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The Self-management Process of Pain and Pathological Fracture Risk in Breast Cancer Patients with Bone Metastases: A Qualitative Study

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ABSTRACT

Background: This study aimed to clarify the process of self-management of pain and pathological fracture risk in patients with breast cancer and bone metastases from the patients' perspective.
Methods: Semi-structured interviews were conducted with 17 patients. Data were analyzed using Kinoshita's Modified-Grounded Theory Approach.
Results: Participants' self-management centered on "pain relief and the acquisition of safe movements using physical sensations and information as clues," progressing while striving to "maintain psychological stability in the face of threats of death and disease progression." Triggered by "fearful experiences due to pain" and "fear of unknown fractures," participants linked "learning safe movement through trial and error" with "strategies to reduce bone load." They further enhanced stability through the "acquisition of skills to use analgesic agents appropriately" and "strengthening physical functions according to bone fragility." Applying these strategies and their own ingenuity, participants "adapted social roles to accommodate physical limitations," and gained a sense that "life will continue."
Conclusion: Adjusting movement based on bodily sensations and proactively selecting actions to reduce fracture risk are key aspects of self-management. Supporting patients' strategies, maintaining psychological stability, and facilitating adaptive movement readjustments in response to changes in bone conditions are essential to avoid excessive activity restrictions.

INTRODUCTION

Breast cancer incidence has been rising worldwide, with an estimated 2.3 million women diagnosed in 2022 [1]. In Japan, approximately 100,000 individuals are diagnosed each year, and this number continues to increase [2]. Breast cancer frequently metastasizes to bone, with bone metastasis observed in approximately 70 % of patients who die from the disease [3]. Furthermore, 79 % of patients with advanced breast cancer and bone metastasis experience pain at the time of diagnosis [4], which is often severe [5].

Patients with breast cancer also face a higher risk of pathological fractures compared with other cancer types [6]. This elevated risk is partly because 75–80 % of

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patients are hormone receptor—positive and commonly receive endocrine therapy [7]. Endocrine therapy can lead to substantial bone mineral density (BMD) loss [8], thereby increasing fracture risk [9]. Vertebral fractures occur in 23 % of patients with breast cancer, with osteoporosis accounting for 11 % of these cases [10]. Additionally, bone metastases from breast cancer often manifest as osteolytic lesions, and reduced BMD further contributes to fracture development [3].

Denosumab, introduced around 2010 as an alternative to conventional bisphosphonates, has emerged as a key therapy for reducing pathological fracture risk. Compared with bisphosphonates, denosumab has demonstrated greater efficacy in preventing skeletal-related events (SREs) and alleviating pain [11]. Bone mass can increase within 1 month of administration, with lumbar spine BMD rising by 5.5 % after 12 months [12], highlighting its importance for patients with breast cancer and bone metastases.

Because SREs and pain substantially reduce functional independence and quality of life (QoL) [13], it is essential to balance pain control with movement readjustments based on bone condition. The median age at diagnosis of bone metastases in breast cancer is 50 years, with pathological fractures occurring at a median age of 54 years [14], a period when patients often carry significant family and societal responsibilities. Consequently, limitations in movement due to pain or pathological fracture risk may impede patients' ability to fulfill these roles.

The median survival time for patients with breast cancer and bone-only metastases is reported as 4.8 years [15]. This prognosis is more favorable than that for metastases to other organs, emphasizing the importance of maintaining QoL. Treatment is predominately outpatient chemotherapy, with recovery occurring primarily at home. Therefore, effective self-management based on an understanding of one's condition is critical for controlling pain, preventing pathological fractures, and maintaining social and familial participation.

Despite its importance, research on self-management of pain and fracture risk in patients with bone metastases remains limited. One intervention study reported that individualized nurse-led education for patients with bone metastases undergoing radiation therapy reduced the time required to achieve pain control [16]. Pathological fracture risk techniques are available using computed tomography images for vertebral lesions [10] and for long bones based on tumor spread [17]. However, no studies have specifically explored self-management of pain and pathological fracture risk in patients with breast cancer and bone metastases.

Therefore, this study aimed to elucidate the process of self-management of pain and pathological fracture risk from the perspective of patients with breast cancer and bone metastases. Clarifying this process is expected to guide nursing care by identifying the content, methods, and support required to help patients independently recognize problems, acquire knowledge and skills, and manage their condition effectively.

MATERIALS AND METHODS

Definitions of terms

Self-management for pain and pathological fracture risk in patients with breast cancer and bone metastases: Based on Lorig's concept of self-management [18], this study defines self-management in this context as the development of skills by patients with breast cancer and bone metastases to understand their condition and monitor physical symptoms caused by bone metastasis, learn and apply strategies to manage these symptoms effectively, maintain daily life in accordance with their individual social background and living environment, and develop coping skills to address emotional challenges arising from bone metastasis and activity limitations.

Study design

This study employed a qualitative descriptive design to explore the process of self-management in patients with breast cancer and bone metastases, specifically regarding pain relief and fracture prevention. Self-management is understood as a phenomenon shaped by patients' social interactions and their relationships with healthcare providers.

To elucidate this phenomenon, it is necessary to clarify the constituent concepts, their interrelationships, and the overall process leading to self-management. Accordingly, we determined that qualitative descriptive research using the Modified-Grounded Theory Approach (M-GTA) was most appropriate.

M-GTA is a refined analytical method based on the Grounded Theory Approach, initially proposed by Glaser and Strauss [19]. While the original method emphasized an objective, analytical approach that minimized contextual influence by segmenting data into numerous codes, M-GTA incorporates the analytical focus. Specifically, it conceptualizes the actions, cognitions, and emotions of individuals within specific social contexts, enabling deeper interpretation of the data and integrating the researcher's perspective into the methodological framework.

