INTRODUCTION
Enhanced core stability, defined as "the ability to maintain or resume an equilibrium position (or trajectory) of the trunk (and pelvis) after perturbation", has been touted to improve injury-prevention in many sports. Additionally, with increasing amounts of evidence showing that neuromuscular activation is delayed in individuals with low back pain, it is important to determine which specific exercises, when utilized as a part of rehabilitation intervention, specifically target those muscles for motor control. There is no consensus as to which exercise elicits the largest activation magnitude for the core muscles, and subsequently, is most appropriate to be included in the exercise-training program for core rehabilitation. Previous EMG studies generally relied on trained eyes to ensure lumbo-pelvic alignment and no objective measure is provided which questions their validity. Using the ‘LevelBelt’ it is possible to objectively confirm lumbo-pelvic alignment during functional postures/exercises. In female college students with no history of low back pain we investigated activation of Transverse abdominis (TAr), external oblique (EO), multifidus (MF) and quadratus lumborum (QL) during three specific core stabilization exercises including static and dynamic stabilization on a physioball, and planking.

METHODS
15 healthy female subjects between the ages of 22-30 years old, with no recent complaint of low back pain, has normal flexibility of lumbar spine and lower extremity range of motion, were recruited from Fresno State for this study. Subjects were excluded if they reported previous fracture or surgery to the spine and/or lower limbs, gross postural deformities, pregnancy and current low back pain symptoms. All subjects were provided informed consent to participate. Following skin preparation and EMG instrument set up, all subjects were verbally and visually cued for the following exercises: sitting unsupported on physioball, and progress to dynamic stabilization (lifting a seven pound weight in seated position) followed by planking. ‘LevelBelt’ was strapped onto each participant across the upper sacrum and secured with the stabilization straps. The level belt was set to provide auditory and vibratory feedback with ≥ two degree of pelvic tilt. Each participant had a visual demonstration of the activity before performing a practice trial. EMG recording was collected three times for accuracy for each exercise. The order of the exercise sequence was randomized for each subject to avoid order effect and fatigue. Muscle activity recorded from the three exercises was normalized to MVIC by dividing the raw data by MVIC values. The percentage of all the exercise activity in each of the four muscles was then averaged and imputed into SPSS software to compute a one-way ANOVA.

RESULTS AND DISCUSSION:
<table>
<thead>
<tr>
<th>Exercise</th>
<th>High (&gt;60%)</th>
<th>Moderate (21-40%)</th>
<th>Low (&lt;21%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static</td>
<td>Transverse Abdominis</td>
<td>Multifidus</td>
<td>Quadratus Lumborum</td>
</tr>
<tr>
<td>Dynamic</td>
<td>Transverse Abdominis</td>
<td>Multifidus</td>
<td>Quadratus Lumborum</td>
</tr>
<tr>
<td>Plank</td>
<td>Transverse Abdominis</td>
<td>Quadratus Lumborum</td>
<td>Multifidus</td>
</tr>
</tbody>
</table>

Table 1. Level of muscle activation during progressive core stabilization exercises
Figure 1: EMG Activity of Core Stabilizers during common physical therapy exercises.

The results suggest that core muscle activity is dependent on the type of core stabilization exercise as some muscles are more heavily activated in one type of exercise than the other. The significant difference between muscle activity during exercise suggest that prescribing static exercise, progressing to dynamic and plank will elicit progressive activation for the TA and EO; however MF and QL are mostly activated with dynamic stabilization type activity and not with planking.

Limitation: The interpretation of this study should be with caution as we examined only healthy female subjects performing the exercises in an attempt to maintain consistency and determine accurate muscle activation, however muscle recruitment pattern will be different in subjects with low back pain and may require additional, if not different, techniques to accurately activate the targeted muscle.

CONCLUSIONS:

Accurate neuromuscular activation of core muscles ensures the stability of the lumbo-pelvic complex, which is required for optimizing sports performance and prevent injuries. This is the first pilot study investigating muscle activation during core stabilization exercises where lumbo-pelvic alignment is objectively measured and confirmed using a novel device called level belt, a clinical tool that provides real-time biofeedback about the antero-posterior and lateral pelvic tilt.

Tar and EO exhibited the most EMG activity during plank. Whereas, (MF) and QL demonstrated highest EMG activity during dynamic stabilization type exercises.

To construct an exercise regimen for treatment or prevention of low back pain or optimization of sports performance and prevent injury in healthy subjects consideration must be made for the desired target muscle and evidence based exercises that elicit the highest muscle activity must be utilized.

REFERENCES