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Effect of low-intensity aerobic exercise using a cycle-ergometer on insomnia level and quality of life in breast cancer patients undergoing chemotherapy

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ABSTRACT

Background: Patients undergoing chemotherapy are two to three times more likely to experience insomnia, with the highest prevalence reported among breast cancer patients. This condition markedly reduces quality of life. This study aimed to assess whether a low-intensity aerobic exercise program using a stationary bicycle could alleviate insomnia and improve patients' quality of life.

Methods: A randomized controlled trial was conducted at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, involving female breast cancer patients undergoing chemotherapy. Participants were assigned to either a treatment group, which performed low-intensity cycling twice weekly for eight weeks, or a control group with no exercise intervention. Changes in insomnia severity and quality of life were assessed using validated questionnaires before and after the intervention.

Results: Among the 20 participants who completed the study, the treatment group showed a significant reduction in insomnia severity ($p < 0.001$) and greater improvements in physical function, symptom management, and overall well-being compared to the control group.

Conclusion: Low-intensity aerobic exercise on a cycle ergometer is a safe and effective way to reduce insomnia and improve quality of life in breast cancer patients undergoing chemotherapy.

Keywords: aerobic exercise, breast cancer, chemotherapy, insomnia, quality of life.
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INTRODUCTION

Insomnia is a common sleep disorder characterized by difficulty initiating or maintaining sleep, resulting in daytime fatigue, impaired functioning, poor work performance, social isolation, and reduced quality of life.[1] Its prevalence is especially high among cancer patients, who experience insomnia at rates nearly three times greater than the general population, with 30–50% reporting sleep disturbances.[2]

Research indicates that 31–54% of newly diagnosed cancer patients or those within six months of treatment onset experience insomnia.1 Breast cancer is one of the most common cancers worldwide, accounting for nearly 12% of all cases and predominantly affecting women. By 2020, 7.8 million women had survived breast cancer for at least five years, making it the most prevalent cancer globally. The incidence rate among women is 42.[1] per 100,000 population.3 In Indonesia, a survival study at Dr. H. Abdul Moeloek Regional General Hospital reported 20.8% deceased (10 patients), 64.6% lost to follow-up (31 patients), and 14.6% alive (7 patients).[4] Savard (2009) reported the highest rates among breast cancer patients and the lowest among prostate cancer patients.[5]

Breast cancer patients face a significantly higher risk of insomnia than both other cancer patients and the general population.[6] Over one-quarter experience insomnia during chemotherapy, with many continuing to suffer after treatment compared to those not undergoing chemotherapy.[7] Insomnia in breast cancer patients is influenced by cancer stage, time since diagnosis, recurrence, comorbidities, and treatment. Treatments may exacerbate insomnia through emotional stress and side effects such as nausea, vomiting, pain, fatigue, hormonal changes, and hot flashes from chemotherapy.[1] So (2021) reported that fatigue, sleep disturbances, and psychological symptoms (e.g., anxiety, depression, irritability, sadness, worry) are the most common symptom clusters in these patients.[8]

Insomnia in breast cancer patients can arise from the disease itself, its treatment, or treatment-related side effects. Depression is common after diagnosis or disease progression and is often aggravated by reduced aerobic capacity, fatigue, and muscle weakness, all of which impair quality of life and sleep.[9] During chemotherapy, insomnia may be triggered by tumor effects, psychological

stress, chemotherapy's direct impact, pre-treatment medications such as steroids, and decreased physical activity.[4] Consequently, cancer patients face an elevated risk of chronic insomnia and reduced quality of life. Despite its high prevalence, insomnia has received less attention than other symptoms, underscoring the need for further research.[10]

Exercise is a non-pharmacological option for managing insomnia. A study reported improved sleep quality and significant reductions in melatonin and cortisol levels after six weeks of moderate aerobic exercise compared to a control group following only a home program.[11] Similarly, a systematic review and meta-analysis of ten studies on patients with neurological disorders (Tramontano, 2021) found that aerobic exercise significantly improved insomnia symptoms.[12] Thirty minutes of low-intensity aerobic exercise using an ergometer during chemotherapy is safe and enhances patients' ability to perform activities of daily living (ADL). It also improves sleep quality, reduces anxiety, depression, and fatigue, and enhances overall quality of life.[11] Patients with stage I–III breast cancer undergoing adjuvant chemotherapy reported better sleep quality and quality of life by the eighth week of exercise.[13]

Research on the safety and effectiveness of exercise during chemotherapy has been conducted in several countries, but data from Indonesia remain limited. This study aimed to demonstrate that low-intensity cycle-ergometer exercise can reduce insomnia and enhance quality of life in breast cancer patients undergoing chemotherapy.

