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Effect of Progressive Lumbar Stabilization Exercises Among University Students with Non-Specific Low-Back Pain Over Post-COVID-19

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Abstract Low-back pain (LBP) has significantly reduced daily activities, work hours and societal productivity, with an increase since the COVID-19 pandemic. The study aimed to investigate the effects of progressive lumbar stabilization exercises (LSE) on back flexibility and pain intensity after four weeks and follow-up until week eight in students with Non-specific low-back pain (NSLBP) after COVID-19. A total of 34 UPSI students with NSLBP (pain duration: >6 months, age: 23.4±2.1 years, weight: 67.2±9.2 kg, BMI: 24.9±1.35 $kg.m^{-2)}$ participated in this study and they were randomly assigned to the LSE (n=17) or control (n=17) groups. The LSE group performed pelvic tilt, double knee-to-chest, bridging, bird dog, superman, cat and camel and partial curl-up exercises for eight weeks, 30 minutes and three sessions per week. The Sit and Reach test was used to assess back flexibility, and pain intensity was assessed using the VAS at the baseline, weeks 4 and 8. In baseline, week 4^{th} and endpoint times, there was a significant difference in back flexibility (F 1, 28= 9.9, p =0.003) and pain intensity (F 1, 28= 4.8, p =0.023) between the LSE and control groups. After four weeks, the LSE group experienced a significant increase in back flexibility (p=.019). In conclusion, this progressive LSE improved back flexibility after four weeks and reduced pain intensity after eight weeks in university students who suffered from NSLBP after the COVID-19 pandemic.

Keywords Lumbar Stabilization Exercise, Back Flexibility, Pain Intensity, Non-Specific Low-Back Pain, UPSI Students, Post-COVID-19

1. Introduction

Low-back pain (LBP) has become a common symptom and a major health problem in the working age population for both men (39%) and women (40%) [1, 2]. LBP is not only common among workers with uncomfortable postures [3] and older adults or the elderly [4], but it is also the most common pain symptom and 70 to 85% of the population will experience LBP at some point in their lives [5]. Furthermore, the incidence and intensity of LBP increased

during the COVID-19 lockdown and recently it has been reported as a common health issue among young students as post-COVID-19 challenge [6]. Interestingly, a recent study revealed that students who spent most of their time on their laptops suffered from musculoskeletal pain, especially from LBP compared to active ones [7].

Since LBP pain can reduce back flexibility and cause daily life disability [8, 9], previous studies have been completed in order to find a perfect and quick treatment to improve LBP [10, 11]. Similarly, Hlaing et al. (2021) found that short-term programs involving dynamic or static proprioceptive neuromuscular facilitation (PNF) were effective in improving trunk muscle endurance and mobility to reduce LBP symptoms [12], and that they could improve functional performance in people with LBP [13].

In addition, another study by Bhadauria and Gurudut (2017) aimed to compare the effects of lumbar stabilization, dynamic strengthening and Pilates on pain perception, range of motion, core strength and function in patients with chronic LBP. Their study results showed significant improvement in pain, range of motion, functional capacity and abdominal and core strength in all three exercise groups, but a greater improvement on all measures results were observed in the lumbar stabilization group after session 10 [14]. In other words, the lumbar stabilization was more effective and quicker than the dynamic strengthening group and Pilates group in treating chronic LBP. Additionally, while reduced back flexibility is thought to be a cause of LBP [15], lumbar strength exercises aim to strengthen the deep lumbar stabilizing muscles [16], including transversus abdominis, lumbar multifidi and internal oblique muscles [17].

Although various intervention activities, land or water-based exercise have been studied well, little research exists concerning progressive lumbar stabilization exercise among young university students with NSLBP. Moreover, most studies focused on the rehabilitation and therapeutic methods among adults or the elderly population who generally faced challenges while performing exercises autonomously [1]. Meanwhile, despite the fact that prolonged physical inactivity is increasing in educational methods and learning over time [7], performing lumbar stabilization exercise can provide an applicable opportunity to motivate university students with NSLBP to improve back flexibility and pain intensity will self-sufficiently and probability is able to carry out this exercise on their own easily.

