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Effectiveness of Lifetime Fitness Course Activities in Improving Movement Efficiency

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Abstract: University physical education courses are meant to teach the fundamentals of various sports and exercise techniques. The main purpose of this study was to determine how effective lifetime fitness (LF) courses in higher education can enhance movement efficiency (ME). Eleven participants performed the Fusionetics movement efficiency test at the beginning, middle, and end of the academic semester. Overall ME scores showed a significant effect, whereby the scores increased from the pre- to the mid-test but fell from the mid- to the post-test. Both the 1- and 2-leg squat subtests revealed a similar pattern. The second half of the semester's increased use of endurance-based class activities may have caused the ME score to decline.

Keywords: Fusionetics, Functional Movement Screening, Lifetime Fitness, Movement Efficiency

1. Introduction

The benefits of exercise have been demonstrated in multiple studies highlighting the increased quality of life in all ages (Huang & Wu, 2024; Ozturk & Unver, 2020; Sun *et al.,* 2024). Benefits specifically for university students include sleep quality, mental health, and academic performance (Ozturk & Unver, 2020). Currently, 39% of university students are considered active according to the American College of Sports Medicine's (ACSM) criteria for active people. The ACSM recommends either 150 minutes of moderate activity or 75 minutes of vigorous activity per week and participating in physical activity at least 3 days per week. Unfortunately, statistics show that 61% of students do not satisfy this criterion (Ozturk & Unver, 2020). The injury prevalence in physical education courses has been shown to be higher in adolescents (ages 13-17) than children (ages 8-12), with adolescents sustaining more severe injuries (Abernethy & MacAuley, 2003). One explanation for the higher injury risk in adolescence is a higher performance concentration leading to stress-related injuries, growth plate injuries, and trauma injuries (Maffulli *et al.,* 2011). Severe injuries have negative consequences later in life and may limit the ability to benefit from physical activity (Maffulli *et al.,* 2011).

Screenings in the health care setting are used to identify a pathological condition that could make someone more prone to harm before they manifest any particular signs of that disorder (Bahr, 2016). A movement screening is specifically designed to identify movement deficits that could impact injury *(Bennett et al.,* 2020). The importance of early identification is to allow for intervention to mitigate the risk of the specific condition (Bennett *et al.,* 2020). Movement screenings that have been proven effective in athletic populations are the Functional Movement Screening (FMS) (Triplett *et al.*, 2021) and Fusionetics (Cornell & Ebersole, 2018). Neither movement screening has been studied in sedentary university students. FMS, although effective for athletic populations, has conflicting evidence surrounding inactive populations, including the inability to distinguish between injured and non-injured individuals (Karuc *et al.,* 2021). A meta-analysis on FMS effectiveness found poor sensitivity for athletes with a high injury risk while also reporting a limited predictive ability, concluding that FMS was not a valid test for predictive injury risk (Moore *et al.,* 2019).

Similar to FMS, Fusionetics analyzes movement quality based on seven different tasks, three of which focus on the lower extremity. Because Fusionetics assesses global movement patterns based on normal standards rather than comparing dysfunction bilaterally, the test is more sensitive than other tools (Cornell & Ebersole, 2018; Krosshaug *et al.*, 2016). In addition, research shows that 92% of individual movement compensations had high intra-rater reliability (Cornell & Ebersole, 2018). Concerns about the injury prediction value of FMS are also addressed by Fusionetics (Bonazza *et al.*, 2017). Cornell and Ebersole (Cornell & Ebersole, 2018) suggest there are no consistent values, including optimized sensitivity, necessary to use as a cutoff point between injury risk and no risk within FMS. Fusionetics uses a scale of 1-100 instead of a scale of 0-21 used with FMS. Although new, Fusionetics offers a more effective solution to detecting movement deficits and prevention of injuries (Chaikovskaya *et al.*, 2022) in multiple populations compared to FMS.

The purpose of this study was to determine if a Fusionetics Movement Efficiency Test could be used to assess the effectiveness of lifetime fitness (LF) course activities in sedentary university students. With regard to enhancing movement efficiency (ME) in a sedentary university population, the objective was to specifically determine how successful exercises in a Fitness Theory and Practice (FTP) course are at doing so. A secondary purpose was to identify specific movement and muscular deficits in this population.