METHODS

This study employed a randomized controlled trial with two groups and pre-test/post-test evaluations, conducted at the Medical Rehabilitation Outpatient Clinic of Dr. Soetomo General Academic Hospital from May to November 2024. Eligible participants were female breast cancer patients aged 18–59 years with histopathologically confirmed stage II or III disease undergoing chemotherapy. Inclusion required well-controlled diabetes (HbA1c < 7%, fasting glucose 80–130 mg/dL, 2-hour postprandial < 180 mg/

(continuous or two 10-minute sets), and a 5-minute cool-down. Rest intervals were allowed (exercise-to-rest ratio ≤ 1:1). Two physicians supervised sessions, monitoring vital signs, oxygen saturation, and fatigue.

The control group performed home-based breathing exercises for eight weeks, following pamphlet instructions and daily telephone monitoring. The protocol involved slow nasal inhalation and prolonged exhalation through pursed lips (exhalation twice as long as inhalation), performed for three minutes, 2–5 times daily, in various positions (lying, sitting, standing), and integrated into daily activities. Both groups continued standard oncological care and daily routines but were advised to avoid excessive fatigue and unsupervised aerobic exercise (> 2 times/week, 30 minutes/session). The intervention lasted eight weeks, adjusted to each patient's health status.

Outcomes were assessed pre- and post-intervention using the insomnia severity index (ISI) and the European organisation for research and treatment of cancer quality of life questionnaire-core 30 (EORTC QLQ-C30) for quality of life. Data were analyzed with SPSS v26. Between-group comparisons used independent t-tests or Mann–Whitney U tests, while within-group changes were analyzed with paired *t*-tests or Wilcoxon signed-rank tests, depending on normality (Shapiro–Wilk test). Significance was set at $p < 0.05$.

RESULTS

The study included 23 female patients randomly assigned to the treatment group (n=12) or the control group (n=11). Three participants dropped out: one from the treatment group due to chemotherapy discontinuation, one for not completing the exercise protocol, and one from

