Effect of Resistance Exercises on Muscle Strength, Fatigue Severity and Daily Living Activities among Patients with Liver Cirrhosis

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Abstract

Background: Decreased muscle strength, fatigue and limited in implementing activity of daily livings (ADLs) are prominent symptoms in liver cirrhosis patients. Resistance exercises have shown promising effects on decreasing fatigue severity, increasing muscle strength, increasing the level of independence in performing ADLs. **Aim:** To evaluate the effect of resistance exercises on muscle strength, fatigue severity and ADLs among patients with liver cirrhosis. **Design:** Quasi experimental research design (pre-post-test group). **Setting:** The current research was implemented at the internal medicine department in the University Liver and Digestive System Hospital. **Sample:** Non probability (a purposive sample) of 80 male as well as female patients with liver cirrhosis were recruited and allocated into one group. **Tools:** A structured interview questionnaire sheet, Oxford Scale for Muscle Strength Grading, The Fatigue Severity Scale (FSS), The Katz Index for ADLs. **Results:** illustrates that the proportion of patients with high muscle strength (7-10) increased from 25.0% at baseline to 72.5%, as well as fatigue severity decreased from 75.0% (high fatigue scores 7–10) at baseline to 12.5%, also, ADLs, the percentage of independent patients rose from 12.5% to 62.5% after 12 weeks of intervention. **Conclusion:** Resistance Exercises demonstrated efficacy in reducing fatigue severity as well as, increasing muscle strength and the level of independence in performing ADLs with more pronounced impacts seen with interventions lasting twelve months. **Recommendations:** Resistance exercises should be included in routine treatment regimens for patients with liver cirrhosis, particularly those who are suffering muscular weakness and fatigue.

Keywords: Daily Living Activities, Fatigue, Muscle Strength, Resistance Exercises, Liver Cirrhosis

Introduction

A major global health concern, cirrhosis is most noticeable in the Middle East and North Africa (MENA) area, where it is the primary cause of liver-related death **(Al Ta'ani, et al., 2024).** One of the main causes of illness, mortality, and Disability-Adjusted Life Years (DALYs) worldwide, liver cirrhosis (LC) has caused over 1.3 million fatalities **(Cui, et al., 2024).** The last stage of increasing liver fibrosis is cirrhosis, which ranks as the fourteen most common cause of death globally (**Moon, Singal, & Tapper, 2020 & Al Ta'ani, et al., 2024).** The prognosis of individuals with cirrhosis is significantly impacted by the numerous complications that arise as the disease progresses, such as ascites, variceal hemorrhage, and hepatic encephalopathy (HE) **(Cui, et al., 2024)**. Furthermore, cirrhosis represents a financial burden to society with an approximate 22,808 $ cost

per year per person **(Couret, et al., 2025).** Decreased skeletal muscle strength, fatigue and decreased ability to perform ADLs, are the most common symptoms associated with LC. ADLs need the use of muscles, which are vital for bodily function. Reduced muscle mass and strength are common complications of cirrhosis, which impairs quality of life and makes it harder to perform ADLs **(Aamann, et al., 2020 & Brown, et al., 2025).** Reduction in physical performance, strength, and muscle mass are called sarcopenia is prevalent in individuals with liver cirrhosis and has been detected in 14% to 55% of them **(Cui, et al., 2024).** On other hand, patients with LC frequently experience fatigue and weakness which substantially lowers their quality of life (QoL) **(Liu, et al., 2023).** Fatigue is a component of

nonspecific symptom complexes that are frequently linked to various illness states, including malaise, lethargy, anorexia, listlessness, loss of social engagement, and difficulty concentrating. These symptoms are thought to be secondary to the disease process and have been referred to as "sickness behaviors" **(Bhandari, & Kapoor, 2022).** Fatigue prevalence in cirrhotic patients ranging from 44% to 80%. **(Philips, 2024).** ADLs are essential to manage and to cope with symptoms that arise with LC. Activities or actions that people perform on a daily basis are referred to as ADLs, which is the general term for self-care **(Majeed, & Atiyah, 2020).** The majority of people with chronic liver disease led sedentary lives and is typically not physically active **(Sirisunhirun, et al., 2022).** One in five cirrhosis patients are deemed fragile, and forty percent of patients have functional impairment **(Handelzalts, et al., 2022).**

Exercise has been shown in numerous studies to have benefits, including delaying the onset of sarcopenia, improving muscle mass and strength, enhancing functionality, lowering the risk of falls and fatigue, promoting glycemic control, increasing protein synthesis, and improving QoL, all of which improve prognosis (**Rossi, et al., 2022; AbdelHakim, et al., 2023).** Exercise training is a crucial prescription for all patients with chronic conditions, in keeping with the American College of Sports Medicine's (ACSM) guidelines for the care of individuals with disabilities and chronic illnesses. The American Association for the study of liver diseases suggests tailored exercise regimens for cirrhosis patients in its online educational resource **(Tandon, et al., 2018).** Additionally, exercise significantly lowers the prevalence of critical illnesses like infection, hepatocellular carcinoma (HCC), liver failure, and liver function capacity, according to a meta-analysis of 11 randomized controlled trials (RCTs) (**Namisaki, Sato, & Yoshiji, 2024).** Low-repetition exercise those contrasts with high resistance (like lifting weights) is known as resistance training. It increases muscle growth and strength and stimulates the synthesis of muscle proteins while having little to no effect on maximum oxygen capacity **(Bellar, Welch, & Dasarathy, 2020; Elham Mohammed, et al., 2022).** It has been demonstrated that resistance training, also known as anaerobic or strength training, can reverse muscle loss and enhance physical performance, muscle growth, strength, and QoL **(Aamann, et al., 2020; Mohamed, et al., 2023).** Resistance training (such as wall push up, resisted overhead press with weights, weighted bicep curl, biceps curls, seated leg lifts, leg extension, and calf raises, mini-squats) has been repeatedly demonstrated to improve fatigue, anxiety, and general QoL in addition to physical fitness. A portion of this impact is brought about by an increase in physical fitness, which helps patients maintain their autonomy and enable them to complete ADLs **(Vuille-Lessard & Berzigotti, 2022).**