Data collection period

March 2025–July 2025

Research participants

Participants were patients with breast cancer diagnosed with bone metastasis who were visiting outpatient clinics at designated cancer treatment hospitals or general hospitals. All participants were informed of the study's purpose and provided informed consent. Inclusion criteria were as follows: 1) metastasis to one or more weight-bearing bone

(spine, pelvis, or femur); 2) patients with breast cancer under 80 years of age; 3) bone metastasis diagnosed 3 months to 5 years prior to the study, based on established diagnostic criteria [20]; and 4) patients judged by healthcare professionals to have adequate pain control and to be actively engaged in fracture prevention measures. Exclusion criteria were: 1) patients not receiving bone-modifying agents; 2) patients who had undergone surgery for bone metastasis; and 3) patients with impaired cognitive function, such as due to brain metastases.

Patients not receiving bone-modifying agents were excluded because international and Japanese guidelines, including those of the American Society of Clinical Oncology and the European Society for Medical Oncology, recommend prompt administration of these agents following a diagnosis of bone metastases. The absence of bone-modifying agents was therefore interpreted as a deviation from standard care [21, 22, 23]. Patients who had undergone surgery for bone metastases were also excluded because postoperative restrictions vary widely, making it difficult to uniformly assess self-management and physical limitations.

Finally, the use of bone-modifying agents in this study was limited to denosumab, based on prescribing practices at participating institutions and prior research, considering the timing of symptom changes and bone density responses [11, 12].

Recruitment procedures

The recruitment process began with the submission of a research request form to the directors and head nurses of participating facilities. This form explained the purpose, objectives, methods, and ethical considerations, and their consent for understanding and cooperation was obtained.

Subsequently, a similar research request form was presented to nurses or doctors who could serve as collaborators in the study. Their consent for understanding and cooperation was also obtained.

The selection criteria for research participants were then provided to these collaborators, who were asked to identify patients meeting the specified conditions. The identified patients were introduced by the responsible personnel, after which the researchers directly explained the study in detail and obtained written informed consent from each participant.

Data collection method

Data were collected through semi-structured interviews and reviews of participants' medical records. With participants' consent, interviews were audio-recorded using an IC recorder and transcribed verbatim. Each interview lasted approximately 30–60 minutes, with one or two sessions conducted per participant. Interviews were conducted during outpatient treatment waiting times in a private room to ensure confidentiality.

Contents of the interview

An interview guide, developed by the researcher based on the study objectives, was used to facilitate discussion. Participants were encouraged to speak freely about:

• The monitoring and strategies they have used to prevent pain and fractures since being diagnosed with bone metastasis.

• Changes in their lifestyle due to pain and pathological fracture risk associated with bone metastasis, and how they managed these changes.

• Emotional responses following the diagnosis of bone metastases, and the strategies they employed to cope with these emotions.

The interviewer was a nurse specializing in cancer care with extensive experience caring for patients with bone metastases. Although trained in qualitative interview techniques, the interviewer's professional perspective may have influenced the data collection process.

Contents of the medical record investigation

After obtaining participants' consent, information was extracted from their medical records, including age and primary disease diagnosis, nature and location of bone metastases, restrictions on bed rest, use of bone-modifying drugs, and administration of chemotherapy, molecular targeted therapy, endocrine therapy, or radiation therapy, or a history of surgery related to bone metastases, and the use of prosthetic devices.

Data analysis method

Medical record data were analyzed by organizing each participant's characteristics, including the nature of bone metastases, assessment of pathological fracture risk, history of treatments related to pathological fracture prevention, necessary lifestyle restrictions, and measures taken to address these restrictions. These factors were treated as participant attributes.

Interview data were analyzed using Kinoshita's M-GTA [24]. The analytical focus was defined as "patients with breast cancer and bone metastases," and the analytical theme was "the process by which patients with breast cancer self-manage pain and pathological fracture risk, associated with bone metastases."

Analysis began with a detailed reading of the verbatim transcript of a case containing a rich narrative. Passages relevant to the analytical theme were extracted to generate concepts. For each concept, an analysis worksheet was created, including a definition, variations (specific examples), and theoretical notes. Data from subsequent participants were continuously compared with existing concepts, and concepts were revised iteratively in response to new variations. Theoretical saturation was considered achieved when no new variations emerged.

After completing the analysis of all participants, relation-

ships between concepts were examined, categories and core categories were identified, and a diagram illustrating the results was created. Finally, a narrative storyline was developed to explain the diagram.

Rigor

M-GTA enhances the depth of interpretation by identifying the analytical theme and focal patient, allowing researchers to consider the social and cultural context of participants' actions and interactions. Multiple concepts generated during analysis were compared, examining both similar and contrasting examples, and continuous comparative analysis was conducted to refine concept generation and achieve theoretical saturation. Data interpretation was further refined through repeated analysis until discrepancies between researchers were resolved. The entire analytical process was also supervised by experts in qualitative research and cancer nursing to ensure methodological rigor.

Ethical considerations

This study was approved by the Osaka Medical and Pharmaceutical University Ethics Review Committee (2024-048) and by the Ethics Review Committee of the data collection facility. Participants received both verbal and written explanations regarding the voluntary nature of participation, the right to withdraw at any time, the protection of privacy, and methods for data management.

RESULTS

Overview of study participants

The study included 17 patients currently receiving treatment at three medical institutions across two regions of Japan (**Table 1**). The median age was 54.0 years (range, 44–76 years). Tumor subtypes were luminal A in eight patients (47 %), luminal B (HER2 - positive) in eight patients (47 %), and luminal B (HER2-negative) in one patient (6 %). Fifteen patients had received chemotherapy, including molecular targeted agents, and all had received endocrine therapy. The interval from bone metastases ranged from 5 months to 4 years and 7 months. Ten patients had metastases to organs other than bone, whereas seven had bone-only metastases. Metastatic sites included the spine alone in three patients, the spine and scapula in two, the spine and pelvis in four, and the spine, pelvis, and femur in eight. All participants received the bone-modifying agent denosumab, and four had additionally undergone radiation therapy for bone metastases.