A decline in quality of life and an increase in functional limitations are clinically linked to pain and stiffness of the muscles and joints [18], especially in light of the increasing frequency and severity of NSLBP in young students as a result of the COVID-19 pandemic [6]. Therefore, this study aimed to examine the effects of progressive lumbar stabilization exercise (LSE) on changes in back flexibility and pain intensity at four weeks and eight weeks follow-up for students with NSLBP after two years of lockdown.

2. Materials and Methods

2.1. Sample Size

In the current study, 43 students with NSLBP voluntarily enrolled from Sultan Idris Education University (UPSI), Malaysia. Taking into account the inclusion criteria, healthy, physically active subjects with LBP for more than six months were recruited for this study. They were also recognized as NSLBP and referred to the Sports Rehabilitation Unit at Sultan Idris Education University (UPSI). They were undergraduate students, with ages of 23.4± 2.1 (range: 20-27) years old, the weight of 67.2 ± 9.2 (range: 51.6-83.1) kg, the height of 166.4 ± 7.0 (range: 149-179) cm, with BMI of 24.9±1.35 (range (19.7 – 26.9) $kg.m^{-2}$.

The subjects with injuries or surgeries within the past six months or with cardio-respiratory diseases were excluded. All subjects were informed about the study procedure and signed a consent form before participating, and they could withdraw from the program at any time without any consequences.

In addition, based on the participant's reports, 6% of them experienced NSLBP for more than two years, 44% experienced between 1-2 years, and most of them (50%) experienced more than six months and never had back pain problems before the episode of the COVID-19 pandemic. They have undertaken a minimum of 18 months of lockdown and continued their study through online educational systems.

Although during the study, four subjects (2 in each group) did not carry out the study after week 4, finally, 15 participants for each group completed the study program for eight weeks. Figure 1 shows the diagram of sampling and data collection three times during eight weeks of follow-up.