Significance of the study

Chronic liver disease impact about 1.5 billion persons global. The LC accounting for 2.4% of global deaths **(Lan, et al., 2023**). Egypt is the most age-standardized death rates from LC worldwide from 1990 to 2017, at 103.3 every 100,000 populations **(Fouad, et al., 2022)**. In previous studies, LC was shown to be the seventh leading cause of disability and the 16th largest contributor to disability-adjusted life years worldwide -adjusted life years, which have a significant effect on human health and QoL, between the ages of fifty and seventy-four years **(Vos, et al., 2020).** According to, the evidence-based practice, decreased skeletal muscle strength, fatigue and inability to perform the ADLs, are common symptoms among the patients with LC which negatively affective their ability to cope and to manage the disease. This study's significances represented that resistance exercises have a synergetic positive effect on increasing muscle strength, as well as, reducing the dependence level and fatigue severity, additionally, enhancing the ability to perform ADLs. These exercises are easy to implement, cost-effective, and require little to no specialized equipment.

Aim of the research:

The aim of the current research is to evaluate the effect of resistance exercises on muscle strength, fatigue severity and daily living activities among patients with liver cirrhosis

Research hypothesis:

H1: Resistance exercises will increase the muscle strength, and decrease severity of fatigue and increase the ability to perform activity of daily living in patients with liver cirrhosis.

H2: Resistance exercises will not have any effect on the muscle strength, severity of fatigue and ability to

perform activity of daily living in patients with liver cirrhosis.

Methods:

Research design: Quasi experimental design (pre-posttest group) was used to complete the aim of this research which used to establish a cause-as well as-effect relations between an independent as well as dependent variable to determine whether there is a causal relationship between the intervention and the outcomes **(Ali, et al., 2020).**

Research setting: The current study was implemented at the internal medicine department in the University Liver and Digestive System Hospital, affiliated to The Main Minia University Hospitals.

Research sample: Non probability (a purposive sample) of 80 male as well as female patients with LC was recruited and allocated into one group.

Sample size:

The number of patients who was provided the necessary proper sample size is **(80 patients** that is calculated according to this formula as (N = n x 30/80) **(Isaac & Michael, 1995)**, in which

- N = Size of the sample
- n = Total cases 400 of patients with liver cirrhosis who admitted to medical department at Minia University Hospital.
- N = 215 x 30 / 80 = 80 Patients.

A purposive sample of eighty patients with LC were assigned in the present research,

Inclusion criteria:

- Patients with LC (Child-Pugh class A (CP-A) or B (CP-B)),
- Between the ages of 18 and 75.
- The two genders (male & female).
- Patients with LC of any etiology.
- Follow-up inpatient and outpatient.

Exclusion criteria:

- Mental or neurological conditions, unusual eating habits,
- Physical inability or neuromuscular diseases
- Hepatocellular carcinoma or others neoplasia,
- Significant cardiac disease
  - ***These conditions can affect negatively in performing resistance exercises***

Data collection tools:

One tool and three scales were utilized in the present study:

Frist tool: A structured interview questionnaire sheet was designed by the researchers post revising extensive relevant evidence

Part I: Demographic characteristics of patients, such as name, age, gender, marital status, occupation, level of education, etc.)

Part II: Medical data of the liver cirrhosis patients, as presence of DM, HTN, liver profile, smoking.... etc.)

Second tool: Oxford Scale for Muscle Strength Grading: The Medical Research Council (MRC), UK government research body, created the scale in 1943. Modified version was reprinted in 1976. A numerical rating system called the Oxford Muscle Scale is used to measure the strength or power generated when a muscle contracts. A scale of zero to five is used to grade the measurement, with five denoting maximum strength. Muscle power can be quickly evaluated and graded using the Oxford Scale. A thorough understanding of muscle anatomy is necessary to do an evaluation correctly. By evaluating important muscles in the upper and lower extremities against the examiner's resistance, the Oxford Scale, which has a 0–5 scale, is then recorded as 0/5 or 2/5. Shoulder abductors, elbow flexors, elbow extensors, wrist extensors, finger flexors, hip flexors, knee extensors, dorsiflexors, great toe extensors, and plantar flexors are among the muscles that are commonly evaluated. The patient should be positioned correctly by the physiotherapist to provide precise assessment, clear eyesight, and the ability to palpate the relevant structures (**Clarkson, 2000; Naqvi,**

2019).

0/5 for no contraction
1/5 for visible/palpable muscle contraction but no movement
2/5 for movement with gravity eliminated
3/5 for movement against gravity only
4/5 for movement against gravity with some resistance
5/5 for movement against gravity with full resistance

Third tool: The Fatigue Severity Scale (FSS):

The FSS is a unidimensional, nine-item survey that **Krupp et al. (1988)** created.

