# EFFECTS OF A MOBILITY AND DYNAMIC STRENGTH INTERVENTION PROGRAM ON THE RANGE OF MOTION, STRENGTH, AND STRENGTH ASYMMETRY IN PEOPLE WITH NECK OR LOW BACK PAIN

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**Abstract:**

The purpose was to ascertain the effects of a 12-week intervention program based on exercises of mobility and dynamic strength on the stabilization of neck and trunk muscles in people with neck or low back pain according to gender. Forty-two participants (n = 25 males and n = 17 females; age 49.62±8.82 years) with neck or low back pain completed a recovery-training program focused on improving mobility and strength in the stabilizing muscles of the trunk and neck. A range of motion test, a strength (maximum voluntary contraction) test and the muscle strength asymmetry of the muscle groups analyzed were assessed at the beginning (T1), after six (T2) and after 12 (T3) weeks of intervention. Improvements were seen in nine out of the 12 range of motion variables at T2 (ES=0.52 to 1.26, moderate-high; p<.05) and T3 (ES=-0.28 to -0.44, low; p<.05 or p<.01). Improvements were also evident in all the strength variables at T2 (ES=-0.81, high; p<.01) and T3 (ES=-1.08 to -0.95, high; p<.01). In contrast, in the strength asymmetry variables improvements were found in one out of the five variables analyzed at T2 (ES=-0.81, high; p<.01) and two out of five at T3 (ES= -1.08 to -0.95, high; p<.01). In conclusion, the intervention was effective for improving range of motion and strength. However, to improve muscle strength asymmetry it may be necessary to include specific exercises.

***Key words:*** *mobility, force, training, pathology, spine*

## Introduction

Both low back and neck pain are the most common musculoskeletal disorders in nowadays society (Sadler, Spink, Ho, De Jonge, & Chuter, 2017), with a prevalence in the population of around 50-67% (Bautista-Aguirre, et al., 2017; Kim, & Kim, 2018; Saliba, et al., 2010). In addition to the inconvenience they cause to those who experience them, they also cause a lot of direct and indirect costs to society (Bhadauria & Gurudut, 2017; Korthals-de Bos, et al., 2003; Müller, et al., 2019; Saliba, et al., 2010). Previous research has described how the lack of physical exercise in daily life and unsuitable postures generate instability of the spine (Kim, & Kim, 2018), causing chronic back pain (Kumar, Kumar, Nezamuddin, & Sharma, 2015; Soares, et al., 2016; You, et al., 2015). Chronic back pain may cause movement restriction and subsequent deterioration of muscles (Silfies, Mehta, Smith, & Karduna, 2009), which could lead to problems in neuromuscular control (Kienbacher, et al., 2016; You, et al., 2015). Such a situation can make working and daily activities difficult (De Celis, López, & Mateo, 2009), with the consequent negative impact on the quality of life of the people affected (Rheault, et al., 1992; Sadler, et al., 2017).

Physical exercise is considered one of the best non-pharmacological treatments, as it has been shown that suitable practice reduces pain, improves movement in the affected area, reduces physical impairment and improves the quality of life (Soysal, Kara, & Arda, 2013). It has been seen that a decrease in range of motion (ROM), lack of strength (STR) or weakness of the trunk muscles (Cairns, Foster, & Wright, 2016; Kienbacher, et al., 2014) are risk factors for low back pain (Feldman, Shrier, Rossignol, & Abenhaim, 2001). Mazloum, Sahebozamani, Barati, Nakhaee, and Rabiei (2018) and Wójcik and Siatkowski (2011) showed that physical exercise can help to improve ROM in patients suffering from low back pain. Kim and Kim (2018) reported that training the lumbar musculature is the most beneficial treatment for preventing impairments of the lumbar spine. In the same line, it has been shown that individuals with high levels of muscle strength are less likely to suffer from low back pain (Kienbacher, et al., 2014), as strong trunk muscles can protect the spine during daily activities (You, et al., 2015). Therefore, a physical exercise program that improves both ROM and STR could contribute to decreasing the probability of developing back pain.