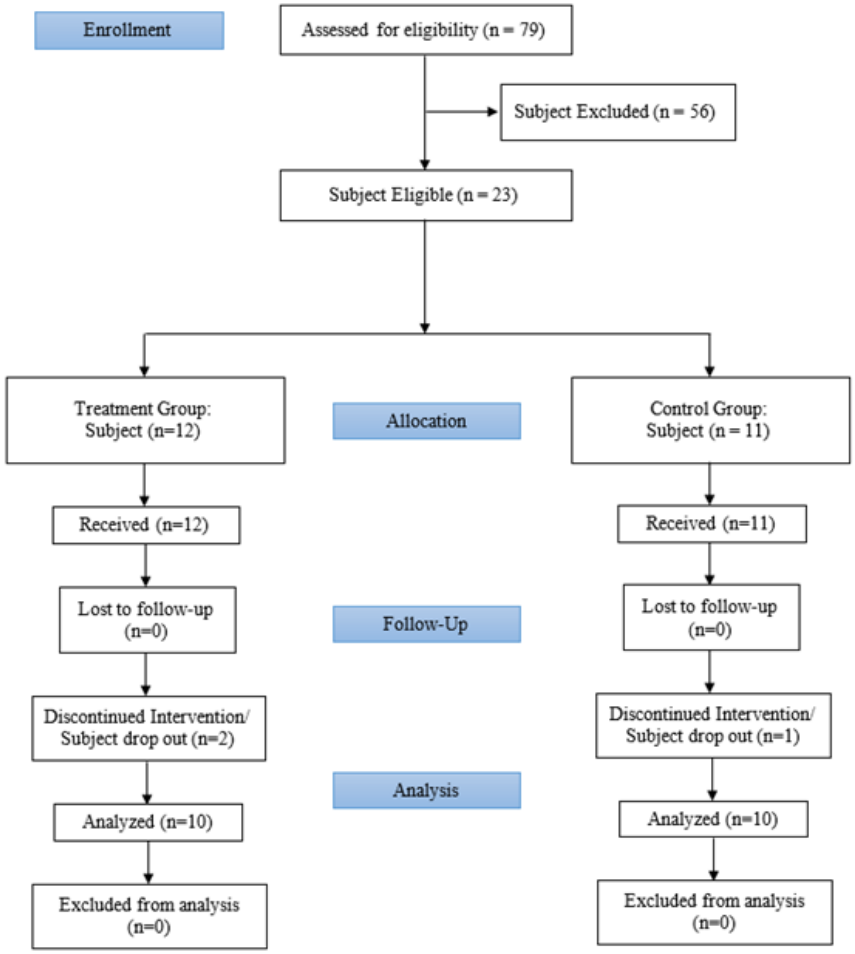

Figure 1. Consolidated standards of reporting trials (CONSORT) flow chart diagram of the study.

dL), well-controlled hypertension (systolic < 140 mmHg, diastolic < 90 mmHg), normal chest X-ray and echocardiography (LVEF ≥ 50% within the past 6 months), MoCA-INA score ≥ 26, low COVID-19 risk score (1–4), ability to perform 30 minutes of low-intensity aerobic exercise, signed informed consent, and oncologist clearance.

Exclusion criteria included hemodynamic instability (systolic BP > 160 mmHg, diastolic BP > 100 mmHg, pulse ≥ 120 bpm, oxygen saturation < 95%, temperature > 38°C), blood abnormalities (Hb < 10 g/dL, platelet < 50,000/µL or > 450,000/µL, leukocyte < 4,000/µL or > 11,000/µL), arrhythmias, respiratory disease exacerbations, musculoskeletal limitations (e.g., lower extremity pain > 4/10), muscle strength < grade 3, brain metastasis, ongoing radiotherapy, recent surgery (≤ 1 month), prior regular aerobic exercise (≥ 2–3 times/week in the past 2 months), inability to walk independently, or Hamilton Depression Rating Scale score ≥ 17. Participants could be withdrawn if they discontinued voluntarily, missed > 3 consecutive sessions or > 20% of total sessions, developed new exclusion conditions, or died during the study.

Screening included medical history, physical examination, cognitive, depression, and fatigue assessments, as well as review of laboratory results, echocardiography, and chest X-ray. Candidates meeting all criteria were approved by the oncologist, provided informed consent, and were randomly assigned to intervention or control groups by drawing lots. Participants received detailed instructions and kept daily diaries of activities, symptoms, and nutrition.

The intervention group performed supervised low-intensity aerobic exercise on a cycle ergometer at the Medical Rehabilitation Unit, combined with independent breathing exercises at home. Exercise commenced alongside chemotherapy cycles, beginning on the laboratory screening day before chemotherapy or the day prior to the third cycle, and continued on day 5 post-chemotherapy. Each session included a pre-exercise assessment. Pedaling speed and resistance were adjusted to achieve the target heart rate (THR = resting heart rate + 30% heart rate reserve, per (American college of sports medicine (ACSM) guidelines). Perceived exertion was monitored using the Borg Scale (11–12).14 The protocol comprised a 5-minute warm-up, a 20-minute core session