This measure was created to evaluate fatigue as an indication of several chronic illnesses and diseases. The measure examines how fatigue affects day-to-day functioning and how it relates to motivation, exercise, employment, family, and social interactions. The scoring system of the fatigue severity scale: Every item has statements that are scored on a seven-point Likert scale, with 1 denoting "strongly disagree" and 7 denoting "strongly agree." This implies that the lowest possible score is nine, and the greatest possible score is sixty-three. A patient may not be experiencing fatigue if their overall score is less than thirty-six. A patient may require additional medical assessment if their overall score is thirty-six or above. (**Shahid, et al., 2011**)

During the past week, I have found that:							
1. My motivation is lower when I am fatigued.	1	2	3	4	5	6	7
2. Exercise brings on my fatigue.	1	2	3	4	5	6	7
3. I am easily fatigued.	1	2	3	4	5	6	7
4. Fatigue interferes with my physical functioning.	1	2	3	4	5	6	7
5. Fatigue causes frequent problems for me.	1	2	3	4	5	6	7
6. My fatigue prevents sustained physical functioning.	1	2	3	4	5	6	7
7. Fatigue interferes with carrying out certain duties and responsibilities.	1	2	3	4	5	6	7
8. Fatigue is among my three most disabling symptoms.	1	2	3	4	5	6	7
9. Fatigue interferes with my work, family, or social life.	1	2	3	4	5	6	7

Fourth tool: The Katz Index:

The most suitable tool for evaluating functional status as a gauge of the client's capacity to carry out ADL on their own is the Katz ADL index, which was created by Katz et al. in the 1960s and is also known as the Katz ADL (This Index of Independence in ADL). The tool is usually used by clinicians to identify difficulties with performing activities of daily life and to adjust care plans

Katz Index of Independence in ADL		
Activities Points (1 or 0)	Independence (1 Point) NO supervision, direction or personal assistance.	Dependence (0 Points) WITH supervision, direction, personal assistance or total care.
BATHING Points: _____	(1 POINT) Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area or disabled extremity.	(0 POINTS) Need help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing
DRESSING Points: _____	(1 POINT) Get clothes from closets and drawers and puts on clothes and outer garments complete with fasteners. May have help tying shoes.	(0 POINTS) Needs help with dressing self or needs to be completely dressed.
TOILETING Points: _____	(1 POINT) Goes to toilet, gets on and off, arranges clothes, cleans genital area without help.	(0 POINTS) Needs help transferring to the toilet, cleaning self or uses bedpan or commode.
TRANSFERRING Points: _____	(1 POINT) Moves in and out of bed or chair unassisted. Mechanical transfer aids are acceptable	(0 POINTS) Needs help in moving from bed to chair or requires a complete transfer.
CONTINENCE Points: ___	(1 POINT) Exercises complete self-control over urination and defecation.	(0 POINTS) Is partially or totally incontinent of bowel or bladder
FEEDING Points: _____	(1 POINT) Gets food from plate into mouth without help. Preparation of food may be done by another person.	(0 POINTS) Needs partial or total help with feeding or requires parenteral feeding.
TOTAL POINTS: _____ SCORING: 6 = High (patient independent) 0 = Low (patient very dependent		

accordingly. The Index rates how well people accomplish the six functions of dressing, toileting, feeding, transferring, bathing, and continence **(Rathnayake, 2023).** For each of the six functions, clients receive a yes/no score for independence. Full function is indicated by a score of six, moderate impairment is indicated by a score of four, and severe functional impairment is indicated by a score of two or below **(Wallace, & Shelkey, 2007).**

The educational material:

An Arabic educational training booklet was designed by researchers based on the patients' predetermined needs, baseline evaluation and pertinent literature. It was written in a simple Arabic language as well as enhanced with picture and illustrations regarding the techniques of resistance exercises, this booklet was given to the patient and their caregiver to help them understanding the content. The booklet was revised by a group of expertise in medical and surgical nursing for the content validity. The booklet outlines included; definition, causes, treatment, and prevention of liver cirrhosis, as well, as, definition, importance techniques and precautions of the resistance exercise, in addition to the warm-up as well as cool down exercises.

Ethical considerations:

All necessary formal permits were taken from the appropriate authorities to conduct this research. After reviewing the research proposal,

• The research acceptance was obtained from the ethical committee pre implement the research

• Written research acceptance was also taken from the Director of Minia University Hospitals, the head nurse of hospitals, and the Head nurse of each unit.

• Oral consent was obtained freely and voluntarily from each patient after clarifying the purpose of the research to patients who was included in the research,

• Patients were informed that they could select whether or not to share in the study and that they have the right to withdraw at any time. Privacy, confidentiality, and anonymity were all ensured during data collection and encoding.

Content validity:

A jury committee made up of five academic specialists in the field of medical surgical nursing tested the study tools. Together, the experts provided a thorough evaluation of the instruments' face validity and content, each of whom is an active participant in their specific setting.

Reliability:

The tools of the study were established reliability alpha (coefficient alpha) as a statistical analysis way to check the stability of the internal consistency of the tool. Intraclass Correlational Coefficient of oxford muscle strength scale was (ICC) = 0.95 (0.92-0.97) **(Hermans, et al., 2012**). The FSS indicate high internal consistency (Cronbach's α = 0.96**) (Aronson, et al., 2023).** The reliability of the Katz index. Cronbach's alpha (overall) revealed an internal consistency of 0.82, with item-total correlations ranging from 0.31 to 0.85. The test re-test reliability was 0.82 (0.77-0.85) ($p < 0.001$), as measured by ICC (95% CI) **(Rathnayake, 2023**)

Pilot study:

Post having the ethical acceptance as well as permission to access the hospital, a pilot of the research was performed on a sample of ten percent (8 patients) of the subjects to test the research process and to assess the efficiency of tools that was utilized in the research. The necessary modification was done. This sample was included in total study sample.

Study procedure

The study procedure was included these phases as the following:

Preparation Phase:

The actual study started by preparing various data collection tools after reviewing the recent national and international related literature in the field of the current study by reviewing textbooks, journals, articles, periodicals, and the internet to get a clear frame of all dimensions related to the topic of research, such as **Marcantei, et al., 2024**; **Hosoi, et al., 2025; and Medeiros et al., 2025).** This phase assisted in designing, planning, and developing the study procedure, as well as obtaining a formal paper agreement, which was taken for duration of one-month pre implementing the research.