2. Methods

2.1 Participants

There were 11 participants in the study (8 females and 3 males). Participants were sedentary young adults between the ages of 18 and 22 enrolled in a Lifetime Fitness course at a university. Any students with a musculoskeletal injury limiting activity in the past 5 years were excluded. Participants were recruited in the first week of classes via class visits. All participants signed an informed consent form and inclusion/ exclusion criteria form that had been approved by the University Institutional Review Board for the Protection of Human Subjects in Research.

2.2 Tasks

All class activities were done in a rotation between an aerobic activity, strength activity, and game each week for 12 weeks. The first 6 weeks were four different rotations including all three of the different activities (Table 1). The second 6 weeks followed the same rotation format as the first half and contained three rotations of activities (Table 2).

2.3 Procedures

The test was administered according to the guidelines provided by Fusionetics, LLC. Each screening was performed in the following order of 7 sub-tests: 2-leg squat, 2-leg squat with heel lift, 1-leg squat, push-up, shoulder movements, trunk movements, and cervical movements. Each participant completed 5 reps of the 2-leg squat, 2-leg squat with heel lift, 1-leg squat, and push-up. Any observed compensations were recorded for scoring purposes. The shoulder, trunk and lumbar spine, and cervical movements were performed once for each movement and any observed compensations were recorded for scoring purposes. When scoring the Fusionetics ME test, the final score was averaged from all 7 sub-test scores out of 100. Each sub-test had a list of compensations to observe, and the score was decreased based on compensations detected during the sub-test.

Fusionetics movement efficiency tests were administered at 3 different times during the semester. The pre-test was conducted before students participated in class activities. The mid-test was performed after 6 weeks of class and the post-test was performed after 12 weeks.

Table 1. Rotations/ Activities for the First Half of FTP

Aerobic	Strength	Game/ Activity
Target Tabata	Agility Bootcamp	Team Handball with Scooters
Cardio Relays	Weight Room Etiquette	Floor Hockey
Rah Rah Hepa (Soccer)	Kettlebell and Dumbbell Workout	Secret Agent Tag
Spartan Adventure Race	Functional Fitness Workout	Kin Ball Games

Table 2. Rotations/ Activities for the Second Half of FTP

Aerobic	Strength	Game/ Activity
Aerobic Bootcamp	Weight Room Workout	Team Handball
Free Cardio Day	Bands and Bodyweight Stations	Ultimate Frisbee
Baylor Scavenger Hunt	Power Yoga	Kickball

2.4 Statistical Analysis

An analysis of variance (ANOVA) with repeated measures (pre-, mid-, and post-test) was performed on all ME and sub-tests. A 2 (Side: left and right) x 3 (Test: pre-, mid-, and post-test) ANOVA with repeated measures was performed on symmetry scores provided by Fusionetics. Means were considered significantly different when the probability of a type I error was less than .05. If the sphericity assumption was violated, Huynh-Feldt corrections for the *p*-values were reported. Partial eta-squared (η_p^2) values were computed to determine the proportion of total variability attributable to each factor or combination of factors. With a moderate effect size of 0.5 and an alpha value of 0.05, the estimated sample size was 10 for 80% power and 13 for 90% power.

3. Results

Fusionetics ME test was scored on a 100-point scale and each score was classified as good (75-100), moderate (50-74.99), or poor (0-49.99). The pre and mid-test averages for the overall ME scores were classified as good (pre = 75.33 ± 6.34, mid = 79.87 ± 8.22), and the post-test average was in the moderate category (post = 70.69 ± 4.96). There was a statistically significant effect found on test ($F = 4.764$, $p = 0.020$, $\eta_p^2 = 0.323$). The pre and mid-tests were higher than the post-test (*ps* < 0.05). On the sub-tests, significant effects were found only on the 2-Leg Squat ($F = 3.849$, $p = 0.039$, $\eta_p^2 = 0.278$) and the 1-Leg Squat ($F = 7.441$, $p = 0.004$, $\eta_p^2 = 0.427$, Figure 1).

Data related to sub-test symmetry scores revealed significant effects only on the side for the hip joint ($F = 9.164$, $p = 0.013$, $\eta_p^2 = 0.478$, Figure 2). There was no effect on other symmetry scores for the neck/ cervical spine, shoulder, trunk/lumbar spine, knee, and foot/ankle ($p > .05$), and there was no main effect on test and no interaction between side and test ($p > .05$) on any sub-test symmetry scores. Despite no effect on test, only hip sub-test symmetry scores followed the overall ME score trend where both left and right sides increased from the pre- to mid-test but decreased from mid- to post-test (Figure 2).