Fourteen patients had previously experienced pain associated with bone metastases, whereas three reported little or no pain. At the time of diagnosis, 10 participants reported severe pain with Numerical Rating Scale scores of 7–10; by the time of the interview, pain levels in almost all participants had reduced to 0–3. Patients with extensive metastases, such as involvement of the entire spine and femur, tended to experience more severe pain than those with more localized metastatic disease. Twelve participants continued working, while five retired following the diagnosis of bone metastasis. Of those who retired, three did so due to severe pain. Notably, four of the five retired participants were diagnosed synchronously with breast cancer and bone metastases.

Summary of results

A total of 27 concepts were generated and consolidated into nine categories, from which one core category was identified. Hereafter, categories are denoted using single quotation marks (‘ ’). The resulting storyline is presented below, together with a diagram illustrating the analytic process (**Figure 1**).

Storyline (Figure 1)

Self-management of pain and pathological fracture risk in patients with breast cancer and bone metastases was conceptualized as a process based on the core category of ‘pain relief and the acquisition of safe movements using physical sensations and information as clues.’ This process progressed in stages as participants sought to ‘maintain psychological stability in the face of threats of death and disease propression.’

The core categories served as a starting point for behavioral change, triggered by ‘fearful experiences due to pain’ and ‘fear of unknown fractures’ following the diagnosis of bone metastases. In response, participants explored coping strategies in their daily lives by linking ‘learning safe movement through trial and error’ with ‘strategies to reduce bone load.’

To further alleviate pain, participants engaged in the ‘acquisition of skills to use analgesic agents appropriately’. To address pathological fracture risk, they also sought to enhance physical stability through ‘strengthening physical functions according to bone fragility’. Because reducing bone load and strengthening physical function could sometimes be conflicting goals, participants consciously adjusted their activities to maintain a safe balance while avoiding excessive restrictions on daily activity.

By employing these strategies and innovations, participants were able to ‘adapt social roles to accommodate physical limitations’ and continue fulfilling their roles within the family and society. As a result, they developed a sense that ‘life will continue,’ which served as an important source of psychological support and motivation to live.

Definitions of each category and concept

The definitions of each of the nine categories are presented below. Angle brackets (< >) indicate concept names, italics denote variations (specific examples), square brackets ([ ]) indicate additional information provided by the

Table 1 Overview of participants

	Age	Period from the diagnosis of bone metastasis (Breast cancer diagnosis timing)	Bone metastasis site	Non-bone metastases	Radiation therapy · Corset	NRS (Past →present)	Occupation
A	40s	4 years and 5 months (4 years and 7 months)	Th4,7, Th9–12, L2, left ilium	liver, pleura	soft corset	10→2	Nutritionist
B	40s	3 years and 5 months (3 years and 6 months ago)	Th12, L2,5	bones only	None	2–3	Administrative work
C	50s	2 years and 2 months (Synchronous)	Th9,11, L2, scapula, ribs, femur	stomach/small intestine	Th8–L2: 30 Gy	10→0	Former nursery school teacher
D	60s	1 year and 4 months (17 years ago)	entire spine, left clavicle, ribs, scapula, both pelvis, left femur	bones only	None	4→0	Certified clinical psychologist
E	40s	4 years and 7 months (Synchronous)	Th2,5,12, L3,5, S1, sternum, ilium	liver	None	5→1	Former part-time worker
F	60s	2 years and 8 months (4 years ago)	C4, Th6,12, L1–2	liver, pleura	None	0	School librarian
G	60s	2 years and 9 months (18 years ago)	C6, Th3–7, right scapula	left mediastinum, hilum	soft corset	7→0	Former office worker
H	40s	3 years (Synchronous)	C6, Th9–11, L3, left sacrum, right ilium	brain	None	10→0	Administrative work
I	50s	2 years and 7 months (14 years ago)	C2, Th4,7,9–11, L1–3, pelvis	cerebellum, liver metastases	cervical collar	0	University secretary
J	40s	2 years and 9 months (Synchronous)	entire spine, hips, sacrum, both humeri, both femurs, clavicle, pelvis	bones only	Rigid corset	10→0	Mail order store worker
K	50s	2 years and 9 months (Synchronous)	C1,3,6, Th5,7,10,11	bones only	C6,7, Th5–11: 30 Gy, cervical collar	8→0	Administrative work
L	40s	5 months (Synchronous)	whole spine, pelvis, sternum, left femoral head,	bones only	None	10→0	Former proofreading administrative work
M	70s	6 months (21 years ago)	L3, right scapula	bones only	None	9→2	Department store food sales
N	60s	1 year (19 years ago)	C5–6, Th3–6,11,12, L2,5, sacrum, pelvis, left clavicle, right scapula, right femur	axillary lymph nodes	C5,6, L2,5: 8 Gy	5→3	Administrative work
O	60s	1 year and 2 months (Synchronous)	entire spine, ribs, pelvis, scapula, sternum, right femur	bones only	None	10→2	Former hypnotist
P	50s	3 years and 4 months (5 years and 8 months)	Th9–12, L4, pelvis, femur, sternum	both ovaries, right gluteal muscle	None	0	Cosmetics sales associate
Q	70s	2 years and 10 months (24 years ago)	Th7–8,10,12, L1,3–5, Ilium, femur	lungs, subclavian lymph nodes	L5: 25 Gy	8→0	Housewife