Implementation phase:

The collection of research data was done on a daily basis (three days a week; Sunday, Tuesday and Thursday) via the morning shift. The total data collection was done over a period of four months, starting from the starting of February to the end of May 2025. All cases were consecutively screened for acceptance via the first interview visit at

Internal medicine department at the University liver and Digestive System Hospital. Before starting the

exercises program, the researchers assessed all patients regarding the demographic and clinical. characteristics, muscle strength (**Oxford Muscle Strength Scale),** fatigue (fatigue severity scale), activity of daily living scale **(KATZ scale).**

The American Heart Association's and the American College of Sports Medicine's recommendations for physical activity served as the foundation for the resistance training regimen, which aimed to build muscular growth and strength in the main muscle groups. The patient in study group was offered 36 planned sessions along 12-week period including 2-3 motivational sessions by the researchers, which could be the most important treatments to get patients to change their habit and find possible obstacles to exercising as well as make sure completely understanding the exercises technique. The resistance exercise sessions were performed on three consecutive days per week. Each session was about 60 minutes which included 10 minutes as warm-up exercises such as; arm circles, hip circles, leg swings, and march -or- jog in place. After that, 30 to 45 minutes of resistance exercises included a variety of resistance exercises for the muscle groups such as wall push up, resisted overhead press with weights, weighted bicep curl, biceps curls, seated leg lifts, leg extension, and calf raises, mini-squats (repetitions of each exercise was 8 to 10 reps during the first six weeks then increased to 8 - 12 reps during the last six weeks of intervention). In order to limit the risk of injury and improve the blood flow, and lessen the stress on the heart and other muscles, the training concluded with five minutes of cool-down exercises. In addition, return the heart rate, body temperature, and blood pressure levels back down to their normal levels before continue carrying on with the usual activities. Cool down exercises included overhead triceps stretch, arm swings or rotations and calf stretch. The sessions during the patient's staying in the hospital were guided by the researchers; all patients were assessed at the baseline, four, eight and twelve weeks of intervention (using Oxford Scale for Muscle Strength Grading, Katz Index for ADLS, and Fatigue Severity Scale (FSS). Before beginning the exercises, the patients' vital signs were taken, and they were told to stop exercising right away if they experienced any of

the following symptoms: dizziness, shortness of breath, arrhythmias, or malaise, and to get medical help right once. The researchers ensured that the patients' compliance to the scheduled exercises training via recording their performance to the planned exercise program daily during their staying in the hospital, and after the discharge from the hospital by calling them through the cell phone and the interview with them during the outpatient's follow-up at the internal medicine clinic.

Statistical analysis

The statistical software for social sciences (SPSS) version 22 was used to arrange, classify, and analyze the collected data. For qualitative and quantitative variables, respectively, the mean and standard deviations of the data were reported using descriptive statistics. The paired t-test, chi-square test, and correlation r-test were the statistical tests that were applied. When the p-value was less than 0.05, strong significance was assumed, and no statistical significance difference was taken into account when the p-value was greater than 0.05.

Results

Table (1) reveals that the highest percent of participants were aged between 50 and 75 years (45%), with a mean age of 52.1 ± 8.3 years. Males constituted 62.5% of the sample, most participants were married (87.5%), and educational levels varied, with 42.5% being illiterate, regarding occupation, 37.5% were housewives, 30% engaged in manual work, The majority of families consisted of 3 to 5 members (87.5%), and most participants resided in rural areas (77.5%)

Table (2) emphasizes medical aspects of people with liver cirrhosis. Indicating a modifiable risk factor. Hypertension (52.5%) was the most common comorbidity, followed by diabetes (35%),. Most patients had compensated cirrhosis (Child-Pugh A/B: 83.8%). Decompensated illness (Child-Pugh C: 16.2%) was less prevalent as well as this table shows a considerable proportion (56.2%) of patients smoked

Table (3): illustrates that patients with liver cirrhosis experienced significant improvements in

muscle strength across upper limbs, lower limbs, and core muscles over a 12-weeks of resistance exercise intervention. At baseline, a substantial proportion of patients exhibited minimal strength (Grades 0–2), but by week 12, many progressed to higher strength

grades, with notable increases in Grades 4 & 5 across all muscle groups. These improvements with p-values less than 0.001 for all muscle groups.

Table (4): reveals that at baseline, 75% of participants experienced severe fatigue (FSS ≥ 36), with a mean score of 5.8 ± 1.4. After 4 weeks of resistance training, this percentage declined to 37.5% (mean score: 4.9 ± 1.3; p = 0.002), indicating a significant improvement. By week 8, only 12.5% of participants reported severe fatigue (mean score: 4.2 ± 1.2; p = 0.005), and by week 12, this further decreased to 6.25% (mean score: 3.7 ± 1.1; p = 0.001). These findings highlight a progressive and statistically significant reduction in fatigue severity over the 12-week resistance exercise intervention.

Fig (1): highlights a marked improvement in activities of daily living over a 12-week period of resistance exercise implementation, with notable enhancements in grooming, toileting, feeding, transferring, mobility, stair use, and dressing compared to baseline.

