

STEAMS Application on Chronic Low Back pain and Exercise Intervention

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Abstract

This paper adopts STEAMS (Science, Technology, Engineering, Artificial Intelligence, Math, Statistics) methodology to investigate practical facts about exercise intervention on chronic low back pain population. In the modern Big Data era, the application of Artificial Intelligence (AI), data analysis and statistics are becoming more and more important. Therefore, integrating AI and Statistics with STEM (Science, Technology, Engineering, Math) to become STEAMS, will be a very powerful methodology to investigate scientific issues and solve problems. The science research revealed chronic low back pain (CLBP) is a common, long-lasting, and disabling condition with high costs for society and patients. Impairment of lumbopelvic stability is considered as a significant factor in patients with CLBP, and lumbopelvic stabilization exercise has been established as a treatment of chronic low back pain. Pilates is a recognized fitness program that follows core strengthening and also trains lumbopelvic stability. 45 CLBP participants undertook a 6-week Specific Pilates Exercise Program emphasizing on lumbopelvic stabilization, posture training and body awareness. We used visual analogue scale(VAS), Oswestry Low Back Disability Questionnaire, and pressure biofeedback unit to assess pain intensity, functional limitation and lumbopelvic stability before and after the exercise program. There were many previous researches investigating the effectiveness of Pilates exercise on improving CLBP patients, and the results among different researches are arguable. We believe the difference in the subjects' characteristics may be one of the reason that causes different results among those researches. In our paper, first, we used paired t test to determine if the 6-week Specific Pilates Exercise Program will improve pain intensity and the results showed significant improvement. Second, logistic regression and profiler and sensitivity analysis were used to investigate a predictive model of pain improvement. Occupation and age*occupation interaction were determined as the top two ranked variables related to improving pain condition after the program. This research also successfully demonstrated that "STEAMS" approach is very useful for conducting health science research.

Key Words: Low back pain, stability exercise, exercise intervention, statistics, predictive model.

1. Introduction and Creating Questions

Chronic low back pain is a common, long-lasting, and disabling condition worldwide¹. Approximately 75-85% of the population will experience low back pain at once during

their life time, which costs largely both economically and socially²⁻⁴. Proper exercises seems to be helpful for low back pain, but what kind of exercise is effective on improving the condition and who will be benefitted are interesting questions. Pilates is a popular exercise and it has been applied to improve CLBP in recent years⁵⁻⁹. However, we reviewed the previous researches and the benefits and effects of Pilates on chronic low back pain are arguable¹⁰⁻¹⁵. Many researches showed positive effect but some did not. The inconsistent results could be from different exercise interventions, different outcome measurements, different chosen subject characteristics and many other confounding factors. We are interested in whether the Pilates exercise can benefit the CLBP population and with what characteristics can the patients have better improvement from Pilates exercise. Therefore we applied STEAMS methodology to investigate these issues in this research.

2. STEAMS Approach on the CLBP and Exercise Issues

2.1 STEAMS Methodology

“STEM” or “STEAM” (Science, Technology, Engineering, Art, Math) is a popular term in School Education that is used to group together these academic disciplines¹⁶⁻¹⁷. In the modern Big Data Society, Artificial intelligence (AI) is becoming a new dominant Data Science. Statistics is a important and very powerful tool to analyze and interpret the data. Therefore, we think integrating AI and Statistics with STEM (Science, Technology, Engineering, Math), becoming STEAMS, will be a more comprehensive and powerful methodology to investigate scientific issues and solve problems.

2.2 Understand Chronic Back Pain and Exercise Intervention “Science”

CLBP is defined as back pain lasting more than 12 weeks¹⁸, and it affects more than 50% of the general population. Prevalence is higher in young, economically active adults in comparison with other chronic pain or disabilities¹⁹. Chronic low back pain prevalence is 4.2% in individuals aged between 24 and 39 years old and 19.6% in those aged between 20 and 59²⁰. Low back pain is the second most common reason for absenteeism from work, and one of the most common reasons for medical consultation²¹. Chronic low back pain has high impact and cost for society and patients. Also, its high prevalence influences young population at their work-productive age. Therefore, we are also very interested the improvement chance among different ages and occupations.