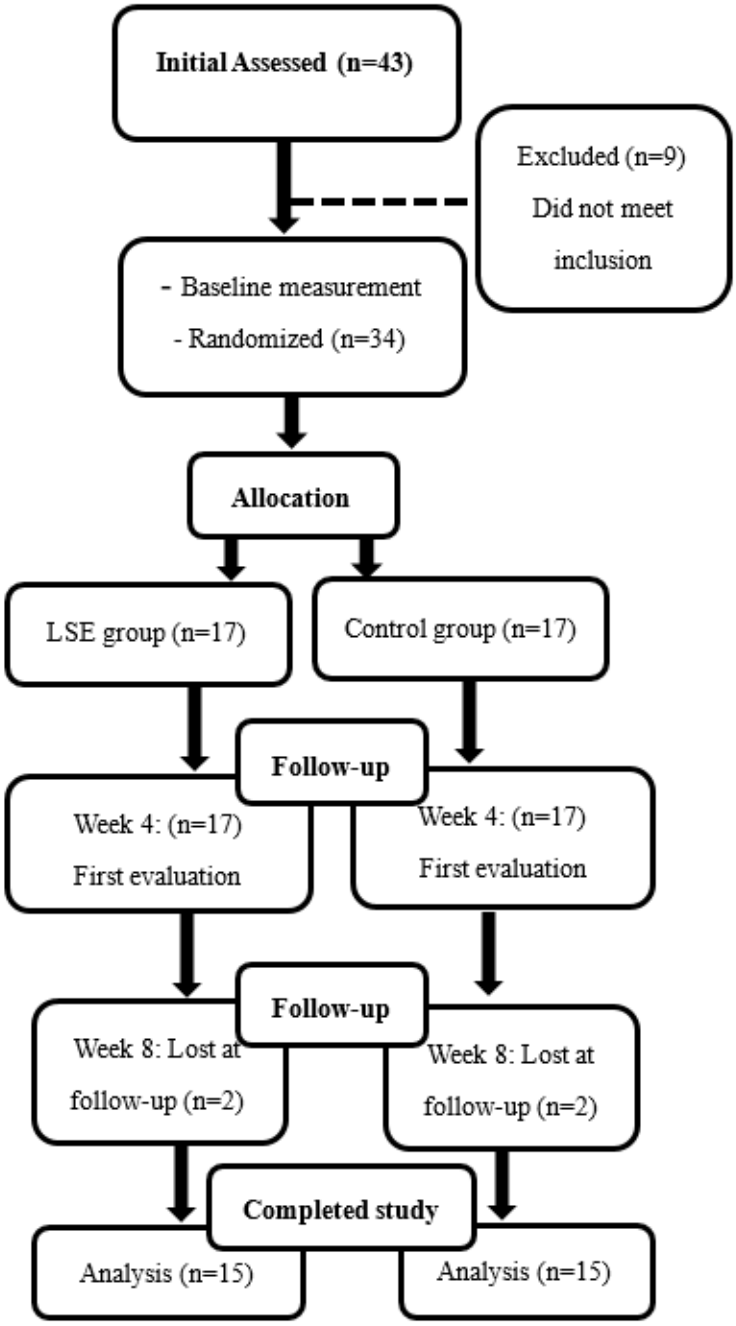

Figure 1. Diagram of sampling and data collection (8 weeks follow-up)

Recruited subjects were randomly divided into two groups; LSE (53% male and 47% female), and control Group (60% male and 40% female). Both groups also reported that they performed light exercises such as walking three to four times weekly; 20-30 minutes per session, when their pain was manageable.

Meanwhile, refer to the design of sampling calculating method with G*Power 3.0.10, (for an ANOVA with a repeated measure, within-between interaction effect) a model of 15 sample size will produce a power of 95% (α=0.05; effect size: 0.28) to detect differences between the effects of the intervention program.

2.2. Outcome Measurements

Body composition measurement, including weight, height, BMI, and body fat percentage, were assessed using the Inbody 230 (Biospace, Korea). Pain intensity was measured using the Visual Analogue Scale (VAS). The VAS consists of a straight line (0-10 lines) with parameters that define extreme ranges such as ‘no pain at all’ and ‘pain as worst’ [18]. Participants were asked to mark their pain level on a line between the two endpoints.

The sit and reach test was conducted to measure the back flexibility [19], and it was conducted three times and

the best measurement was recorded. It should be mentioned that, before the pre-test, a pilot study was conducted among eight students with NSLBP who were not selected in the actual study. The test was carried out two times, with 72 hours of rest among the same subjects. The data was analyzed using the Pearson Product-Moment Correlation test and showed r value = 0.76 for the sit and reach test, which presented high reliability. Additionally, Levene's test was also used to examine the variations in VAS and sit and reach test between groups. The significance level was set at $p < 0.05$.

The data collection was performed a day before (baseline), exactly a day after week 4th and a day after week 8th (endpoint) of the intervention program. This study was conducted in October-November 2022 at the Sports Rehabilitation Unit at USPI, Malaysia.

2.3. Intervention Program

Lumbar Stabilization Exercise (LSE) was carried out for the LSE group, firstly four weeks and then followed till week eight (24 sessions), three times per week and 30 minutes per session, while the control group received no treatment during these weeks. LSE program consisted of seven exercises, including pelvic tilt, double knee to chest, bridging, bird dog, superman, cat and camel and partial curl-up exercises (See Figure 2) [20]. Each session lasted for 30 minutes with 10 minutes of warming up and cooling down [21].