Despite the benefits physical exercise seems to offer to people with back pain (Soysal, et al., 2013), most studies have measured the effect of the interventions using functional aptitude tests or subjective questionnaires (Cairns, et al., 2016; You, et al., 2015). A few studies have analyzed the effects of an intervention using physical exercise on ROM and muscle STR. Bhadauria and Gurudut (2017) have recently found that an intervention program using dynamic strength exercises strengthens the spine and its support structures, achieving more activation in these muscles (You, et al., 2015). Authors of most studies consider that at least six weeks of intervention are necessary to improve ROM and STR in patients with back pain (Hammer & Pfefer, 2005; Kienbacher, et al., 2014). However, no studies were found that analyzed the effect of intervention programs lasting longer than six weeks on people with neck and low back pain. Also, it is not known if there are gender differences in effects.

Thus, the purpose of the present study was to ascertain the effects of a 12-week intervention program based on exercises of mobility and dynamic strength on the stabilizing muscles of the trunk and neck on people with neck or low back pain according to gender. The initial hypothesis of the present study was that the intervention program used would have positive effects on the stabilizing muscles of the trunk and neck in people with neck or low back pain.

## Methods

### Experimental approach to the problem

With the objective of developing monitored capacities, a 12-week recovery training program (mobility and dynamic strength) using six DAVID® machines Fi (F110, F120, F130, F140, F150 and F160, DAVID**®,** Health Solution, Helsinki, Finland) (Kienbacher, et al., 2014; Müller, et al., 2019) was carried out. Before the program (T1), six weeks in the intervention program (T2) and at the end of the intervention 12 weeks later (T3), participants performed a ROM test and a maximum voluntary isometric strength test (MVC) (Müller, et al., 2019) on each of the machines used in the intervention program. At T1, T2 and T3, in preparation for tests, the participants carried out the same warm-up which consisted of 10 min of aerobic exercise on an elliptical machine (Life Fitness Activate Series, Rosemont, Illinois, U.S.A.). They subsequently performed the ROM and MVC tests on each of the six DAVID® machines used in the intervention program. Participants were familiarized with the tests because they had been performed before the start of the study.

### Participants

Forty-two participants (n = 25 males and n = 17 females; age 49.62 ± 8.82 years; body height 1.70 ± 0.10 m; body mass 73.21 ± 16.48 kg; body mass index 25.12 ± 4.42 kg/m$^2$) participated in this study. The inclusion criteria were that the potential partici-pants suffer from some type of neck or low back pain and that they have completed at least 85% of the intervention program. The exclusion criteria were: the involvement of any nerve tissue in the neck or back, a recent fracture, severe instability experienced, a serious cardiovascular disorder or a major surgery in the previous year. The participants, after the medical diagnosis of low back or cervical pain, were referred to participate in the intervention program. Among the participants, 17 suffered from cervical pain and 25 from low back pain. Participants were informed of the purpose of the study, as well as of the research procedure, and took part voluntarily having the possibility to withdraw from it at any moment. The study was carried out with the consent of the management of the clinic where it was conducted, and all the participants signed an informed consent before the start of the intervention. The procedures followed the guidelines established by the Declaration of Helsinki (2013) and the study was conducted according to the ethical standards established for research in sport and exercise sciences (Harriss & Atkinson, 2013).

### Procedures

The DAVID® machines both for the ROM and MVC tests were used in the following order: F130, F140, F120, F150, F160, and F110 (lumbar thoracic flexion, cervical lateral extension/flexion, lumbar thoracic rotation, lumbar thoracic lateral flexion, cervical rotation, and lumbar thoracic extension, respectively). First, the ROM test and then the MVC test were conducted on the first machine (F130).