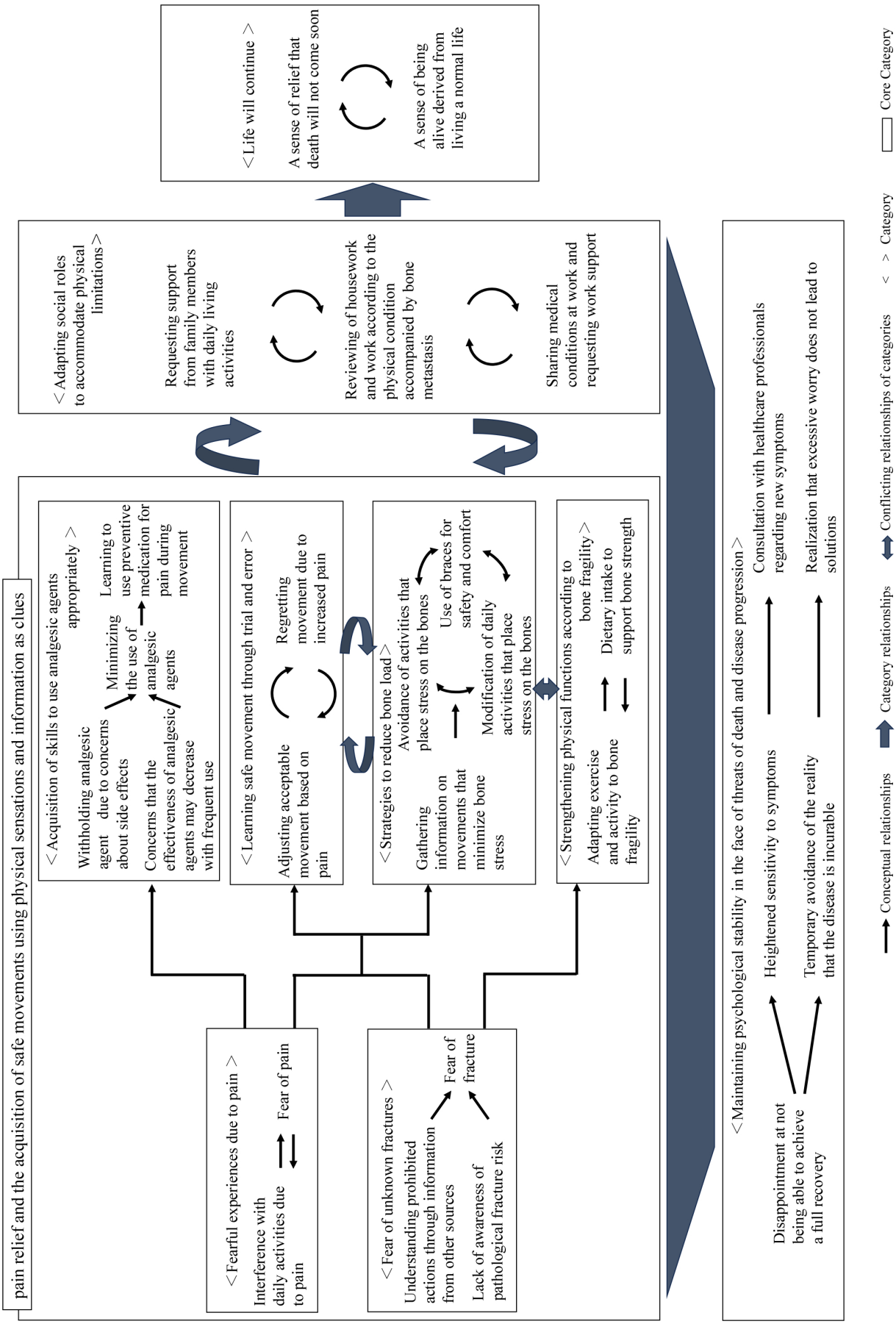

Figure 1 The Self-management Process for Pain and Risk of Pathological Fractures Associated with Bone Metastases in Patients with Breast Cancer

researcher, and parentheses at the end of a sentence identifies the research participants. Detailed definitions of each concept are provided in **Table 2**.

Maintaining psychological stability in the face of threats of death and disease progression

This category consisted of the following concepts: <Disappointment at not being able to achieve a full recovery>, <Heightened sensitivity to symptoms>, <Consultation with healthcare professionals regarding new symptoms>, <Temporary avoidance of the reality that the disease is incurable>, and <Realization that excessive worry does not lead to solutions>.

Although participants experienced psychological distress due to the perceived threat of death and the limited possibility of complete recovery following a diagnosis of bone metastasis, they demonstrated the ability to interpret new symptoms as potential indicators of disease progression and to seek timely medical consultation. At the same time, they maintained psychological stability by temporarily distancing themselves from persistent anxiety about death and by recognizing that excessive worry would not resolve their concerns.

I was told it was incurable due to the recurrence of distant metastasis, so I was more concerned about the fact that it was incurable than about the bone metastasis. I think I was pretty exhausted for about a month, wondering what to do. (Omitted) I kept going around in circles, thinking only about negative things. But when I think about it, I can't escape from it, so I try to separate those thoughts from myself and put them aside for a while. Even so, I still think about them. I can't stop thinking altogether. I know these worries will not go away, but for now, I deal with them by setting them aside. (F)

It happened once, my back hurt so badly that I could barely move.

I didn't have an appointment at the hospital at that time, but I was able to [contact doctor] to see a doctor. I was frightened because I suddenly experienced pain that I had never felt before. In the end, I learnt that it was temporary... (Omitted) [When I experience pain that I have never had before], I immediately imagine that the disease is getting worse. I think situations like this will probably happen again. (K)

Fearful experiences due to pain

This category comprises the concepts of <Interference with daily activities due to pain> and <Fear of pain>.

Participants experienced pain that substantially disrupted their daily lives. Episodes of particularly severe pain left a lasting impression of fear associated with intense physical sensations.