Table (5): demonstrates that there was a statistically significant decrease in body weight, from 72.4 ± 8.2 kg at baseline to 71.5 ± 7.7 kg at 12 weeks of resistance exercise intervention as (p = 0.001, F = 5.4), and a corresponding reduction in BMI from 26.3 ± 3.1 to 25.9 ± 2.9 kg/m² (p = 0.003, F = 4.2). Both mid-arm and calf circumferences showed significant increases, indicating potential muscle hypertrophy, with mid-arm circumference rising from 28.5 ± 2.8 cm to 29.8 ± 2.5 cm (p < 0.001, F = 8.1) and calf circumference from 34.2 ± 3.4 cm to 35.6 ± 3.1 cm (p < 0.001, F = 7.9). Waist circumference significantly decreased from 92.5 ± 7.8 cm to 91.2 ± 7.3 cm (p < 0.001, F = 6.3), while hip circumference showed a modest but statistically significant decline (p = 0.012, F = 3.5). The waist-to-hip ratio demonstrated a non-significant decreasing trend (p = 0.082, F = 2.1).

Table (6): illustrates significant improvements across multiple functional outcomes following 12 weeks of resistance exercise. The proportion of patients with low muscle strength (score < 4) decreased markedly from 25.0% at baseline to 2.5%, while those with high muscle strength (scores 7–10) increased from 25.0% to 72.5% (p < 0.001).

Fatigue levels also showed notable improvement: the percentage of patients reporting high fatigue (scores 7–10) declined from 75.0% at baseline to 12.5% at week 12, whereas those with low fatigue levels (scores < 4) increased from 6.25% to 50.0% (p < 0.001). Regarding activities of daily living (ADL), the proportion of independent patients rose significantly from 12.5% to 62.5%, while those classified as dependent decreased from 37.5% to 12.5% ($\chi^2 = 25.32$, p = 0.002), indicating a substantial enhancement in functional independence.

Table (7): indicates strong negative correlations between muscle strength and fatigue (r=-0.75 at 12 weeks) and strong positive correlations between muscle strength and ADL independence (r=0.71 at 12 weeks, all p<0.001). Fatigue and ADL were also negatively correlated (r=-0.67).

Table (1): frequency distribution of the sample of patients with liver cirrhosis regarding to their socio-demographic traits (N =80)

Sociodemographictraits	No.	%
Age(Years):		
20 -<30Yrs.	4	5
30 – <40 Yrs.	20	25
40-< 50 Yrs.	20	25
50-75 Yrs.	36	45
Mean±SD	**52.1 ±8.3 years**	
Gender:		
Female	30	37.5
Male	50	62.5
Maritalstatus:		
Married	70	87.5
Single	6	7.5
Widowed	4	5
Education:		
University	6	7.5
Intermediate education	8	10
Basic education	16	20
Read &write	16	20
Illiterate	34	42.5
Job:		
Didn't work	16	20
Manual work	24	30
Housewife	30	37.5
Other	10	12.5
Family members:		
3 to 5	70	87.5
≥6	10	12.5
Residence:		
Rural	62	77.5
Urban	18	22.5
Total	**80**	**100**

Table (2): Frequency Percentage of the sample regarding to their medical data (N=80)

Medical Variable	Frequency (n)	Percentage (%)
Chronic Diseases		
- Diabetes Mellitus (DM)	28	35.0%
- Hypertension (HIT)	42	52.5%
- Cardiac Disease	12	15.0%
- Endocrine Disease	9	11.3%
Liver Profile		
Child-Pugh A	32	40.0%
Child-Pugh B	35	43.8%
Child-Pugh C	13	16.2%
Smoking Status		
Yes	45	56.2%
No	35	43.8%

Table 3: Percentage Distribution of Muscle Strength scale at baseline, 4 weeks ,8 weeks and 12 weeks of Resistance Exercises (N=80)

Muscle Group	Grade	Baseline n (%)	4 Weeks n (%)	8 Weeks n (%)	12 Weeks n (%)	χ^2	p-value
Upper Limbs	0-1 (None)	12 (15.0)	4 (5.0)	2 (2.5)	0 (0.0)	42.7	<0.001
	2 (Gravity eliminated)	28 (35.0)	16 (20.0)	10 (12.5)	6 (7.5)		
	3 (Against gravity)	24 (30.0)	32 (40.0)	28 (35.0)	22 (27.5)		
	4 (Some resistance)	12 (15.0)	20 (25.0)	26 (32.5)	32 (40.0)		
	5 (Full resistance)	4 (5.0)	8 (10.0)	14 (17.5)	20 (25.0)		
Lower Limbs	0-1 (None)	16 (20.0)	6 (7.5)	4 (5.0)	2 (2.5)	38.4	<0.001
	2 (Gravity eliminated)	32 (40.0)	20 (25.0)	14 (17.5)	10 (12.5)		
	3 (Against gravity)	20 (25.0)	30 (37.5)	32 (40.0)	28 (35.0)		
	4 (Some resistance)	8 (10.0)	16 (20.0)	20 (25.0)	26 (32.5)		
	5 (Full resistance)	4 (5.0)	8 (10.0)	10 (12.5)	14 (17.5)		
Core Muscles	0-1 (None)	20 (25.0)	10 (12.5)	6 (7.5)	4 (5.0)	35.2	<0.001
	2 (Gravity eliminated)	36 (45.0)	24 (30.0)	18 (22.5)	14 (17.5)		
	3 (Against gravity)	16 (20.0)	28 (35.0)	32 (40.0)	30 (37.5)		
	4 (Some resistance)	6 (7.5)	14 (17.5)	18 (22.5)	24 (30.0)		
	5 (Full resistance)	2 (2.5)	4 (5.0)	6 (7.5)	8 (10.0)		

NS= not significant *** p = ≤.05 (statistical significance)** **** p = ≤.01 (highly statistical significance).**

Table 4: Means Scores of Fatigue Severity Scale (FSS) at baseline ,4 weeks ,8 weeks and 12 weeks Following Resistance exercises (N=80)

Timepoint	Mean ± SD	% with Severe Fatigue (FSS≥36)	p-value*
Baseline	5.8 ± 1.4	75.0%	—
4 weeks	4.9 ± 1.3	37.5%	0.002*
8 weeks	4.2 ± 1.2	12.5%	0.005**
12 weeks	3.7 ± 1.1	6.25%	0.001**