The same procedure was repeated on the rest of the machines until the participants finished tests on the F110 machine. The duration of rest applied between the tests and machines was the time needed to move from one machine to the next. To avoid possible personal interference in the results of the tests, the verbal instructions given prior to the tests were standardized according to the recommendations of a specialist and a member of the research team who supervised the performance of the tests.

*Range of motion (ROM) test.* All the participants carried out six ROM tests, one on each of the six DAVID® machines. The test consisted of performing the movement corresponding to each DAVID® machine with the greatest range of motion possible in the absence of pain (Müller, et al., 2019). For this, the machines were placed in the neutral position (0º) with no load or weight. The results of the test were recorded with a cervical ROM basic device (Performance Attainment Associates, cervical ROM Basic, Roseville, Minnesota) (Rheault, et al., 1992; Youdas, Carey, & Garrett, 1991; Youdas, et al., 1992) for the cervical ROM on the F140 and F160 machines and a standard mechanical goniometer (DAVID® Health Solutions, Helsinki, Finland) incorporated into each DAVID® machine for the results of the lumbar ROM on the F110, F120 and F150 machines. The ROM obtained by each participant on each machine was recorded in degrees (0º). Each machine was adapted to the anthropometric measurements of each participants using the different adjustable elements. The results from each test were automatically transferred via a wireless connection using DAVID® software (version 2.1.0. 2009-2017, DAVID® Health Solutions, Helsinki, Finland). Accordingly, the values were obtained for cervical (ROMC) and lumbar (ROML) ROM corresponding to each machine: cervical (ROMC140Flx and ROMC140Ext) and lumbar (ROML130Flx and ROML110Ext) flexion and extension, right and left lateral cervical (ROMC140FlxLatR and ROMC140FlxLatL) and lumbar (ROM150FlxLatR and ROM150FlxLatL) flexion, and right and left cervical (ROMC160RotR and ROMC160RotL) and lumbar (ROML120RotD and ROML120RotI) rotation.

*Test of maximal voluntary isometric strength (MVC).* All the participants performed six MVC tests, one on each of the DAVID® machines. For this, the machines were blocked at 30º except for the F130 and F140 machines, which were blocked in the neutral position (0º) (Kienbacher, et al., 2014). The results of the tests were recorded using a standard dynamometer (DAVID® Health Solutions, Helsinki, Finland) incorporated into each DAVID® machine (Kienbacher, et al., 2014). The peak force exerted by each participant (Nm) was recorded on each of the machines. The results were normalized according to the body mass of each participant and converted into kg by the software program (version 2.1.0., 2009-2017 DAVID® Health Solutions Helsinki, Finland), calculating them as workload (kg) = MVC (1RM) / 9.81 (gravitational constant) * 0.6 (static to dynamic load factor) (David Sports LTD, 2015).

The results obtained in each test were automatically transferred via a wireless connection by the DAVID® software (version 2.1.0. 2009-2017, DAVID® Health Solutions, Helsinki, Finland). In order to isolate the isometric work carried out by the muscle group to be analyzed, the remaining body segments were kept immobile using the different adjustable elements on the machines. In this way the following values were obtained: maximum voluntary isometric cervical (STRC) and lumbar (STRL) strength exerted on each of the machines: cervical extension (STRC140Ext), lumbar flexion and extension (STRL130Flx and STRL110Ext), right and left lateral cervical (STRC140FlxLatR and STRC140FlxLatL) and lumbar (STRL150FlxLatR and STRL150FlxLatL) flexion, and right and left cervical (STRC160RotR and STRC160RotL) and lumbar (STRL120RotR and STRL120RotL) rotation. This test also made it possible to calculate the muscle strength asymmetry (STRA) of the muscle groups analyzed, understood as the difference in percentage between the values obtained for flexion-extension or right-left (RL). In this way the following measurements were recorded: lumbar flexion-extension asymmetry (STRAFlxExt), right and left cervical (STRACFlxLatRL) and lumbar (STRALFlxLatRL) lateral flexion asymmetry, as well as right and left cervical (STRACRotRL) and lumbar (STRALRtRL) rotation asymmetry.

