

## “NO LOAD” resistance training increases functional capacity and muscle size in hospitalized female patients: A pilot study

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### Abstract

The aim of the present study was to compare the effects of resistance training performed with no external load (NLRT) versus resistance training performed with elastic bands (RTEB) on muscle hypertrophy and functional performance in hospitalized patients. Twenty hospitalized females (age, 59.05±3.2 years; height 163.6±2.5 cm; body mass 70.2±3.6 kgs) were randomly assigned to RTEB or NLRT. Both groups trained three times a week for five weeks. RTEB was performed with elastic bands, while NLRT involved maximum voluntary contractions with no external loads. Biceps brachii, triceps brachii and pectoralis muscle thickness (MT) were measured by ultrasound. Functional performance was measured by the 30s elbow flexion test. MT significantly increased in all muscles tested for both groups, with no differences between groups. Changes ranged from 14 to 38%. Functional performance significantly improved by 42.7% for NLRT and 52.1% for RTEB, with no difference between them. The present results suggest that NLRT might be an efficient, feasible and low-cost strategy to promote morphological and functional benefits in the upper limb of hospitalized patients.

**Key Words:** Resistance training; Physical Functional Performance; Hospitalization; Sarcopenia; Exercise Therapy.

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The hospitalization process is characterized by loss of functionality due to inactivity.<sup>1,2</sup> Previous studies reported a muscle loss of up to 1.5 kg per day in intensive care units,<sup>3</sup> as well as a loss of 4 to 5% of muscular strength weekly,<sup>4</sup> which is directly related to hospitalization time.<sup>5</sup> In some cases, patients are discharged from the hospital with significant physical deficits that persist for long periods.<sup>6,7</sup> In order to minimize the negative effects of hospitalization, passive and early mobilizations in the bed, as well as stretching are commonly used in intensive care unit or after discharge.<sup>8</sup> However, less is known about the effects of resistance training (RT) in hospitalized patients. RT may be an interesting strategy in these patients, since it promotes benefits in muscle strength, function, and muscle mass in frail people.<sup>9-11</sup> RT is usually performed with moderate and high loads in order to promote strength gains and muscular hypertrophy,<sup>12</sup> and it often requires specialized equipment's, which in many cases is

not feasible in the hospital environment.<sup>13</sup> As an alternative, RT programs have been carried out effectively with elastic bands, promoting muscle strength gains in middle to old aged persons.<sup>14,15</sup> According to previous studies, the improvements in functional performance after RT performed with elastic bands (RTEB) are similar to those obtained with the use of machines and free weights.<sup>16-18</sup> Elastic bands have gained popularity because of their low cost, simplicity, versatility, and portability.<sup>19</sup> Another promising low cost alternative is “NO LOAD” RT (NLRT) that has been shown to promote high levels of muscle activation,<sup>20</sup> and similar gains in muscle size as traditional RT.<sup>21</sup> In summary, during NLRT the participants are instructed to perform maximal muscle contractions over the range of motion without any external load. Based on previous studies,<sup>20,21</sup> NLRT might be a viable strategy to implement in environments that do not have equipment, such as intensive care units. The objectives of the present

study were to evaluate muscle size and functional performance after NLRT in upper limbs of hospitalized patients and compare it to RTEB.

## Materials and Methods

### *Experimental overview*

This study is a parallel randomized clinical trial in which patients were allocated independently for two interventions groups from July to September 2017. After screening for eligibility of patients by inclusion criteria, a simple random sampling was done following a 1:1 ratio, without restrictions, to define the groups that received the different treatments: No load resistance training (NLRT) or resistance training with elastic bands (RTEB). To enable blind analysis, randomization and data coding were performed by different researchers. Pre-intervention measures involved muscle thickness and functional performance. The experimental protocols were performed three times a week during five-weeks of hospitalization, totaling 15 intervention sessions.

