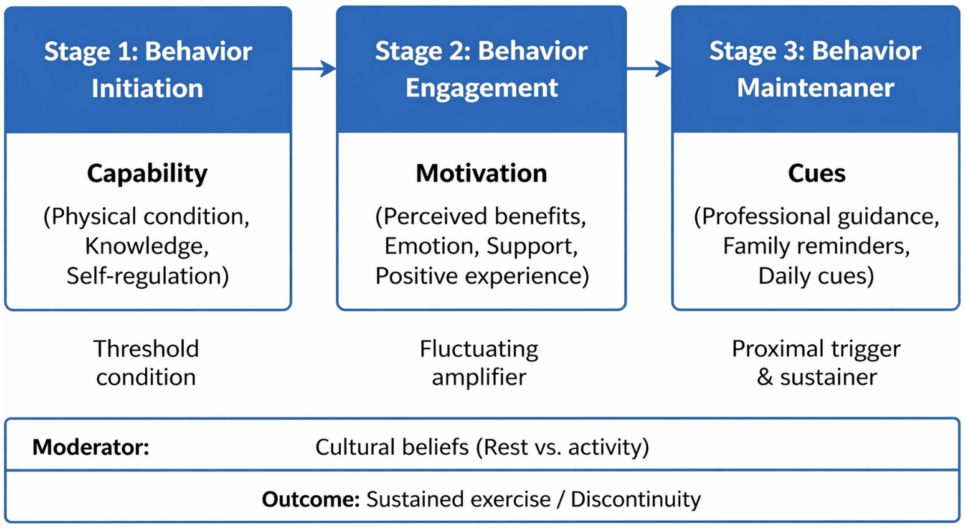

Figure 1 Conceptual model of the staged mechanisms of postoperative exercise behavior among breast cancer patients.

interviews were conducted using stage-specific prompts and probing questions to facilitate more accurate recall.Moreover, although participants covered a wide range of disease durations, the cross-sectional nature of qualitative recall may not fully capture the real-time evolution of capability across stages. Longitudinal studies are needed to further validate the stage-specific transitions identified in this study.

Second,the sample was recruited from a single tertiary hospital in China, and the findings may reflect specific sociocultural characteristics, particularly the strong role of family involvement and culturally shaped beliefs about postoperative recovery. These factors may limit the direct transferability of certain context-specific findings to other cultural settings.In addition, all participants in this study were married, which may limit the representativeness of the findings, particularly regarding the role of family-based cues. Patients without close household support may experience different cue structures and behavioral dynamics.

Summary of Contributions

This study makes several contributions. First, consistent with existing behavior change theories, it confirms the importance of capability, motivation, and external support in shaping exercise behavior. Second, based on qualitative data, it identifies the dynamic interplay among these components across recovery stages, particularly the fluctuating nature of motivation and the discontinuity of behavior in the absence of cues. Third, the study offers a refined interpretation of the COM-B model by highlighting the threshold role of capability, the temporal instability of motivation, and the proximal triggering function of cues. While grounded in a specific cultural context, these findings not only align with but also extend existing behavior change theories by introducing a staged, threshold-based, and cue-driven perspective. This contributes to a more comprehensive understanding of how health behaviors are initiated and sustained, offering theoretical and practical insights applicable across diverse recovery-oriented healthcare settings.

Taken together, these findings suggest a staged and conditional behavioral mechanism, which can be visualized in Figure 1.

Conclusion

Postoperative exercise behavior among breast cancer patients arises from a dynamic interaction among capability, motivation, and cues. Capability determines whether exercise can be initiated, motivation shapes short-term engagement, and cues sustain behavior over time; however, their long-term effectiveness depends on sustainability and may decline due to cue fatigue if not dynamically optimized. Conventional education-centered approaches are insufficient to support long-term adherence, particularly in the absence of sustainable and adaptive cueing mechanisms.

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Nurse-led, system-based, and theory-informed interventions should incorporate structured discharge exercise planning, stage-specific follow-up, technology-assisted reminders, and family-supported cueing strategies to ensure continuity of exercise support throughout recovery.However, to provide a more nuanced justification for family involvement, it is critical to balance external reminders from family members with patients' autonomy, ensuring that such cues support rather than undermine intrinsic motivation or create perceptions of pressure.This balance is essential to align with principles of self-determination theory, which emphasize the importance of autonomy in sustaining long-term health behaviors.This highlights the importance of autonomy-supportive approaches (eg., offering choices, encouraging self-initiation, and using collaborative goal-setting) when incorporating family involvement into exercise interventions.To ensure long-term effectiveness, cues should be dynamically tailored and periodically adjusted (eg., through variation, personalization, and context-aware delivery) to prevent cue fatigue and maintain behavioral responsiveness over time.

While these mechanisms may be broadly applicable, the specific forms of support and cues should be adapted to the cultural context in which interventions are implemented.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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