*Intervention program.* The intervention program used in this study was the *Athlon Intervention Normal*, an individualized recovery-training program for mobility and dynamic strength in the stabilizing muscles of the trunk and neck (David Sports LTD, 2015), supervised by a physical exercise expert and the research team. The program lasted 12 weeks (1-2 sessions per week) with each session lasting 37.18 ± 4.45 min on average (Table 1).

Each session began with a warm-up of 5–10 min on an elliptical machine (Life Fitness Activate Series, Rosemont, Illinois, U.S.A.). The main part of the exercise program consisted of mobility and dynamic strength training for the stabilizing muscles of the trunk and neck performed on six DAVID® machines (DAVID® Health Solution, Helsinki, Finland), which were executed in the same order as the tests: F130, F140, F120, F150, F160, and F110. Rest between exercises was the time necessary to shift from one machine to the next and adopt the correct position for performing the exercises. The cool down (8-min) consisted of a series of stretching exercises for all the muscles addressed during the exercise program.

*Table 1. General data on the Athlon Intervention Normal Program performed by the participants in the study*

| | Minimum | Maximum | Mean ± SD |
|---|---|---|---|
| Visits per week (days) | 1.00 | 2.00 | 1.48 ± 0.27 |
| Visit duration (min) | 29.54 | 48.48 | 37.18 ± 4.45 |
| Effective training time (min) | 16.16 | 18.16 | 17.27 ± 0.29 |
| Repetitions per session on each machine | 20.00 | 23.00 | 21.36 ± 0.76 |
| % compliance with the program | 88.00 | 98.00 | 95.24 ± 1.94 |

The program workload was: progressively increased by a percentage according to the program work phase, individualized based on the results obtained at the start of the program (T1), and adjusted depending on the results obtained at T2. Thus, taking the individual values of T1 and recalculating them after T2 for each of the machines, every participant worked at a workload of 25% (Phase 1; sessions 1-8), 30% (Phase 2; sessions 8-12), 35% (Phase 3; sessions 12-18) and 40% (Phase 4; sessions 18-24) of the MVC with a ROM of 95% on the ROML F110, F120, F130 and F150 machines and a ROM of 50% on the ROMC machines F140 and F160.

## Statistical analysis

The descriptive statistics (mean ± standard deviations; SD) were calculated. The Kolmogorov-Smirnov test was used to check the normality of the data, which showed a normal distribution permitting the use of parametric statistics. The differences between T1, T2 and T3 in different variables were calculated with repeated measures ANOVA, using Bonferroni *post-hoc* analysis. The difference in means was calculated in percentage (Dif%) between T1, T2 and T3 in each of the variables with the formula:

Dif. (%) = (mean post – mean pre) x 100/ mean pre.

The effect size (ES) was calculated following the method proposed by Cohen (1988). Effects sizes smaller than 0.2, between 0.2 and 0.5, between 0.5 and 0.8 or greater than 0.8 were considered trivial, low, moderate, or high, respectively. A two-way ANOVA was calculated (gender x test or location of pain x test) to ascertain differences in the effects of the program according to gender or the location of pain (cervical or lumbar). The statistical analysis was carried out with the Statistical Package for the Social Sciences (SPSS Inc, version 23.0, Inc. Chicago, Illinois, U.S.A.). Statistical significance was set at $p<.05$.