4. Discussion

Despite the participants representing sedentary college students, their results were comparable to those of athletic populations whose averages were likewise on the border between the good and moderate categories. The average increased by 1.6% between the pre- and the mid-test, whereas it decreased by 7.8% between the mid- and post-test. One explanation for these results is the types of activities students engaged in during the class. In the first six weeks of the semester, the students completed more strength workouts (Table 1) that included some of the same movements that mimicked the ME tests such as squatting and push-ups. This increasing familiarity with the movements may have contributed to the increase in overall ME scores from the pre- to the mid-test. On the other hand, there were fewer of these workouts during the final six weeks of class. The second half of the semester featured more aerobic activities and fewer strength-related exercises that were similar to the actual test (Table 2). The focus of the second half schedule was endurance compared to the strength focus of the first half. Strength-style activities improved ME scores at a greater rate than aerobic-focused activities. What is intriguing is the degree to which the ME scores improved and then declined. There was a slight improvement in ME scores after six weeks of activity, two days a week. However, there was a greater decrement in ME scores with different activities despite the same length of training.

A secondary purpose of this study was to determine specific mobility and muscular deficits of sedentary college students. Seven distinct sub-test scores were created from each individual score, which was then averaged across individuals for each sub-test.

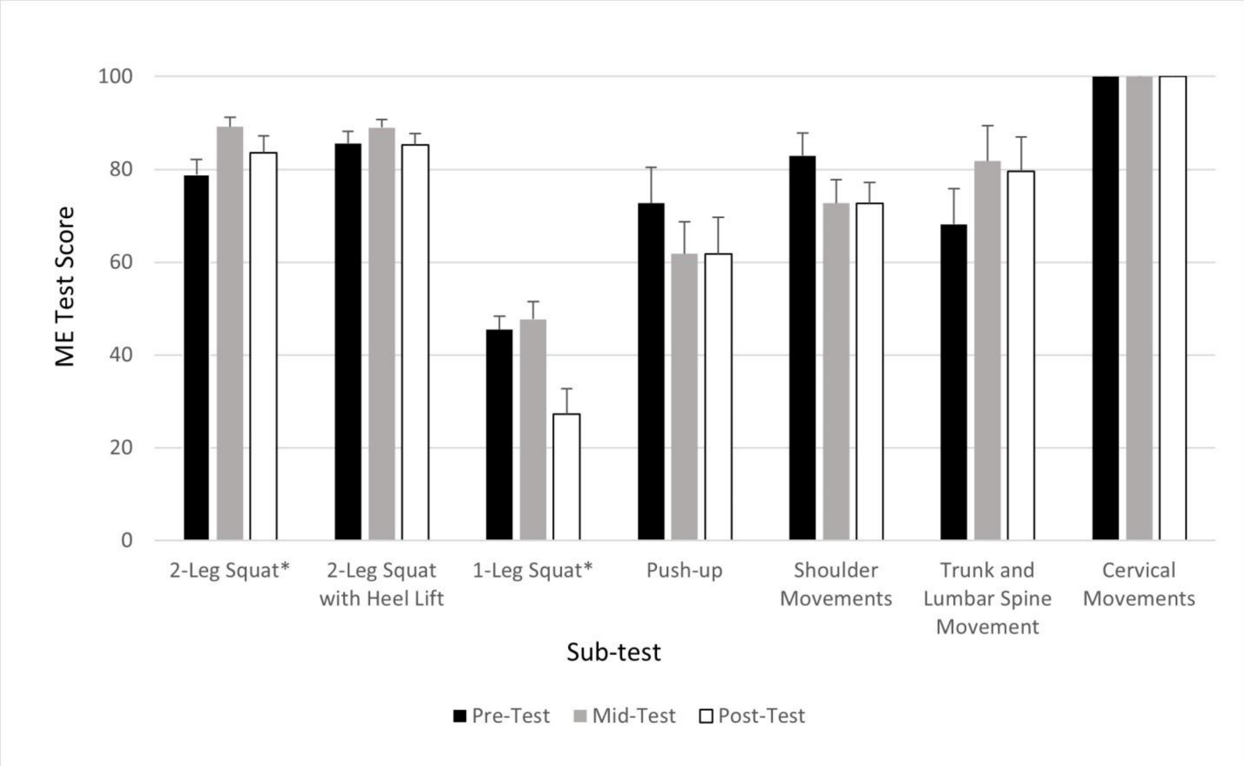

Figure 1. Sub-test Scores Across Pre-, Mid-, and Post-test. * = Significant effect, $p < .05$