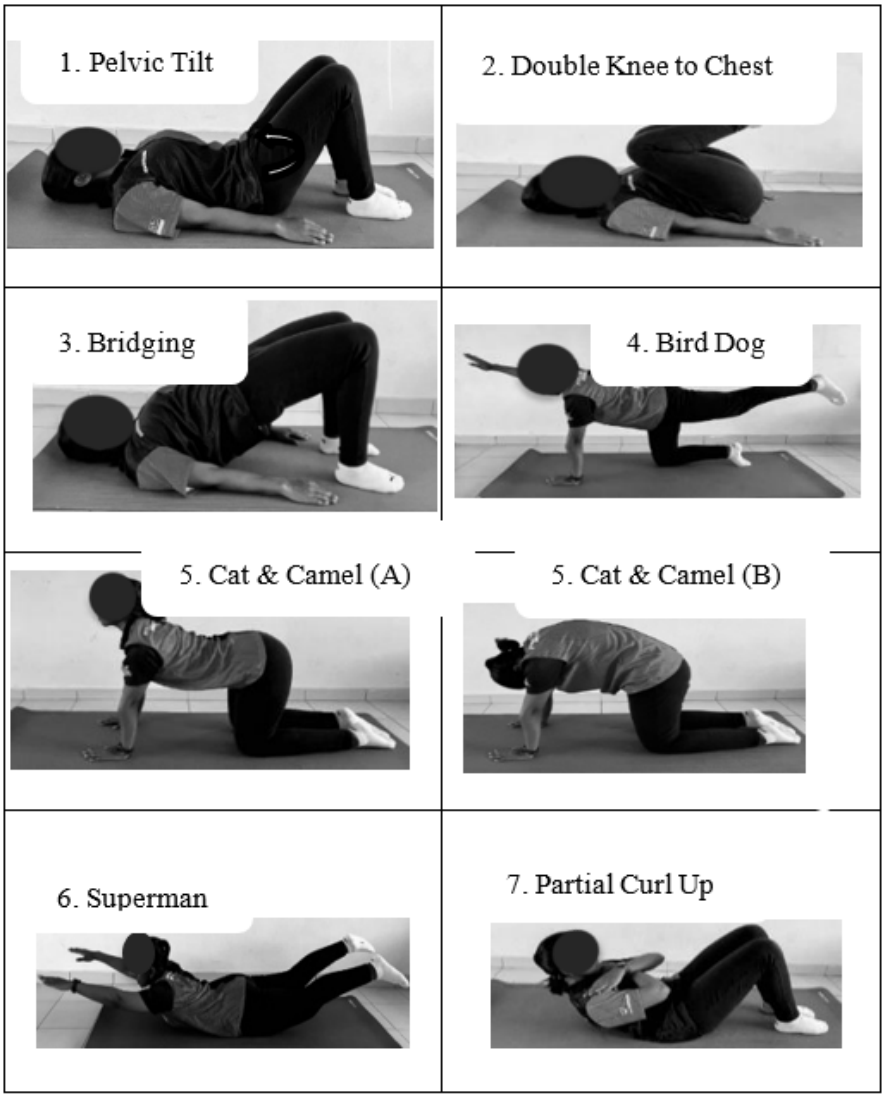

Figure 2. Lumbar Stabilization Exercises

A single master sports rehabilitation therapist who was certified as an exercise practitioner conducted the progressive intervention program including the number of repetitions, set, exercise holding time, and rest time between each set (time of intervals) for the LSE group (LSEG) for all sessions over the eight weeks. Before starting the intervention program, the exercise practitioner provided a details explanation, demonstration, and visual instructions, the starting position and the end position as well as the interval time of the protocol.

Accordingly, LSEG performed the exercises once, consecutively in the same order. The LSE program was performed within the evening on even days. It ought to be noted that even though the control group was advised and exhorted to have no workout or exercise for eight weeks and a rehabilitation treatment arrangement was given after week eight, this study was not able to control all of their self-treatment circumstances. Table 1. shows a summary of the progressive procedure of the LSE protocol (See Table 1 in appendix).

2.4. Data Analysis

Descriptive statistical analysis was used to analyze the demographic data. Since this study sample size was less than 50, the data normality was confirmed using Shapiro-Wilk normality test. The data were presented by comparisons of means and standard deviation at baseline, after week 4^{th} and week 8^{th} between LSE and control groups.

One-way ANOVA was conducted to compare the most impacts of the LSE program and time contrasts (baseline, week 4^{th} and week 8^{th}) on the back flexibility and pain intensity among groups. Meanwhile, an independent t-test was conducted to determine the different changes in back flexibility and pain intensity after week 4^{th} and week 8^{th} (as the endpoint) between LSEG and control group. The data were analyzed using IBM SPSS Statistics (Version 27) and the statistical significance level was considered at $p \leq 0.05$.