## Results

No significant differences were obtained ($p>.05$) in the two-way ANOVA in the gender-test analysis or in the case of the location of pain-test in any of the variables analyzed. The results from the

*Table 2. Results of all the participants (n= 42) in T1, T2 and T3 for the range of motion (ROM) variables*

| | T1 | T2 | T3 | T1-T2 Dif. % (ES) | T1-T3 Dif. % (ES) | T2-T3 Dif. % (ES) |
|---|---|---|---|---|---|---|
| ROMC (º) | | | | | | |
| ROMC140Ext | -57.19 ± 18.48 | -63.26 ± 9.24 | -64.07 ± 9.52 | 10.61 (-0.66) | 12.03 (-0.72)* | 1.28 (-0.08) |
| ROMC140Flx | 51.57 ± 7.292 | 54.76 ± 6.15 | 55.95 ± 8.045 | 6.19 (0.52)* | 8.49 (0.54)** | 2.17 (0.15) |
| ROMC140FlxLatR | 32.71 ± 5.53 | 35.48 ± 4.95 | 35.07 ± 13.60 | 8.44 (0.56)** | 7.20 (0.17) | -1.14 (-0.03) |
| ROMC140FlxLatL | -32.98 ± 7.33 | -34.95 ± 12.01 | -33.76 ± 17.54 | 5.99 (-0.16) | 2.38 (-0.04) | -3.41 (0.07) |
| ROMC160RotR | 67.21 ± 10.22 | 72.57 ± 10.15 | 74.12 ± 9.09 | 7.97 (0.53)** | 10.27 (0.76)** | 2.13 (0.17) |
| ROMC160RotLl | -59.07 ± 22.03 | -67.33 ± 9.41 | -69.98 ± 9.32 | 13.99 (-0.88)* | 18.46 (-1.17)* | 3.92 (-0.28)* |
| ROML (º) | | | | | | |
| ROML110Ext | -28.67 ± 4.87 | -30.33 ± 4.09 | -30.38 ± 4.49 | 5.81 (-0.41) | 5.98 (-0.38) | 0.16 (-0.01) |
| ROML130Flx | 41.76 ± 8.79 | 47.57 ± 4.62 | 48.05 ± 4.58 | 13.91 (1.26)** | 15.05 (1.37)** | 1.00 (0.10) |
| ROML120RotR | 39.05 ± 7.59 | 46.14 ± 6.57 | 49.19 ± 8.46 | 18.17 (1.08)** | 25.97 (1.20)** | 6.60 (0.36)* |
| ROML120 RotL | -38.52 ± 7.66 | -45.81 ± 6.34 | -49.29 ± 7.87 | 18.91 (-1.15)** | 27.93 (-1.37)** | 7.59 (-0.44)** |
| ROML150FlxLatR | 37.95 ± 7.92 | 43.15 ± 6.76 | 44.95 ± 6.58 | 13.70 (0.77)** | 18.44 (1.06)** | 4.17 (0.27) |
| ROML150FlxLatL | -38.20 ± 8.32 | -43.90 ± 5.58 | -45.60 ± 6.08 | 14.92 (-1.02)** | 19.37 (-1.22)** | 3.87 (-0.28) |

Note. ROM – range of motion; C – cervical; L – lumbar; T1 – test 1 (week 0); T2 – test 2 (week 6); T3 – test 3 (week 12); Ext – extension; Flx – flexion; Lat – lateral; R – right; L – left; Rot – rotation; Dif. % – difference of means in percentage; ES – effect size.

* =p<.05; ** =p<.001 significant differences between the means.

*Table 3. Results of all the participants (n = 42) in T1, T2 and T3 for the strength (STR) variables*