### *Participants*

The participants were recruited in two reference hospitals. Initially, 23 hospitalized women were recruited after intensive care unit admission, they were informed of the procedures and potential risks associated with the study protocol. All participants gave written informed consent before enrolment. The study was approved by the University Research Ethics Committee (n. 56907716.5.0000.5083). The inclusion criterion was to be admitted to the nursing ward, from July to September 2017, to be hospitalized and in the rehabilitation process, being able to perform the proposed protocol, being able to ambulate (with/without assistance), being able to communicate and collaborate with the research team. The reasons for admission in the rehabilitation sector after intensive care unit were: heart failure (n = 12), oncological patients (n = 7), orthopedic fractures (n=4). The patients were counterbalanced considering the reasons for admission, so each group would have similar clinical characteristics. Exclusion criteria included: multiple fractures, patients who did not want participate in appropriate rehabilitation, unable to cooperate in the tests and terminal illness. Those who did not complete all tests or intervention sessions were excluded (n=1 in the NLRT group, n=1 in the RTEB group), and one participant stopped NLRT for considering it uncomfortable. Twenty participants were included in the final analysis.

### *Assessments*

#### Muscle Thickness

Muscle thickness was measured using the ultrasound method (Toshiba Tossbe model, 7.5 MHz linear transduction) for the biceps brachii, triceps brachii and pectoralis major, following the standard procedures previously suggested.<sup>22</sup> For the biceps and triceps brachii, measurements were taken 60% distal between the lateral

epicondyle of the humerus and the acromion process of the scapula. Pectoralis major MT was measured four centimeters below the coracoid process at 60% of the distance between the acromion process of the scapula and the middle of the sternum (50% of the distance between the xyphoid process and the jugular notch). The procedure was performed once on each subject, pre and post intervention and performed by the same evaluator, which was blinded to group allocation and had experience with method. The intraclass correlation coefficients was 0.96-0.99 and the CV was 1.8-3.2%.

#### Functional Performance

Functional performance was evaluate by the 30-second elbow flexion test, wich involved the greatest number of elbow flexion and extension that the participant could perform with a 5-pound weight in 30 seconds.<sup>23</sup>

#### Nutritional control

All patients had their meals controlled through a meal plan divided into three meals per day throughout the intervention period. The standard dietary plan prescribed by the hospital dietitian involved 6-8g/kg of carbohydrate, 0.8-1.2g/kg of protein and 0.8-1.0g/kg of fat per day.

#### *Training Protocol*

The RTEB group performed six exercises for the upper body in the following order: seated row, seated chest press, push press, lat pull, elbow extension and elbow flexion. All exercises were performed with elastic bands (Kit max, Elastos®, Rio de Janeiro, Brazil), because it was more practical to implement in a hospital setting and previous studies showed that it promotes similar results to machines and free weights.<sup>17</sup> Each exercise was performed with 2 sets of 8 to 12 maximum repetitions and 2 seconds in each phase. Resistance was adjusted by changing the elastic bands whenever necessary for maintaining the prescribed number of repetitions. The NO LOAD training condition was characterized as voluntarily maximally contracting the muscle through the full range of motion without the use of external load. The NLRT group was oriented to contract the muscle at maximum intensity with a 2-second cadence in each phase. The participants performed 2 sets of 20 repetitions maximum per exercise. Considering that previous studies showed that agonist and antagonist muscle are recruited to the same extend during NLRT,<sup>20</sup> this group performed seated row/bench press, lat pulldown/shoulder press and elbow flexion/extension with reciprocal actions. The exercises were performed within a RPE of 8 to 10 from the Borg-10 scale.<sup>20</sup> Each session was supervised by Physical Therapy and Physical Education professionals and care was taken to ensure proper exercise execution.

#### *Statistical analysis*

After normality and sphericity tests by Shapiro-Wilk and Levene's, respectively, data is presented by mean and

**Table 1.** Physical characteristics in the training group

	NLRT	RTEB
Age (years)	60.5±2.8	57.6±3.2
Height (cm)	163.8±2.5	163.4±2.7
Body mass (kg)	70.1±4.3	70.3±3.1

Data are presented as mean ± standard deviation. SBP: systolic blood pressure. DBP: diastolic blood pressure. NLRT: No load resistance training group; RTEB: Resistance training with elastic bands group.

standard deviation. The paired t-test was performed to compare pre and post-training for each group. ANCOVA analysis were performed to compare the post-interventions results using the pre interventions results as covariates. Statistical analysis was performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Japan, Ltd., Tokyo, Japan), with significance accepted when  $p < 0.05$ .

**Results**

The characteristics of the participants are shown in Table 1 and no differences were found between groups. Table 2 presents the pre and post values for each variable by groups, where it is evidenced that all variables showed significant improvements.