NS= not significant *** p = ≤.05 (statistical significance)** **** p = ≤.01 (highly statistical significance).**

Fig (1): Activity of Daily Living at baseline, 4 weeks, 8 weeks and 12 weeks for patients with liver cirrhosis (n=80)

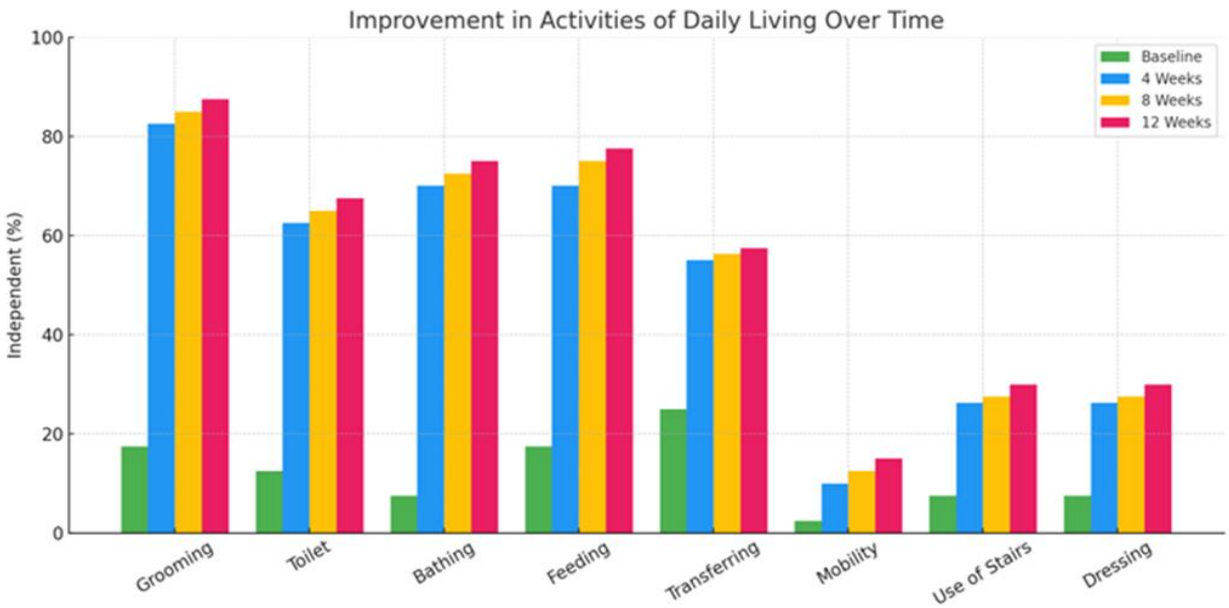

Table 5: Mean Scores of Anthropometric Measurements After 12 Weeks from Resistance exercise intervention (N = 80)

Measurement	Baseline	8 Weeks	12 Weeks		
	Mean ± SD	Mean ± SD	Mean ± SD	p-value	F-statistic
Body Weight (kg)	72.4 ± 8.2	71.8 ± 7.9	71.5 ± 7.7	**0.001**	**5.4**
BMI (kg/m²)	26.3 ± 3.1	26.1 ± 3.0	25.9 ± 2.9	**0.003**	**4.2**
Mid-Arm Circumference (cm)	28.5 ± 2.8	29.2 ± 2.6*	29.8 ± 2.5*	**<0.001**	**8.1**
Calf Circumference (cm)	34.2 ± 3.4	35.0 ± 3.2*	35.6 ± 3.1*	**<0.001**	**7.9**
Waist Circumference (cm)	92.5 ± 7.8	91.8 ± 7.5	91.2 ± 7.3*	**<0.001**	**6.3**
Hip Circumference (cm)	98.6 ± 6.9	98.2 ± 6.7	97.9 ± 6.5	**0.012**	**3.5**
Waist-to-Hip Ratio	0.94 ± 0.06	0.93 ± 0.06	0.93 ± 0.05	0.082	**2.1**

NS= not significant * p = ≤.05 (statistical significance) ** p = ≤.01 (highly statistical significance).

Table (6): Comparison between patients' Muscle Strength, Fatigue, and Activities of Daily Living at three time points of the study (n = 80)

Tool (score range)	Baseline	8 weeks	12 weeks	test of sig. (value)	P-value	% of change
Muscle Strength (1–10)	N (%)	N (%)	N (%)			
< 4 (low)	20 (25.0%)	5 (6.25%)	2 (2.5%)	$\chi^2 = 25.32$**	<0.001	80.0%
4 - <7 (moderate)	40 (50.0%)	30 (37.5%)	20 (25.0%)			
7 - 10 (high)	20 (25.0%)	45 (56.25%)	58 (72.5%)			
Mean ± SD	4.5 ± 1.2	6.8 ± 1.0	8.1 ± 0.9	f = 15.67**	<0.001	
Fatigue (1–10)	N (%)	N (%)	N (%)			
< 4 (low)	5 (6.25%)	20 (25.0%)	40 (50.0%)	$\chi^2 = 20.45$**	<0.001	45.83%
4 - <7 (moderate)	15 (18.75%)	30 (37.5%)	30 (37.5%)			
7 - 10 (high)	60 (75.0%)	30 (37.5%)	10 (12.5%)			
Mean ± SD	7.2 ± 1.5	5.4 ± 1.3	3.9 ± 1.1	f = 20.45**	<0.001	
Activities of Daily Living (0–100)	N (%)	N (%)	N (%)			
Dependent	30 (37.5%)	20 (25.0%)	10 (12.5%)	$\chi^2 = 25.32$*	0.002	66.67%
Needs help	40 (50.0%)	30 (37.5%)	20 (25.0%)			
Independent	10 (12.5%)	30 (37.5%)	50 (62.5%)			
Mean ± SD	45 ± 10	60 ± 15	75 ± 20	f = 25.32*	0.002	

NS= not significant * p = ≤.05 (statistical significance) ** p = ≤.01 (highly statistical significance).