Currently, I am not as physically active as I used to be, and I am still a little terrified to lift heavy objects. Compared with the past, there are times when I can lift things naturally can use my strength; I [just] lift it without consciously thinking about it. However, if I overexert myself, I am afraid that the pain will recur. That possibility makes me feel frightened [because I experience pain]. (C)

My back pain is so much that I haven't taken a bath for a long time. I barely manage to bathe, so I feel dirty. I could hardly wash my hair. I can't even wash my face. Because I can't bend over, I can't put on or change my clothes. When I come to the hospital, I always wear a skirt because I can't put on pants. It was tough to put both legs into pants. (O)

Fear of unknown fractures

This category comprises the concepts of <Understanding prohibited actions through information from other sources>, <Lack of awareness of pathological fracture risk>, and <Fear of fractures>.

Participants were initially unaware of their risk of pathological fracture. However, information and warnings from physicians and family members regarding daily movements heightened their awareness of the possibility of unexpected fractures, which in turn generated anxiety.

My daughter told me it is not good to move my body suddenly, that I should move slowly, and that twisting my body is also not good. I try to be careful, following my daughter's advice. (D)

I became afraid of falling off my bike. I live in an apartment building, and the bike parking area is not flat; it is somewhat mechanical, so I have to lift the bike, which is difficult. The doctor told me that if I fell off and broke a bone, I wouldn't be able to walk, so I became frightened and stopped [riding my bike]. (J)

Acquisition of skills to use analgesic agents appropriately

This category comprises the following concepts: <Withholding analgesic agents due to concerns about side effects>, <Concerns that the effectiveness of analgesic agents may decrease with frequent use>, <Minimizing the use of analgesic agents>, and <Learning to use preventive medication for pain during movement>.

Participants expressed concerns about the side effects and reduced effectiveness of analgesic agents. Through experience, however, they learned to determine appropriate timing and methods of administration in advance, based on anticipated physical activity and movements.

When I use analgesic agents too actively, I worry that their effects will eventually wear off. So, even if I feel some pain, I do not switch to a more potent analgesic agent; instead, I continue using the same one from the beginning. I am afraid that increasing the strength (dosage) will cause the effect to wear off. This is my own belief, but I still feel anxious about it. (G)

I have heard that this analgesic agent is effective for about 12 hours after a single dose, so I adjust my dosing

Table 2 Concept list

Category	Concept	Definition
Maintaining psychological stability in the face of threats of death and disease progression	Disappointment at not being able to achieve a full recovery	After receiving an explanation of the patient's condition of bone metastasis from the doctor, the patient is faced with the reality that the cancer is incurable, the awareness of death, and the possibility that it may become difficult to continue to fulfill their social roles, which can lead to a deep sense of loss and depression.
	Heightened sensitivity to symptoms	After receiving an explanation about bone metastasis, patients' attention is excessively focused on the site of bone metastasis, leading to increased sensitivity to pain and discomfort, and an overly conscious awareness of physical discomfort, a psychological and sensory reaction.
	Consultation with healthcare professionals regarding new symptoms	When a person experiences discomfort or pain they have never had before, they become increasingly anxious that the condition is progressing or worsening, and they act quickly to seek advice from a healthcare professional to determine the cause.
	Temporary avoidance of the reality that the disease is incurable	This is the mental process of maintaining a certain psychological distance from the reality of metastasis and temporarily separating one's consciousness from that reality, so as not to worry excessively about the depression and negative thoughts that come with the reality that a cure for cancer is not possible.
	Realization that excessive worry does not lead to solutions	After being diagnosed with bone metastasis and deeply worried about the reality that a complete recovery is not possible and about the future, the patient undergoes a psychological transformation, realizing that worrying about these things will not change the situation and that there is no point in continuing to worry.
Fearful experiences due to pain	Interference with daily activities due to pain	A condition in which pain increases with movements that put stress on the weight-bearing bones, making it difficult to perform physical movements such as bending the hips or knees or walking.
	Fear of pain	When performing a movement that previously caused severe pain, people may feel anxiety or fear that the same pain will recur, resulting in a psychological resistance to the movement.
Fear of unknown fractures	Understanding prohibited actions through information from other sources.	Through multiple sources of information, such as doctors' explanations, advice from family, increased pain, radiological findings, and online information, it is important to recognize movements that put strain on the bone metastasis site and understand that these movements are dangerous and should be avoided.
	Lack of awareness of pathological fracture risk	Because the condition does not interfere with daily life and the patient has not experienced a fracture in the past, the patient is unaware that their bones are at risk of pathological fracture and does not feel a real risk of fracture.
	Fear of fracture	Before and after performing a movement, the patient may feel anxious or worried that the movement will place excessive stress on the bones, causing a fracture, or that a fracture will make it difficult for the patient to walk.
Acquisition of skills to use analgesic agents appropriately	Withholding analgesic agents due to concerns about side effects	Based on past experiences of side effects and information provided by healthcare professionals, the patient is concerned that side effects may occur again if an analgesic agent is used, and refrains from taking oral analgesic agents due to this anxiety.
	Concerns that the effectiveness of analgesic agents may decrease with frequent use	Concerns that the progression of the disease and continued use of analgesic agents may lead to drug resistance, making pain relief ineffective in the future.
	Minimizing the use of analgesic agents	Due to concerns about the weakening of efficacy and the development of tolerance due to frequent use of analgesics, the use of medications in pain management is being avoided as much as possible.
	Learning to use preventive medication for pain during movement	By predicting pain that may occur during movement and using an analgesic agent preventatively before the pain occurs, patients will be able to intuitively understand the effective timing and effects of medication and use it daily.