3. Results

According to descriptive data, both groups of study were statistically comparable. In the end, after eight weeks of the study program, thirty recruited subjects completed whereas the average attendance of the LSEG was 94% during 24 sessions. In overall characteristics of both groups were similar in terms of age (LSEG: 23.13±1.8; CG: 23.9±2.5 years) and height (LSEG: 167.4±11.2; CG: 168.5±8.3cm). The Kolmogorov-Smirnov assessment results verified that the distribution of the outcome variables was normal and parametric assessments were applicable. The demographic data (Mean ±SD) of each group is shown in Table 2. It should be specified that no significant difference was found in age, weight, height, BMI and body fat percentage between both study groups. Analyzing the depending variables One-way ANOVA illustrated significant differences between baseline, week 4th and endpoint for back flexibility in LSE and control groups with F 1, 28 = 9.9, p = 0. 003, and for pain intensity with F 1, 28 = 4.82, p = 0. 023. In addition, a significant difference in back flexibility (p= 0.019) was displayed between LSEG and control group after week 4, whereas there was no significant difference in pain intensity (p=0.061) after week 4 between LSEG and control group. Meanwhile, pain intensity was significant between the groups only at the endpoint (p=0.013). The results of One-way ANOVA (groups and times) and independent t-test of progressive LSE program on study variables in students with NSLBP are shown in Table 3.

Table 2. The demographic data of each group (mean ± SD)

Variable	Group	Baseline (n=17)	Week 4 (n=17)	Endpoint (n=15)	*P*
Weight (kg)	LSEG	68.6±9.8	66.82±8.9	66.51 ±8.4	0.71
	CG	66.8 ± 7.6	66.14 ± 8.1	65.74 ± 7.8	0.82
BMI ($kg.m^{-2}$)	LSEG	25.3 ± 1.1	25.19 ± 1.1	25.14 ± 1.3	0.93
	CG	24.5 ± 1.4	24.5 ± 1.07	24.2 ± 1.1	0.85
Body fat (%)	LSEG	26.4 ± 4.5	26.04 ±4.6	26.11 ±5.6	0.81
	CG	25.6 ± 5.1	25.3 ±5.4	25.26 ±4.7	0.7

Table 3. Body location that involved in the aquatic sports injuries

Variable	Group	Baseline (n=17)	Week 4 (n=17)	Endpoint (n=15)	*F*	*P*
Back flexibility(cm)	LSEG CG	25.41 ± 3.9 26.23 ± 4.1	31. 2 ± 4.2 27.9 ± 4.3	33.23 ± 4.2 28.7 ± 4.3	9.9	.003*
Independent t-test		*t* = .6 *P* = .27	*t* = 2. 2 *p* = .019*	*t* = 3.16 *P* =.002*		
Pain Intensity (VAS) 0-10 score	LSEG CG	*5.1*±1.1 *5.4*±1.2	*3. 8*±.8 *4.4*±.9	*2.3*±.7 *4.0*±.8	4.8	.023*
Independent t-test		*t* =.89 *P* = .18	*t* =1.6 *P* = .061	*t* =7.6 *P* ≤.001*		

Significant value (p ≤0.05); LSEG: lumbar stabilization exercise group, CG: Control group

4. Discussion

This study investigated the effect of four-week and follow-up to week 8th progressive LSE program on back flexibility and pain intensity in UPSI students who suffered from NSLBP after the COVID-19 pandemic. Our findings revealed that a four-week of progression LSE led to an increase in back flexibility and a significant reduction in pain intensity after eight weeks among students with NSLBP. In accordance with the previous study, the LSE program was evidently pointed at moving forward the neuromuscular control, strength and endurance of core strength muscles to maintain dynamic spinal and trunk stability [22]. Also, Kostadinović et al. (2020) revealed that individuals with chronic LBP could maintain a neutral position of the trunk during LSE perform [23]. Meanwhile, comparable studies indicated that self-stretching exercises may progress the limitation of movement of the spine and improve the facet joint sliding and normalize the articular capsule around it [13]. Hence, it can reduce the risk of possibility kyphosis and increase the flexibility of thoracic extension [2].

In addition, LSE involving the transverse abdominal muscles was primarily activated and contracted before any movement of the limb, regardless of direction [24], whereas other core and abdominal muscles intended to have different firing patterns from direction of movement [25]. In that, individuals with NSLBP have delayed transverse abdominis contraction and follow a specific direction pattern [5], which can cause a decrease in spinal stability and motor control among those who have NSLBP. This statement suggested that the improvement of transverse abdominis through LSE can improve lower back flexibility, reduce spinal muscle stiffness and a betterment of lumbar spine posture [11].