When humans evolved into erect walking, the vertebral structure needs to carry much more load because of gravity. Low back pain could result from repetitive microtrauma of the spinal structures due to poor control of spinal stability²². Core muscles can act as a nature body corset of the lumbar spine and pelvis. Lumbopelvic stabilization exercise has been proved to be beneficial in the improvement of CLBP²³. Pilates is a recognized fitness program that follows core strengthening principles with lumbopelvic stabilization training²⁴.

2.3 “Technology”: application on outcome measurement

In this research project, we used the pressure biofeedback device to measure the ability of maintaining lumbopelvic stability²³. The visual analogue scale²⁵ is used to assess subjects’ pain intensity with maximal, average and minimal pain level in a day. We used the Oswestry low back pain disability questionnaire to assess subjects’ daily activities limitation²⁶.

2.4 “Engineering”: approach to investigate the influencing factors on low back pain improvement

In this research project, 45 CLPB subjects (Table 1) completed a 6-week Modified Pilates Program at a hospital setting. This program was three one-hour group sessions per week, which included and emphasized on lumbopelvic stabilization, posture training and body awareness. VAS pain intensity, Oswestry LBP disability questionnaire and lumbopelvic stability by pressure biofeedback device were assessed before and after the 6-week program. Since we were interested in the influencing factors on low back pain improvement in this paper, we retrieved the data including pain intensity, age, occupation and gender. We investigated if the pain intensity improved after the exercise program intervention as our first step. Then we observed if age, occupation and gender were influencing factors of the pain improvement.

Table 1: Basic data of the 45 subjects

Age	41.1 (17-63) y/o
Gender (M:F)	17:28
Occupation types	House wife, White collar, Blue collar, Teacher, Retired, others

3. Statistic and Data Analysis to Answer the Questions on CLBP and Pilates exercise intervention

3.1 VAS Pain Intensity Improvement

We retrieved the VAS scores of before and after the exercise program, which included maximum VAS, medium VAS and minimum VAS. They indicate the VAS score of maximal pain, average pain and minimal pain intensity during a day. Paired t test was conducted to determine the pain intensity difference before and after the exercise intervention. The results revealed the maximum and average pain VAS had significant improvement after the modified Pilates program, but the minimum pain VAS didn't. The maximum pain intensity reduced 28.3% and average pain intensity reduced 35.6% after the exercise program intervention.(Fig 1)

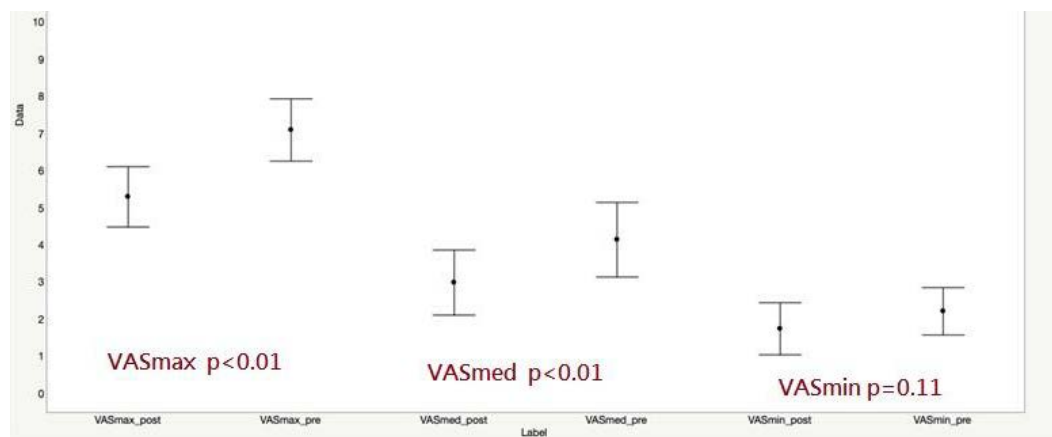


Figure 1: VAS pain intensity before and after the 6-weeks modified Pilates exercise program. 95% confidence interval are marked.

3.2 Influencing Factors of Pain Improvement

We retrieved the subjects' age, gender, occupation information and pain intensity data from their Oswestry low back pain disability questionnaire. The pain improvement is the difference between the pain data before and after the exercise intervention. It would be a negative number if the pain has improved, because the higher score means worse pain. Logistic regression and Profiler sensitivity analysis were conducted to analyze the influencing factor related to the pain intensity improvement. Occupation {House wife & Blue collar - Retired} and Age*occupation interaction are the top two ranked variables with statistical significance (Fig 2). The result plots of Profiler sensitivity analysis and factors' interaction were shown in Fig.3 and Fig. 4. The retired group has better pain improvement with the younger portion having better improvement. Housewife and blue collar groups have less pain improvement, with the older portion having better improvement in these two group.