Table 1. Subject characteristics

Characteristic	Treatment Group (n=10) Mean±SD or N (%)	Control Group (n=10) Mean±SD or N (%)	P-value
Age (years)	51.4±6.0	47.1±3.6	0.14[a]
Cancer stage			
Stage II	2 (20%)	2 (20%)	
Stage III	8 (80%)	8 (80%)	
Chemotherapy regiment			0.47[b]
Anthracyclines + Alkylating	8 (80%)	100 (100%)	
Other	2 (20%)	0 (0%)	
Prescribed Ondansetron	10 (100%)	10 (100%)	1.00[b]
IPAQ-SF			1.00[b]
Low	10 (100%)	10 (100%)	
Moderate	0 (0%)	0 (0%)	
High	0 (0%)	0 (0%)	
Body mass index, kg/m2			1.00[b]
< 18.5	1 (10%)	1 (10%)	
18,5 - 22,9	1 (10%)	1 (10%)	
23.0 - 24.9	3 (30%)	3 (30%)	
25.0 - 29.9	5 (50%)	5 (50%)	
> 30	0 (0%)	0 (0%)	
Anxiety Level			
No Anxiety	7 (70%)	4 (40%)	0.37[b]
Mild Anxiety	3 (30%)	6 (60%)	
Depression Level			
No Depression	7 (70%)	6 (60%)	1.00[b]
Mild Depression	3 (30%)	4 (40%)	

IPAQ-SF, international physical activity questionnaire-short form; kg/ m2, kilogram per meter squared; N, number of subject;
[a], independent t test
[b], Chi Square test

Table 2. Pre- and post-intervention scores of the insomnia severity index (ISI) in both treatment and control groups

Group	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	P-value[a]	Effect size (Cohen's d)
Control Group	19.30±3.268	16.50±1.780	0.008	1.07
Treatment Group	21.60±2.952	2.70±1.160	<0.001	5.88
P-value[b]	0.608	<0.001	-	-
Effect size (Cohen's d)	1.07	9.18	-	-

[a], paired t test
[b], independent t test

the control group due to a change in treatment. Thus, 20 subjects were analyzed (**Figure 1**). No serious side effects from the intervention were reported. Statistical tests were conducted on 10 participants in each group who completed the study, with no significant baseline differences between groups ($p > 0.05$). **Table 1** presents the participants' general characteristics.

Table 2 summarizes ISI scores before and after the intervention. No significant difference was observed between groups at baseline (p = 0.608, Cohen's d = 1.07). Significant within-group improvements were found in both groups (treatment: $p < 0.001$, Cohen's $d = 5.88$; control: $p = 0.008$, Cohen's $d = 1.07$). Post-intervention, ISI scores were significantly lower in the treatment group compared to the control group ($p < 0.001$, Cohen's $d = 9.18$).

Table 3 shows EORTC-QLQ-C-30 results. At baseline, there were no significant differences between groups. After the intervention, significant improvements across all domains were observed in the treatment group, while no significant changes were found in the control group. Post-intervention, all domains differed significantly between groups ($p < 0.001$).

Table 3. Pre- and post-intervention scores of the European organisation for research and treatment of cancer quality of life questionnaire-Core 30 (EORTC-QLQ-C30) in both treatment and control groups.

Group	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	P-valuea	Effect Size
Control group				
Domain functioning	65.77 ± 3.17	65.77 ± 2.61	1.000[a]	3.1[c]
Domain symptom	48.20 ± 8.70	51.28 ± 8.28	0.09[a]	2.9[c]
Domain quality of life	25.0 ± 8.78	29.95 ± 5.82	0.063[b]	1.8[d]
Treatment group				
Domain functioning	62.66 ± 5.82	84.22 ± 7.44	<0.001[a]	3.2[c]
Domain symptom	49.99 ± 9.22	10.25 ± 3.8	<0.001[a]	4.9[c]
Domain quality of life	29.99 ± 4.30	75.83 ± 2.63	0.004[b]	-2.8[d]
P-valueb				
Domain functioning	0.118[e]	<0.001[e]	-	-
Domain symptom	0.795[e]	<0.001[e]	-	-
Domain quality of life	0.208[f]	<0.001[e]	-	-

[a], Paired *t*-test; [b], Wilcoxon signed rank test; [c], Cohen's *d*; [d], Z score; [e], Independent *t*-test; [f], Mann whitney U test

DISCUSSION

This study shows that a structured, low-intensity aerobic exercise program significantly reduced insomnia severity and improved quality of life in breast cancer patients undergoing chemotherapy. The intervention group demonstrated lower ISI scores and greater improvements across all functional, symptomatic, and global health domains of the QLQ-C30 compared with the control group. These results support supervised cycle ergometer exercise as a safe, effective, non-pharmacological intervention that can be integrated into standard oncological care.