Table 2 Concept list (continued)

Category	Concept	Definition
Learning safe movement through trial and error	Adjusting acceptable movement based on pain	Using the changes in pain that occur with movements that place stress on the bone metastasis site and the pain that appears after movements as indicators, movements that can be performed without causing pain should be selected and modified.
	Regretting movement due to increased pain	Estimating one's own abilities and performing an action unexpectedly increases pain, leading to regret and self-blame.
Strategies to reduce bone load	Gathering information on movements that minimize bone stress	To reduce strain on the bone metastasis area, one should obtain information about how to move one's body and how to maintain one's posture from reliable sources such as healthcare professionals, family members, and the internet.
	Avoidance of activities that place stress on the bones	Based on the doctor's explanation, family advice, or physical reactions such as increased pain, the patient becomes aware of activities that may place excessive strain on the bone metastatic site and consciously avoids them.
	Modification of daily activities that place stress on the bones	To prevent damage and recurrence of pain due to excessive stress on the bone metastasis site, previous daily activities should be reevaluated and corrected to be safer and less stressful, taking into account past pain and fear of fracture, explanations from the doctor, and warnings from family members.
	Use of orthoses for safety and comfort	To alleviate pain and fear of fractures associated with physical activity and to enable safe daily living, orthoses should be used based on medical judgment and the individual's needs.
Strengthening physical functions according to bone fragility	Adapting exercise and activity to bone fragility	To avoid the fear that restricting movement too much to prevent fractures may result in muscle weakness and the inability to walk, it is important to incorporate exercises and activities into your daily life that are tailored to your bone fragility.
	Dietary intake to support bone strength	Intentionally consuming foods that are thought to be effective in improving or strengthening bone fragility, based on the recognition that one is at high risk of fracture or has a condition in which bone density has decreased.
Adapting social roles to accommodate physical limitations	Reviewing housework and work according to the physical condition accompanied by bone metastasis	Given the physical limitations caused by bone metastasis, patients should review their current household chores and work patterns, and appropriately adjust their work content, working hours, and household chores according to their physical condition in order to reduce the physical burden.
	Requesting support from family members with daily living activities	When daily activities become difficult to perform due to stress on the bone metastatic site, asking one's family for cooperation or to act on the patient's behalf, taking into account one's own physical condition.
	Sharing medical conditions at work and requesting work support	Appropriately informing one's supervisor or colleagues at work about the work or tasks that have become difficult to perform due to the patient's illness, and asking for their cooperation in adjusting the patient's work or obtaining support.
Life will continue	A sense of relief that death will not come soon.	Understanding that the presence of bone metastasis does not immediately lead to death reduces anxiety about death and provides psychological stability.
	A sense of being alive derived from living a normal life	As symptoms improve during the course of treatment, and patients can live a life in which they can fulfill their social roles, they develop positive feelings and a positive attitude toward life.

based on my activity schedule. I usually go to bed quite late, so taking it before bed works well for me. For example, if I take it at 1 a.m., I am fine the next day and do not need an additional dose. (H)

Learning safe movement through trial and error

This category comprises the concepts of <Adjusting acceptable movement based on pain> and <Regretting movement due to increased pain>.

By using pain associated with movement and activity

as an indicator, participants identified ways to move with less physical strain. By experiencing discomfort following specific movements, they came to understand, via physical sensations, the limits of movement they could perform comfortably and gradually incorporated these limits into their own pattern of behavior.

If I walk too much, I feel pain in my lower back, but I can walk without problems if I limit it to about 30 minutes. If I am late for the morning commute, I sometimes walk at a faster pace. I think I need to be more careful [because I put more strain on my body than usual]. (B)

I noticed this while driving. Even when I am sitting still, there is quite a bit of engine vibration that I had not been aware of before. Because I have pain, I now perceive these fine vibrations as painful. (Omitted) When I lift and carry heavy items, pain appears [depending on the load]. It doesn't last for many days, but pain sometimes remains in my groin or leg for about a day. When I have to carry my luggage for a while, I eventually feel pain in my legs and realize that "I have overdone it". (E)

Strategies to reduce bone load

This category comprises the following concepts: <Gathering information on movements that minimize bone stress>, <Avoidance of activities that place stress on the bones>, <Modification of daily activities that place stress on the bones>, and <Use of orthoses for safety and comfort>.

Although participants were initially unable to recognize their own risk of pathological fractures, they used information provided by healthcare professionals and close friends to identify movements and behaviors in daily lives that posed a higher risk of fracture. Based on this information, they intentionally modified or restricted their activities to reduce bone load and avoid potential danger.

Even when I need to pick something up, I get on my knees instead of squatting. I always make sure to do that because I am afraid of losing strength when squatting. I feel I can walk pretty well, but I might fall backwards, especially in the bathroom. So I have to be careful there. If I fall, I might end up [bedridden]. Because of that, I take everything slowly. I don't rush. I really move very slowly. (Q)

I always wear a corset before starting activities. I also do it when I have to sit for long periods because I tend to have pains. I wear it when I travel as well, since I've had long-standing problems with my lower back. I absolutely need to wear it when bending forward. If I don't wear a corset while cleaning the bathtub, I hurt my lower back. I have strained my lower back many times, so I am familiar with this pattern. I decide whether to use a corset based on the condition of my lower back. A fracture would be the worst outcome, and that possibility scares me. (G)

Strengthening physical functions according to bone fragility

This category comprises the concepts <Adapting exercise and activity to bone fragility> and <Dietary intake to support bone strength>.

Participants sought ways to reduce bone fragility and maintain or strengthen muscles by balancing movement restriction aimed at fracture prevention with the need to avoid physical decline resulting from muscle weakness.

I do exercises like this on my bed before going to sleep [leg-lifting exercises], but I worry that if I rely too much on the support of people around me, I might lose my strength in my abdominal and back muscles. I feel that losing it would not be good (muscle strength). (N)

When I first heard about the bone metastasis, I thought I needed to increase my bone density. So I became very conscious of what I ate and drank, including yogurt, milk, and other calcium-rich foods. I felt that I needed to be careful about my diet. (H)

Adapting social roles to accommodate physical limitations

This category comprises the following concepts: <Reviewing housework and work according to physical condition accompanied by bone metastasis>, <Requesting support from family members with daily living activities>, and <Sharing medical conditions at work and requesting work support>.

Although participants experienced physical difficulties that interfered with daily activities, they shared responsibilities with the support of family members and colleagues. This approach allowed them to continue fulfilling roles at home and at work while maintaining social connections.