*Functional Performance*

The t test showed that both groups significantly increased the performance in the 30-seconds elbow flexion and extension (42.7% for NLRT and 52.1% for RTEB). Between groups comparisons using ANCOVA revealed no significant differences.

*Muscle Thickness Outcomes*

The t test showed that both groups significantly increased MT biceps (38.71% for NLRT and 38.04% for RTEB),

MT triceps (18.68% for NLRT and 20.0% for RTEB), and MT pectoral (14.88% for NLRT and 14.17% for RTEB). Between groups comparisons using ANCOVA revealed no significant differences for changes in any MT outcome

**Discussion**

The present study aimed to compare the effects of RTEB and NLRT on upper body muscle size and performance in hospitalized patients. The main results were that both protocols were equally effective to improve muscular size and functionality. Our results are in agreement with Counts at al., 2016<sup>21</sup> who found similar levels of muscle activation and hypertrophy in untrained young men performing NLRT or traditional RT for the elbow flexors. The present study extended these findings to the pectoralis major and in hospitalized participants. Our findings may be supported by the study by Rudroff, Staudenmann and Enoka,<sup>24</sup> which indicate that high levels of motor units activation produced by repeated contractions may provide stimuli for muscular adaptations. Considering the high levels of activation reported in NLRT exercises,<sup>20,21</sup> this might, at least in part, explain the results.

**Table 2.** Muscle thickness and functional performance pre and post the training period

	NLRT			RTEB		
	PRE	POST	p	PRE	POST	P
MT Biceps (mm)	9.3±3.0	12.9±2.8	<0.001	9.2±3.1	12.7±3.4	<0.001
MT Triceps (mm)	18.2±2.7	21.6±2.8	<0.001	18.0±2.8	21.6±2.9	<0.001
MT Pectoral (mm)	24.2±2.7	27.8±2.7	<0.001	24.0±2.8	27.4±3.4	<0.001
30-seconds Arm Curl (reps)	10.3±1.3	14.6±2.9	<0.001	9.4±1.0	14.3±2.4	<0.001

Data are presented as mean ± standard deviation. MT: Muscle thickness. Reps: repetitions number. NLRT: No load resistance training group; RTEB: Resistance training with elastic bands group.

On the other hand, our results on functional performance are in contrast to the findings by Counts et al.<sup>21</sup> since we found similar gains for RTEB and NLRT. This apparent divergence might be explained by two factors. Initially, due to the different characteristics of the participants, since Counts et al.<sup>21</sup> investigated healthy individuals, while our study involved hospitalized patients in an intensive care unit, which might present a lower adaptive threshold. Another point is the test used, Counts et al.<sup>21</sup> used the 1RM tests, that is a more specific and similar to traditional RT, while we used an endurance-oriented functional performance test. Considering that increases in performance might be specific,<sup>25</sup> this might have influenced the results.

It is difficult to compare our results with previous studies, because, to best of our knowledge, we are not aware of any similar intervention in an intensive care unit. However, previous studies showed that hospitalization lead to significant reductions in muscle strength and mass, reaching 40-48% after three weeks.<sup>26</sup> Therefore, the fact that our participants increased muscle mass and functionality seem to be of clinical importance.

In summary, our findings suggest that NLRT might be a feasible strategy to be adopted in hospitals and rehabilitation centers, since it promoted gains in muscle size and performance without the need of specific equipment.

However, one important limitation was training only upper body muscles. We opted for using only upper body movements because previous studies involved this region and many participants reported difficult in performing NLRT in lower body muscles. Whilst upper body training might be useful for daily activities (personal care, feeding, etc ...), it would be important in future studies to extend these findings to lower body muscles and additional tests.

In conclusion, the present study suggests that hospitalized can benefit from exercises performed without external load, with no detrimental effect. Moreover, our results showed that NLRT promote similar results, when compared to traditional and widely applied methods.

#### List of acronyms

1RM – one repetition maximum

CV – coefficient variation.

DBP - diastolic blood pressure

MT - muscle thickness

NLRT - no external load resistance training

Reps - repetitions number

RPE - rating of perceived exertion

RT - resistance training

RTEB - resistance training performed with elastic bands

SBP - systolic blood pressure

#### Authors contributions

All named authors contributed in equal part to the manuscript.

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#### Conflict of Interest

The authors declare no conflicts of interest.

#### Ethical Publication Statement

We confirm that we have read the Journal’s position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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