| | T1 | T2 | T3 | T1-T2 Dif. % (ES) | T1-T3 Dif. % (ES) | T2-T3 Dif. % (ES) |
|---|---|---|---|---|---|---|
| STRC (Nm) | | | | | | |
| STRC140Ext | 27.15 ± 13.77 | 34.63 ± 13.39 | 39.78 ± 13.65 | 27.58 (0.56)** | 46.54 (0.92)** | 14.86 (0.38)** |
| STRC140FlxLatR | 20.98 ± 9.94 | 26.33 ± 11.41 | 30.26 ± 11.40 | 25.54 (0.47)** | 44.27 (0.81)** | 14.92 (0.34)** |
| STRC140FlxLatL | 21.90 ± 10.08 | 27.49 ± 11.87 | 30.80 ± 11.86 | 25.50 (0.47)** | 40.65 (0.75)** | 12.07 (0.28)* |
| STRC160RotR | 7.12 ± 4.63 | 10.22 ± 5.57 | 12.21 ± 6.21 | 43.66 (0.56)** | 71.59 (0.82)** | 19.44 (0.32)** |
| STRC160RotL | 6.64 ± 4.73 | 9.49 ± 5.38 | 11.39 ± 5.39 | 42.84 (0.53)** | 71.48 (0.88)** | 20.05 (0.35)** |
| STRL (Nm) | | | | | | |
| STRL110Ext | 154.80 ± 90.19 | 206.75 ± 97.42 | 239.68 ± 111.03 | 33.56 (0.53)** | 54.83 (0.76)** | 15.92 (0.30)** |
| STRL130Flx | 112.65 ± 56.48 | 127.58 ± 59.29 | 135.38 ± 57.93 | 13.25 (0.25)** | 20.17 (0.39)** | 6.11 (0.13)** |
| STRL120RotR | 78.36 ± 47.44 | 114.86 ± 52.88 | 133.38 ± 57.54 | 46.58 (0.69)** | 70.22 (0.96)** | 16.13 (0.32)** |
| STRL120RotL | 84.81 ± 56.48 | 118.86 ± 56.34 | 137.14 ± 61.53 | 40.15 (0.60)** | 61.71 (0.85)** | 15.38 (0.30)** |
| STRL150FlxLatR | 110.51 ± 68.63 | 145.00 ± 73.64 | 157.29 ± 67.23 | 31.21 (0.47)** | 42.33 (0.70)** | 8.48 (0.18)* |
| STRL150FlxLatL | 106.73 ± 75.13 | 146.76 ± 73.88 | 167.80 ± 73.58 | 37.50 (0.54)** | 57.22 (0.83)** | 14.34 (0.29)** |

Note. STR – strength; C – cervical; L – lumbar; T1 – test 1 (week 0); T2 – test 2 (week 6); T3 – test 3 (week 12); Ext – extension; Flx – flexion; Lat – lateral; R – right; L – left; Rot – rotation; Dif. % – difference of means in percentage; ES – effect size. * =p<.05; ** =p<.001 significant differences between the means.

*Table 4. Results of all the participants (n = 42) in T1, T2 and T3 for the strength-asymmetry variables (STRA)*

| | T1 | T2 | T3 | T1-T2 Dif. % (ES) | T1-T3 Dif. % (ES) | T2-T3 Dif. % (ES) |
|---|---|---|---|---|---|---|
| STRAC (Nm) | | | | | | |
| STRA CFlxLatRL | 0.96 ± 0.13 | 0.98 ± 0.11 | 1.00 ± 0.12 | 1.44 (0.13) | 4.12 (0.32) | 2.64 (0.21) |
| STRA CRotRL | 1.13 ± 0.27 | 1.08 ± 0.17 | 1.06 ± 0.15 | -4.38 (-0.04) | -6.30 (-0.46) | -2.01 (-0.14) |
| STRAL (Nm) | | | | | | |
| STRA LFlxExt | 0.76 ± 0.30 | 0.61 ± 0.18 | 0.58 ± 0.17 | -19.56 (-0.81)** | -24.28 (-1.08)** | -5.86 (-0.21) |
| STRA LRotRL | 0.97 ± 0.23 | 0.98 ± 0.11 | 0.98 ± 0.11 | 0.83 (0.07) | 1.03 (0.09) | 0.19 (0.02) |
| STRA LFlxLatRL | 1.08 ± 0.22 | 0.98 ± 0.19 | 0.95 ± 0.14 | -9.28 (-0.52) | -12.54 (-0.95)** | -3.60 (-0.25) |