I try to be careful not to overexert myself and to avoid putting too much strain on my body. I fulfill my role at work, but I make efforts to conserve my energy. I also decided for myself not to work overtime and to leave on time. I try to avoid putting too much strain on myself so that I can continue going to work the next day. (A)

Sometimes my condition causes problems at work, so I inform my colleagues when that happens. I feel I may be causing inconvenience to people in my department, especially when I feel tired or have a fever and need to take a day off. (P)

Life will continue

This category comprises the concepts of <A sense of relief that death will not come soon> and <A sense of being alive derived from living a normal life>.

When participants were diagnosed with bone metastasis, they were initially preoccupied with the thought of death. However, as their pain was alleviated and they learnt ways to use their bodies effectively, they began to feel capable of continuing to fulfill their roles at home and in society. As a result, their confidence in maintaining their livelihood

increased, and this confidence became a source of strength that supported their will to live.

Yes, I have cancer, but I am working, doing the same things as everyone else, and I am managing the housework. When I think about it, I am just the same [as everyone else]. Even though I have cancer, I try to live as normally as possible while I can. I take a lot of medication, but I don't feel that I am sick. (J)

I don't have thoughts like, "I am going to die in a few years, so it is all over". I am alive and healthy right now, I can see many things, and I can live a normal life. Because of that, I can't really imagine dying in a few years. I do think that I may die someday, but it does not feel imminent. (O)

DISCUSSION

Upon receiving a diagnosis of bone metastasis, participants were confronted with the reality that metastasis could signify death and were required to cope with an existential threat. To manage this psychological burden, participants employed defensive coping strategies, such as temporarily avoiding the fact that a complete cure was not possible. This pattern of coping with emotional distress was observed regardless of the time elapsed since diagnosis.

Previous research has shown that patients with recurrent cancer intentionally avoid detailed information about their condition and prognosis, enabling them to maintain focus on their daily lives without becoming overwhelmed by the severity of their condition [25]. Such information avoidance has been shown to function as a psychological defense mechanism that helps preserve emotional stability [26]. Similarly, participants in the present study appeared to reduce anxiety and achieve psychological stability through maintaining a certain psychological distance from the threat of death and consulting healthcare professionals when concerns arose. This psychological stability facilitated the core process of "pain relief and the acquisition of safe movements using physical sensations and information as clues."

Okamura et al. reported that 35 % of patients with recurrent breast cancer experience adjustment disorders and 7 % experience major depressive disorder, suggesting a high risk of psychological morbidity following a diagnosis of bone metastasis [27]. Therefore, it is essential to assess whether patients with breast cancer and bone metastases can cope appropriately with death-related anxiety and to provide supportive interventions aimed at maintaining mental stability, which is fundamental to promoting effective self-management of pain and pathological fracture risk.

Participants who experienced pain associated with bone metastasis used pain as an indicator to adjust tolerable movements and to acquire safe movement patterns through physical sensations, thereby avoiding the recurrence of fear-inducing pain experiences. The ability to sensitively perceive pain resulting from distortion of the periosteal structure [28, 29] functioned not only as a means of pain monitoring but also as an effective strategy for preventing pathological fracture. These risks are otherwise difficult for patients to perceive. This represents a novel finding of the present study.

During the process of exploring safe movements, participants often experienced greater pain than anticipated when performing movements they had judged themselves capable of, leading to repeated cycles of trial and failure. Therefore, teaching coping strategies that reduce the likelihood of failure while supporting trial-and-error learning is crucial for facilitating "learning safe behavior through trial and error." Because patients with cancer deepen their understanding of the self-relevance of their symptoms through interactions with healthcare professionals [30], timely and appropriate guidance on pain and pathological fracture risk from healthcare professionals is crucial during the early stages following diagnosis.

Many participants minimized their use of analgesic agents due to concerns about side effects and drug resistance, yet they nonetheless experienced pain relief. This effect may be related to the pharmacological action of the bone-modifying agent denosumab. Denosumab is a human monoclonal antibody that binds to receptor activator of nuclear factor κB ligand, which plays a central role in bone metabolism, thereby inhibiting osteoclast maturation and function [31]. Through this mechanism, denosumab suppresses bone resorption and shifts bone turnover from destruction toward regeneration, resulting in increased BMD [32]. Furthermore, pain reduction associated with denosumab has been reported [33], suggesting that participants were able to achieve pain control while limiting their use of analgesic agents.

These findings highlight the effectiveness of a pain-management strategy that integrates bone-modifying agents with consideration of patients' psychological resistance to analgesic medication. Because denosumab typically requires approximately 2 months to exert a clinically meaningful effect on bone metastasis-related pain [33], it is advisable to inform patients in advance that pain relief may be delayed and not immediate, thereby helping to align expectations. Furthermore, participants successfully managed their pain by using pain as an indicator to adjust their movements and select activities that placed less mechanical strain on the bones. Decision-making regarding the anticipatory timing of analgesic use also represents a key self-regulation strategy. Healthcare professionals should respect patients' symptom-based judgments while providing appropriate guidance on safe and effective medication use.

Participants with limited pain experience relied on information provided by healthcare professionals and family members to identify movements requiring caution. Although they experienced anxiety about losing independence due to fractures, they independently modified or

avoided movements and activities that imposed a high mechanical load on the bones. This behavior reflects their acquired understanding of pathological fracture risk and their ability to identify potential fracture risk through monitoring activities of daily living.

Patients' ability to accurately understand their condition and treatment and to analyze their impact on QoL has been shown to contribute to improved self-management [34]. Additionally, participants utilized external information to accurately assess their physical condition. They voluntarily selected behaviors to avoid fracture risk, demonstrating that they not only accepted the information provided but also actively applied the knowledge they had acquired. Most participants were also receiving denosumab, which has been reported to reduce fracture risk [35]. Therefore, regular assessment of bone characteristics is essential to address the risk of pathological fractures that patients may not readily perceive. In addition, flexible support is need to help patients adjust daily activities in response to changes in bone lesions associated with chemotherapy and denosumab administration. Looking ahead, nursing support should focus on enabling patients to correctly understand their bone condition and to maintain daily life with a sense of security, without imposing excessive activity restrictions driven by fear of fractures.