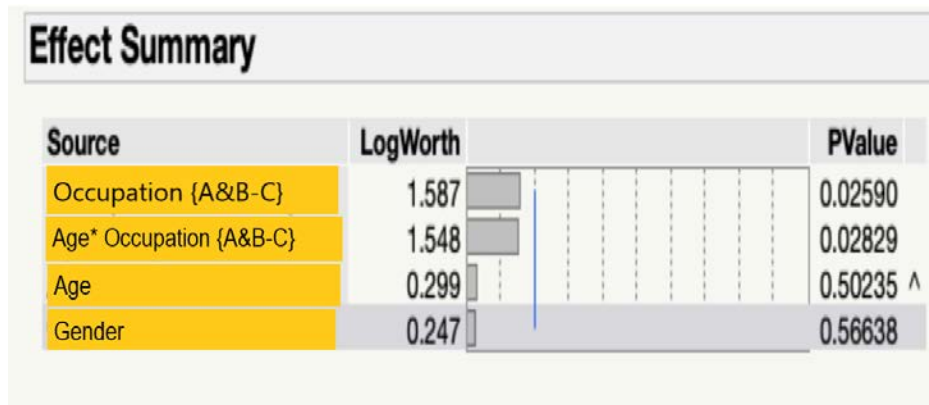


Figure 2: Effect Summary. A: Housewife. B: Blue collar. C: Retired.

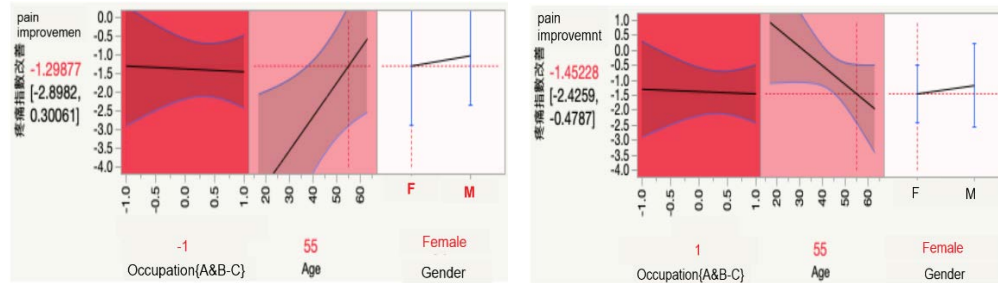


Figure 3: Profiler sensitivity analysis

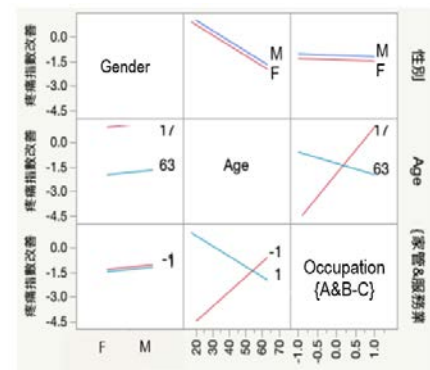


Figure 4: Factors interaction

3.3 Discussion

Retired persons might have better compliance to the exercise program, and they pay more attention to their low back pain issue. Housewife and blue collar population still have more labor work while attending the exercise intervention program. The younger ones might be less economically independent and need to work more, causing their compliance to the program to be worse. This could explain the younger ones have less improvement in these groups. Knowing this, we can offer the data analysis evidence to the exercise program that can give participants information to emphasize that their compliance is important. Using statistical method can create predictive models and help determine who will have better chance to have improvement and make more precise managing decision. Because the data sample is still small, we suggest to keep collecting data to improve the predictive model.

3.4 Conclusion

This paper found CLBP persons have improved in pain level after the 6-week Pilates exercise program. Occupation {House wife & Blue collar - Retired} and age*occupation interaction are the top two ranked influencing variables related to low back pain improvement in this project's data. This project shows STEAMS methodology is a successful method to conduct health science research.

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