Note. STRA – strength asymmetry; C – cervical; L – lumbar; T1 – test 1 (week 0); T2 – test 2 (week 6); T3 – test 3 (week 12); Ext – extension; Flx – flexion; Lat – lateral; R – right; L – left; Rot – rotation; Dif. % – difference of means in percentage; ES – effect size. * =p<.05; ** =p<.001 significant differences between the means.

two-way ANOVA showed significant differences ($p<.01$ between T1-T3 and $p<.05$ between T1-T2) in the gender-test only for STRAFlxLatRL).

Table 2 shows the results of all the participants in ROM at T1, T2 and T3, revealing significant differences between T1 and T2 in nine out of the 12 ROM variables analyzed ($\Delta\%$ = 6.19 to 18.91; ES = 0.52 to 1.26, moderate-high; $p<.05$ or $p<.01$). Regarding the differences between T1 and T3, significant changes were evident in nine out of the 12 ROM analyzed ($\Delta\%$ = 8.49 to 27.93; ES = -0.72 to -1.37, moderate-high; $p<.05$ or $p<.01$). However, only three out of the 12 ROM variables analyzed showed statistically significant differences between T2 and T3 ($\Delta\%$ = 3.92 to 7.59; ES = -0.28 to -0.44, low; $p<.05$ or $p<.01$).

Table 3 shows the results obtained by all the participants in the variables of strength (STR) at T1, T2 and T3. The differences between T1 and T2 or between T1 and T3 were significant in all the STR variables ($\Delta\%$ = 13.25 to 71.59; ES = 0.25 to 0.96, low-high; $p<.01$). Significant differences were also observed between T2 and T3 in 10 out of the 12 STR variables analyzed ($\Delta\%$ = 6.11 to 20.05; ES = 0.13 to 0.38, trivial-low; $p<.05$ or $p<.01$).

Regarding STRA (Table 4), significant changes were found between T1 and T2 in STRALFlxExt ($\Delta\%$ = -19.56; ES= -0.81, high; $p<.01$) and between T1 and T3 in STRAFlxLatRL and STRALFlxExt ($\Delta\%$ = -12.54 to -24.28; ES= -0.95 to -1.08, high; $p<.01$). No significant differences ($p>.05$) were found between T2 and T3 in any of the STRA variables.

## Discussion and conclusions

The purpose of the present study was to ascertain the effects of a 12-week intervention program, based on exercises of mobility and dynamic strength, on the stabilizing muscles of the trunk and neck in people with neck or low back pain. The main findings of this study were that the intervention program was effective in improving the majority of the ROMC and ROML variables (nine out of 12) and all the STR variables. No differences were observed in the effects of the program according to the location of the pain (cervical or lumbar) or the gender of the participants for the ROM or the STR variables and only one STRA variable (STRA-FlxLatRL) showed significant change differences according to the gender of the participants.