Table 7: Correlation Between Increasing Duration of Resistance Training Exercises and Muscle Strength, Fatigue, and ADLs (N=80)

	Baseline	**4 weeks**	**8 weeks**	**12 weeks**
Variables of correlation	**r (*p* value)**	**r (*p* value)**	**r (*p* value)**	**r (*p* value)**
Muscle Strength ↔ Fatigue	**-0.61 (0.041)***	**-0.67 (0.036) ***	**- 0.72 (0.021)***	**-0.75(0.001)***
Muscle Strength ↔ ADL	**0.59 (0.038)***	**0.63 (0.032) ***	**0.68 (0.017)***	**0.71(0.001)***
Fatigue ↔ ADL	**-0.56 (0.045)***	**-0.60 (0.039) ***	**- 0.64 (0.022)***	**-0.67(0.021)***

NS= not significant * p = ≤.05 (statistical significance) ** p = ≤.01 (highly statistical significance).

Discussion.

The condition alters liver function and affects, among other things, muscular tissue, resulting in severe muscle mass loss that reaches pathological levels, defining sarcopenia. Sarcopenia is a progressive and generalized illness characterized by loss of skeletal muscle and muscle strength Furthermore, it harms body composition, aerobic capacity, muscle strength, and power production, resulting in reduced functionality and quality of life. It is an independent mortality factor, suggesting a worse clinical prognosis **(Rossi et al., (2022)**

Our findings showed that, almost half of the cirrhotic patients in the research were between the ages of fifteen and sixteen with a mean age of 52.1 ± 8.3 years. It was greatly supported by these studies, **Nardelli et al. (2022) and Kim et al. (2022)** who stated that the mean age of liver cirrhosis patients between 51 and 73 years. This can be explained as liver cirrhosis is often more prevalent among individuals aged around fifteen and sixteen years due to the long-term, cumulative effects of chronic liver insults. Cirrhosis typically develops after many years of ongoing liver damage caused by risk factors such as viral hepatitis (particularly hepatitis B and C), and non-alcoholic fatty liver disease, often regard to obesity and DM. These conditions may begin in early adulthood, but the liver's regenerative capacity often delays the onset of overt symptoms and structural damage until middle age.

Concerning gender, results reflected that above fifty percent of cirrhotic patients were male, this result it was supported with **Cui et al. (2024)** who found near half of the liver cirrhosis patients male. The highest percent of studies sample lived in rural regions as mentioned by **Adel et al., (2024)** highest present age of liver cirrhosis lived in rural area.

Our opinion is that the prevalence of liver cirrhosis in rural regions can be attributed to several interrelated socioeconomic, environmental, and healthcare access factors. First, rural populations often experience lower health literacy and limited awareness regarding the risks associated with viral hepatitis, and poor nutritional habits—all of which are key contributors to liver cirrhosis. Secondly, rural healthcare infrastructure is frequently under-resourced, leading to delayed diagnosis and inadequate management of chronic liver diseases, involving hepatitis B as well as C infections. Furthermore, access to preventive services such as vaccination and routine liver function monitoring is often restricted in these areas.

Based on the medical data, nearly half of the participants had a normal BMI, while approximately one-third were classified as overweight or obese, this was in parallel with (**Sirisunhirun et al., 2022) they** who reported that the mean BMI of twenty-five point two ± three point zero kilograms per square meter, mean fat mass percentage of twenty-six point eight ± eight-point four percent.

Regarding muscle strength, patients with liver cirrhosis demonstrated significant improvements across the upper limbs, lower limbs, and core muscles following a 12-week resistance exercise intervention, with a clear shift from predominantly low strength grades at baseline to higher grades post-intervention ($p < 0.001$), these findings are in line with, **"Aamann et al. (2020)** found that the exercise group enhance muscle strength by thirteen percent, from a mean of one hundred nineteen to one hundred thirty-four—an eleven greater enhancement compared to the control group ($p < 0.05$). Furthermore, the quadriceps cross-sectional area increased by ten percent, from fifty-eight-point five to sixty-four-point six, representing a four-point four greater gain than that observed in the control group ($p < 0.01$). Also, the same line, **Namisaki, et al, (2024)** who concluded that the physical capacity in patients with LC includes both aerobic and resistance components. Aerobic exercise improves cardiorespiratory fitness and metabolic health, while resistance training enhances muscle strength and mass. Studies have shown that combining both forms over 8–14 weeks can improve strength, handgrip, quality of life, and may help prevent hepatic decompensation.

In addition, these findings are consistent with, **Morkane, et al, (2020)** who documented that exercise also displayed improvement in hand grip strength, showing that elements that impact the circulatory system can improve skeletal muscle performance alongside strength training.

Researchers explained this improvement related to the anabolic effects of resistance exercise, which stimulates muscle protein synthesis and counters cirrhosis-related muscle wasting. Enhancing strength improves functional capacity and helps decrease the risk of complications connect with

sarcopenia.

Thus, resistance training represents a valuable non-pharmacological strategy to support physical function in cirrhotic patients.