The five participants who chose to resign from their jobs were experiencing severe pain at the time of their bone metastasis diagnosis, which markedly interfered with daily activities and made continued employment difficult. Previous research involving patients with metastatic breast cancer has similarly demonstrated that pain and fatigue are major factors inhibiting continued employment [36], highlighting the importance of effective pain management. Because pain relief associated with denosumab requires time to become apparent, it is imperative to communicate this information to patients at the initiation of treatment and to provide early support that enables them to learn safe movements that minimize mechanical stress on bone lesions. In addition, the high proportion of patients who retired after being diagnosed synchronously with breast cancer and bone metastasis suggests that psychological factors may have influenced pain perception and management. Therefore, comprehensive pain assessment immediately following a diagnosis of bone metastasis, together with early, multifaceted pain management interventions, is essential to support patients in maintaining functional capacity and continued employment.

In contrast, participants who were able to continue working informed their workplace about tasks they found challenging and requested appropriate support. Previous research on employment among cancer survivors found that individuals who continue working during treatment are more likely to receive flexible work adjustments [37]. Therefore, it is important to support patients in recognizing work-related roles they can no longer perform and in advocating for reasonable adjustments to their work responsibilities.

Through the process of "pain relief and the acquisition of safe movements using physical sensations and information as clues," participants were able to continue their daily lives as members of society while relying on others to compensate for roles they could no longer fulfill. Maintaining this lifestyle fostered a sense of being able to 'lead a normal life' and reinforced the perception that 'life will continue.' Previous research suggests that role restrictions resulting from declining physical function can undermine patients' sense of control over their lives [38], and that difficulties in continuing work, in particular, may lead to existential confusion and loss of identity [39].

In this study, effective management of pain associated with bone metastases and pathological fracture risk enabled participants to maintain social roles within their families and workplaces, which emerged as a key factor supporting their sense of being alive. Furthermore, the ability to independently 'lead a normal life', despite changes in physical function, has been reported to help maintain QoL [38]. Therefore, providing support that alleviates pain, facilitates the acquisition of safe movement strategies, and promotes mental stability without overwhelming patients with fear of death, while simultaneously enabling them to maintain their social roles and relationships in family and work settings, forms the foundation for maintaining the perception of 'leading a normal life.' Healthcare professionals should respect patients' physical sensations and lived experiences and support self-management of pain and pathological fracture risk associated with bone metastasis without reinforcing excessive preoccupation with death.

This study uniquely elucidates the process by which patients with breast cancer and bone metastases acquire self-management skills for pain and pathological fracture risk. This finding is significant, as it provides a foundational basis for supporting patients in understanding the characteristics of their own bodies, acquiring the necessary knowledge and skills, and independently managing their daily lives.

Limitations of the study

This study had certain limitations. First, the participants were limited to patients who were able to relatively control their pain, which may have excluded individuals for whom symptom management was more challenging. Future studies should include patients with intractable pain to accumulate knowledge applicable to a broader range of clinical conditions.

Second, because this study targeted patients who were able to implement pain management and fracture prevention behaviors, the sample may have been biased toward individuals with higher self-care abilities. Therefore, future studies should also include patients who experience difficulties

with self-management to comprehensively clarify appropriate support strategies.

Third, although this study focused on pain and bone-related events associated with bone metastases, symptoms related to hormonal therapies administered for the primary disease and bone-modifying agents used to prevent SREs were also observed. Due to the limited number of participants, these aspects could not be sufficiently analyzed or conceptualized. Future research should therefore address not only pain and bone-related events associated with bone metastases, but also the management of a broader range of treatment-related complications.

Fourth, this study was conducted across three facilities, including a regional cancer center, all were located in urban areas and advanced in the provision of care for bone metastases. As a result, there may be bias related to patient resources, healthcare environments, and care systems compared with other settings, particularly in rural or less specialized facilities.

Fifth, the researcher is a nurse specializing in cancer nursing with extensive experience caring for patients with bone metastases. Although efforts were made to ensure rigor, the researcher's professional background and clinical experience may have influenced data collection and interpretation during the interviews.

Finally, patients who had not received bone-modifying agents and those who had undergone surgery for bone reinforcement were excluded, thereby limiting the study population. Further research is needed to explore the experience of patients at high risk of fracture, including those who have undergone surgical intervention.

CONCLUSION

After receiving a diagnosis of bone metastasis, patients with breast cancer gradually progressed through the core process of "pain relief and the acquisition of safe movements using physical sensations and information as clues" while maintaining psychological stability in the face of the threat of death and disease progression. This study demonstrates that patients adjusted their movements in response to bodily sensations and proactively selected behaviors to minimize the risk of pathological fracture, highlighting an important aspect of self-management.

In the future, it is essential to respect patients' ingenuity and self-devised strategies while supporting adaptive movement adjustments in response to changes in bone condition, thereby avoiding unnecessary or excessive activity restrictions. In addition to achieving timely management of pain and pathological fracture risk associated with bone metastasis, healthcare professionals should support patients in continuing to fulfill their daily roles and sustaining a sense of 'leading a normal life.'

AUTHOR CONTRIBUTIONS STATEMENT

Masamichi Fukuda: Conceptualization, methodology, formal analysis, investigation, writing–Original draft, visualization, and funding acquisition.

Kumi Suzuki: Supervision, project administration, formal analysis, investigation, and writing–original draft.

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DATE AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

DECLARATION OF COMPETING INTERESTS

The authors declare no conflict of interest associated with this manuscript.

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