Assessment of the mobility of the spine has been defined as an important parameter for studying people's functionality (Andreoni, Negrini, Ciavarro, & Santambrogio, 2005). It has been observed that different types of back pain limit mobility, may increase the risk of low back pain (Adams, Mannion, & Dolan, 1999; Van Nieuwenhuyse, et al., 2009), and affect the general functionality (Mazloum, et al., 2018; Wójcik & Siatkowski, 2011) and quality of life of the people that suffer from it, leading even to physical impairment (Mazloum, et al., 2018). In this regard, like other intervention programs based on working on the mobility of this musculature (Lee, Lee, & Oh, 2016; Mazloum, et al., 2018), the program administered in the present study was effective for most (nine out of 12) of the ROM variables analyzed, obtaining similar effects according to the location of pain (cervical or lumbar) and the gender of the participants. Current results show that ROM variables improvement became evident both after six and 12 weeks of the intervention compared to the initial values and that the improvements between week 6 and week 12 were only evident in some variables (three out of 12). A previous study also observed ROM improvements after six weeks of intervention (Hammer & Pfefer, 2005). As a novelty, current results show that further ROM improvements are not particularly notable between weeks 6 and 12 for most ROM variables. It has also been stated that the difference in mobility between the musculature responsible for right and left lateral flexion of the back, and precisely the lumbar region and the hip, is a predictive factor for back problems (Nadler, et al., 2001; Sadler, et al., 2017; Van Nieuwenhuyse, et al., 2009). In the present study, significant improvements were obtained in the ROM for right and left lateral lumbar flexion (ROML150FlxLatR, $\Delta = 18.44\%$, ES = 1.06, moderate-high, $p<.01$; ROML150FlxLatL, $\Delta = 19.37\%$, ES = -1.22, moderate-high, $p<.01$), an aspect that could be beneficial for reducing back problems (Nadler, et al., 2001; Sadler, et al., 2017; Van Nieuwenhuyse, et al., 2009). Overall, the intervention program used in the present study has positive effects on the ROMC and ROML of the participants who suffer from neck or low back pain.

As well as ROM, the strength of the back muscles is of vital importance to people suffering from unspecific neck or low back pain (Hu, et al., 2017; Kienbacher, et al., 2014; Verbunt, et al., 2005), as low levels of strength are associated with lesser functionality and greater levels of pain (Kumar, et al., 2015; You, et al., 2015), impairing well-being and quality of life (Baerga-Varela & Abréu, 2006; Hu, et al., 2017; Kovacs, et al., 2004). In the present study, all STR variables improved, revealing differences between T1-T2, T1-T3 and T2-T3, with similar effects for men and women regardless of the location of the pain (neck or low back). The results of the present research coincide with those obtained in previous studies (Kienbacher, et al, 2014; You, et al., 2015), which showed that with a similar intervention, but of shorter duration (six weeks), improvements were achieved in low back muscle strength, decreasing the intensity of the pain and the degree of low back disability. In fact, Kienbacher et al. (2014) stated that a 6-week period was the minimum duration necessary for a therapeutic exercise intervention to obtain a clear improvement in strength. As a novelty, the program improved all the STR variables after a 6-week intervention, with further improvements between the 6th and the 12th week of the intervention. These findings lead us to think that it could be useful to implement the program used in this study for 12 weeks to improve STR in both men and women suffering from unspecific neck or low back pain.

Regarding STRA variables, improvements were only obtained in STRALFlxExt at T2 and in STRALFlxExt and STRALFlxLatRL at T3. A suitable flexion-extension and/or right-left muscle strength asymmetry can aid general functionality, while strength dissymmetry may be associated with problems in the low back region (Kalichman, & Hunter, 2008; Nava-Bringas, et al., 2014). These results seem to suggest that perhaps it is necessary to complement the intervention program used with other more specific exercises or tasks which make it possible to improve STRA variables.

The program used in the present study was effective for improving ROM and STR variables in adults with neck or low back pain. However, it did not show clear positive effects for the STRA variables. Therefore, it may be a suitable program for improving ROM and STR in people suffering from neck and low back pain who need to recover and/or train the mobility and strength of their trunk and neck stabilizing muscles. However, it might be necessary to include some specific exercises aiming at improving STRA in this population. According to the results obtained, it could be interesting for physical exercise professionals who design programs for people with neck and low back pain to use the program applied in the present study, and to design interventions lasting 12 weeks since they achieve better results in STR variables and similar ones in ROM compared to the interventions of only six weeks.

The one strength of the research is that the training effects on strength asymmetries have been evaluated, and this one is interesting for training strategies performed by people who suffer from low back and neck pain in order to improve their mobility and their strength thus improving their health. On the other hand, this research is not free of limitations; in future research, it would be interesting to evaluate people with low back and neck pain separately. Future research should be done with bigger samples to elucidate if the training may have different results in people with different pain sites.

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