These findings are consistent with another study conducted by Ko et al. (2018), who studied the effects of lumbar stabilization exercises and sling exercise on changes in lumbosacral region angle, changes in lumbar muscle strength and flexibility, and also changes in pain scale [26]. Their results showed that both LSE and sling exercises significantly increased the lumbar muscle strength and flexibility in patients with chronic LBP after 18 weeks of the program. The findings of this study are also consistent with the results of Hlaing et al. (2021), who reported that four weeks of core stabilization exercises reduced functional disability, pain, balance and fear of movement among patients with sub-acute NSLBP [12].

Meanwhile, most understandable reason for no significant improvement in pain intensity after four weeks of the LSE can probably be related to pain perception as a subjective experience, which depends on individual differences in physiological, emotional and psychological conditions [18]. However, in this study, the LSE program started with a warming-up session including a series of stretching exercises (hamstrings, lower back and quadriceps stretching) which possibly had a consequence on the quick improvement of back flexibility after week 4th in LSE group.

In addition, even though the current study was different from prior studies in terms of age of the study population and intervention protocol, it supported previous studies [23, 27]. These findings also declared that LSE can be well-thought-out as a significant rehabilitation exercise program to increase back flexibility and lessen pain intensity in university students who has a sedentary lifestyle-similar to the COVID-19 lockdown - and suffered from NSLBP. The main limitation of the current study is the inability to monitor self-treatment in the control group, which may have influenced the results at week 4.

5. Conclusions

In conclusion, this study's findings showed a significant improvement in back flexibility after four

weeks and pain intensity reduction after eight weeks of progressive LSE in postgraduate students with NSLBP as post-COVID-19 health challenge. In that, a progressive LSE program can be considered an effective and suitable intervention program to improve NSLBP in university students. Meantime further studies with a larger sample size and different periods of exercise programs with more follow-up duration are needed to validate and elaborate on the superior effect of LSE for prevention and rehabilitation among different ages and groups with NSLBP.

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Appendix

Table 1. Prescription of eight weeks of lumbar stabilization exercise program (8 weeks, 3 frequency)

Week	***Session***	***Exercise***	*Repetition × Set*	*Hold & rest time (sec)*	*Rest between sets (min)*
1-2	1	1. Pelvic tilt 2.Knee to chest	3-5 × 2 3-5 × 2	5 & 10	5
	2	1. Pelvic tilt 2. Knee to chest 3. Bridging	6-8 × 2 6-8 × 2 3-5 × 2	5 & 10	5
	3	1. Pelvic tilt 2. Double knee to chest 3. Bridging	8-10 × 2 8-10 × 2 6-8 × 2	5 & 10	5
3-4	1	4. Bird dog (both sides) 5. Cat and camel	3-5 × 3 3-5 × 3	5 & 10	3
	2	4. Bird dog (both sides) 5. Cat and camel 6. Superman	6-8 × 3 6-8 × 3 3-5 × 3	5 & 10	3
	3	4. Bird dog (both sides) 5. Cat and camel 6. Superman	6-8 × 3 6-8 × 3 6-8 × 3	5 & 10	3
5-6	1	1. Pelvic tilt 2. Double knee to chest 3. Bridging 7. Partial curl up	10 × 3 10 × 3 10 × 3 3-5 × 2	5 & 10 5 & 10 5 & 5 2 & 10	2
	2	4. Bird dog (both sides) 5. Cat and camel 6. Superman 7. Partial curl up	10 × 3 10 × 3 10 × 3 8 × 2	5 & 10 5 & 10 2-5 & 5 2 & 10	2
	3	1. Double knee to chest 3. Bridging 1. Pelvic tilt 7. Partial curl up	12 × 3 12 × 3 12 × 3 12 × 3	5 & 10 5 & 5 5 & 10 2 & 10	2
7-8	1	1. Pelvic tilt 4. Bird dog (both sides) 5. Cat and camel 6. Superman	15 × 3 15 × 3 15 × 3 15 × 3	5 & 10 5 & 10 5 & 10 2-5 & 5	2
	2	2.Double knee to chest 3.Bridging 7. Partial curl up	16-18 × 3 16-18 × 3 16-18 × 3	5 & 10 5 & 5 1-2 & 10	2
	3	1.Pelvic tilt 2.Double knee to chest 3. Bridging 7. Partial curl up	16-18 × 3 16-18 × 3 16-18 × 3 16-18 × 3	5 & 10 5 & 10 5 & 5 1-2 & 10	2

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