Regarding to anthropometric measurements before and after resistance exercise intervention, the research showed a statistically significant reduction in body weight after twelve weeks of resistance training, indicating improved body composition. A similar significant decline was observed in BMI. Significant increases in mid-arm and calf circumferences suggest muscle hypertrophy. Waist circumference significantly decreased, while a modest but significant reduction in hip circumference further reflects positive changes in body composition (all p-values < 0.05), which were parallel with **Hsu et al., (2024),** who explained that, in terms of differences between pre- and post-intervention among the experimental group, several indicators that can be effectively addressed under intervention include thigh circumference, mid arm circumference, and sit-to-stand. Sarcopenia in cirrhosis patients is now induced by muscle depletion due to altered protein turnover, energy disposition, and hormonal and metabolic abnormalities.

This contradicts the findings of **Sirisunhirun et al. (2022),** who reported no significant alteration in BMI between baselines as well as the end of the study in either group, with the mean BMI remaining stable around 25 kg/m². Additionally, there were no significant variations in BMI between the two groups. However, the current results align with their findings regarding muscle mass, as the home-based exercise group showed no change in average muscle mass index or thigh circumference, while the control group experienced a slight decrease. Overall, no statistically significant differences were found in thigh muscle mass indices or thigh circumference between the two groups.

In respect to the ADL, findings of the actually research **a** marked improvement was observed in ADL over a 12-week period of resistance exercise implementation, with notable enhancements in grooming, toileting, feeding, transferring, mobility, stair use, and dressing compared to baseline, which were parallel with **Sirisunhirun et al., (2022)** who clarified that, many exercise evidences have evaluated QoL pre and post an exercise-regard intervention and all of them reported enhancement in QoL. This study showed the benefit of a twelve-week Home-depend on exercise training program for improving cirrhotic cases' QoL by reducing fatigue symptoms. Which in the same context with **Namisaki, et al, (2024)** who explained 8-14 weeks of supervised aerobic exercise training improved cardiorespiratory fitness, muscular strength, and health-related quality of life in individuals with liver cirrhosis.

Based on our researchers' scientific knowledge and observations, resistance training helps stimulate muscle protein synthesis, enhances neuromuscular coordination, and improves overall strength and endurance, which are essential for maintaining independence in daily activities. Improved muscle strength and function reduce the risk of falls and frailty, enhance balance and mobility, and allow patients to perform ADLs with less effort and fatigue.

In respect to the fatigue severity, the findings of the actually research demonstrate a progressive and statistically significant reduction in fatigue severity over the 12-week resistance training period. At baseline, the majority of participants experienced severe fatigue, which substantially declined by weeks 4, 8, and 12. This steady improvement, supported by consistently significant p-values, underscores the positive impact of resistance exercise in alleviating fatigue among patients. These results were agreed with, **Gerber et al., (2019),** they who stated that fatigue was improved both within and between groups, but the activity domain only showed substantial improvement within groups. Weariness is frequent in cirrhotic individuals and difficult to cure with medication; nevertheless, exercise has been demonstrated to reduce fatigue in cirrhotic patients.

The reduction in fatigue observed may be attributed to several physiological mechanisms, including increased muscle mass and strength, enhanced mitochondrial function and energy metabolism, and the anti-inflammatory effects of exercise, which lower levels of cytokines such as TNF-α and IL-6. These adaptations collectively contribute to alleviating fatigue in patients with liver cirrhosis. This interpretation is supported by **Bhandari and Kapoor (2022),** who highlighted that inflammatory pathway—particularly cytokines like IL-1β, TNF-α, and IL-6—can activate vagal afferents innervating the liver, which in turn project to fatigue-related

brain regions.

Finally, the Correlation between duration of resistance training exercises and muscle strength,

fatigue, and ADL, the findings revealed to strong negative correlations between muscle strength and fatigue, and strong positive correlations between muscle strength and ADL independence. Additionally, fatigue was negatively correlated with ADL. These significant associations ($p < 0.001$) suggest that improving muscle strength through resistance training may contribute to reduced fatigue and enhanced functional independence in patients with liver cirrhosis, in our view, exercise improves circulation and muscle strength, which is positively associated with enhanced daily activity performance due to better mobility and reduced physical effort. Conversely, increased strength shows a negative correlation with fatigue, as it lowers strain during tasks, leading to less exhaustion and faster recovery, these findings were agreed with, **Rossi, et al., (2022)** who discussed that **t**he application of exercise showed reduced fatigue ($P<0.001$), muscle strength ($P<0.001$) and improved QoL.

Strengths and limitations

Strength and limitations of the study:
This study has a number of strengths. First of all, the resistance exercise regimen used in this study was straightforward, low-tech, and equipment-free. Furthermore, a vast room is not necessary for these workouts, which can be done in a typical home. Second, every criterion used to assess how exercise affected cirrhotic individuals was assessed. In the other hand, this study has some limitations firstly the self-reported questionnaires used to evaluate several of the outcome variables, such fatigue levels and ADL, might be prone to subjective interpretation or recollection bias as well as eighty individuals were included in this study in total. A bigger sample size in future research might show how beneficial resistance exercises is for these results outcomes

Conclusion:

The results of this study allow making the following deductions: When resistance exercise was implemented accurately, cirrhotic patients had increased muscle strength, decreased fatigue level, and improved ability to do regular activities of daily living.

Recommendations

The researchers provide the following recommendations:

- Patients should be taught on the advantages and safety of resistance exercises in order to promote adherence and minimize misunderstandings of exercise.
- Resistance exercises should be included in routine treatment regimens for patients with liver cirrhosis, particularly those who are suffering muscular weakness and fatigue.
- Patients' physical condition, cirrhosis severity, and comorbidities should all be taken into consideration while designing their resistance exercise programs, which should also be overseen by qualified medical specialists.
- More extensive and prolonged clinical studies be conducted in order to provide uniform protocols and assess the long-term impacts of resistance exercise at various stages of liver cirrhosis.
- Replicated this research with greater numbers of participants from many geographic regions to ensure generality of results.

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