The marked improvement in insomnia in the exercise group supports evidence on the role of physical activity in sleep regulation. The significant reduction in ISI scores suggests mechanisms beyond general well-being. Aerobic exercise may modulate neuroendocrine function, enhancing serotonin and melatonin production to recalibrate disrupted sleep–wake cycles during chemotherapy.[11,12] In contrast, the control group, limited to breathing exercises, showed minimal improvement, highlighting that light activity alone cannot address the multifactorial nature of chemotherapy-induced insomnia.

The improvement in quality of life, measured by the EORTC QLQ-C30, is a key finding. Patients in the treatment group reported better physical function, reduced symptom burden, and greater life satisfaction. These benefits may be attributed to exercise mitigating chemotherapy side effects, particularly by counteracting fatigue through enhanced cardiovascular efficiency and oxygen delivery, which improved daily activity capacity and reduced sedentary behavior linked to weakness and depression.[15,16]

The high baseline prevalence of insomnia and low activity levels in our cohort, as measured by the International Physical Activity Questionnaire (IPAQ), reflected the substantial impact of chemotherapy. All participants were sedentary, a condition worsened by treatment-related fatigue, anxiety, and discomfort.[17] Nevertheless, the treatment group successfully completed the twice-weekly protocol despite experiencing 6–7 days of post-chemotherapy fatigue, demonstrating the feasibility and tolerability of this exercise dosage. These findings challenge the perception that patients are too debilitated to exercise during treatment and highlight physical activity as a potential means to break the cycle of fatigue, inactivity, and functional decline.[18]

Our sample comprised patients with advanced disease (Stages II–III) undergoing active chemotherapy, a group highly vulnerable to functional decline. The exercise intervention appeared to mitigate treatment-related effects, such as reduced aerobic capacity and muscle strength associated with anthracyclines.[19] By enhancing vascular function and stimulating angiogenesis, aerobic exercise likely supported physical performance and independence, contributing directly to improvements in functional quality of life.[20]

Although neurotransmitters such as gamma-aminobutyric acid (GABA) and histamine provide useful context, our study did not measure these biomarkers. Therefore, interpretation should focus on the observed clinical outcomes: reduced insomnia severity and improved patient-reported quality of life. While the significant findings suggest a beneficial physiological effect, the underlying mechanisms, neuroendocrine, immunological, or psychological, remain to be clarified through future biomarker analyses.[21]

This study has notable strengths. The significant reduction in ISI scores, surpassing the minimal clinically important difference (MCID), reflects a meaningful improvement from severe insomnia to sub-threshold symptoms. The

intervention proved both effective and safe for breast cancer patients undergoing chemotherapy. Furthermore, presenting the exercise program as part of a multimodal strategy underscores its value as a complementary, non-pharmacological option for insomnia management in oncology care.

However, several limitations should be acknowledged. The relatively small, homogenous sample (all female, specific age range, cancer type, and treatment stage) limits generalizability. The lack of long-term follow-up prevents conclusions about the durability of effects, and the single-center design may not reflect broader clinical contexts. Future research should recruit larger and more diverse populations, employ multi-center trials, and include extended follow-up to clarify the long-term efficacy of low-intensity aerobic exercise in managing insomnia and improving quality of life in breast cancer patients receiving chemotherapy.

CONCLUSION

This study shows that a structured low-intensity aerobic exercise, 30 minutes on a cycle ergometer with warm-up and cool-down, is safe and beneficial for breast cancer patients undergoing chemotherapy. The regimen significantly reduced insomnia and improved quality of life, highlighting the importance of integrating supervised physical activity into standard cancer care.

ETHICAL CONSIDERATIONS

This study received ethical approval from the Health Research Ethics Committee of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia (No. 0986/KEPK/V/2024).

CONFLICT OF INTEREST

None

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AUTHORS CONTRIBUTION

Concepts, design, intellectual content, literature search, clinical and experimental studies, data acquisition and analysis, statistical analysis, manuscript preparation, editing, and review were carried out by DCP, ILD, DGAS, and DT. DT served as the guarantor.

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