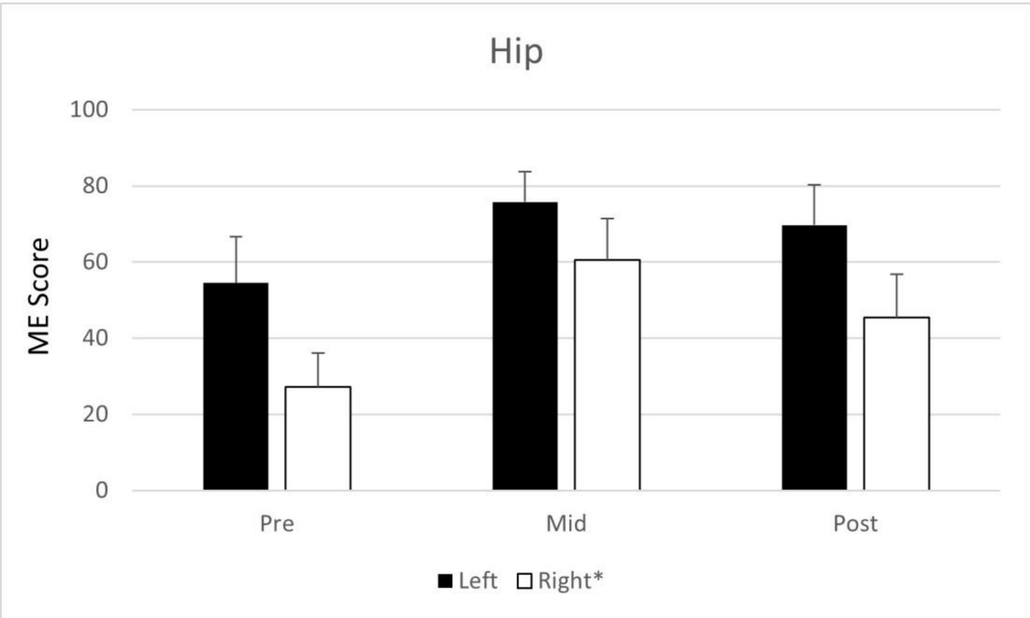

Figure 2. Left and Right Hip Joint Symmetry Test Scores Across Pre-, Mid-, and Post-test. * = Significant difference between left an right, $p < .05$.

Our findings indicate that there were statistically significant effects on test in the 2-leg squat and the 1-leg squat (Figure 1).

Regarding symmetry sub-test scores, a statistically significance difference was found only between the left and right hip joints (Figure 2).The most common compensations for the 2-leg squat were feet flattening, lifted heels, excessive forward lean, and knee varus. Compensations such as flattening feet and lifting heels are signs of mobility issues. Flat feet occur when there are either tight muscles in the foot and calf or weak muscles surrounding the arch of the foot.

The arch is used to absorb some of the loading demands. The optimal position is to have the heel, big toe, and outside of the foot in contact with the floor. For this to occur, mobility and strength must surround these areas to maximize the contact points. The compensations from the participants of the study are a good representation of those demonstrated among the inactive population. An interesting discovery is that although there were signs of transitory strength and mobility improvement as the weeks went on, they eventually did not improve.

The single-leg squat assessment had the most compensation out of the seven subgroups. The three most typical compensations were foot flattening, knee valgus, and loss of balance. Foot flattening as mentioned previously may suggest either tight muscles in the calf or unsupported arches. The 2-leg squat produced the same results. Knee Valgus is a common compensation usually indicating weak abductors and gluteal muscles. Research has also shown that stronger core muscle activation can increase hip stability in a single leg squat (Shirey *et al.,* 2011). Although not evaluated, reduced core stability is expected in a sedentary population, hence this information is helpful for this population. Such weak core stability may cause overactive external rotators (Shirey *et al.,* 2011). Additionally, insufficient core stability and weak surrounding hip muscles may have contributed to a loss of balance. Although FTP activities include a strong emphasis on strength, endurance, and flexibility, they do not allow enough time to develop movement efficiency in the legs. Lessons and exercises should focus on developing lower body strength, especially in the gluteal muscles.

The limitation of this study was the disparity between the first and second half activities. The class was structured around the number of rotations and limited amount of time in class. The rotations resulted in an unequal distribution of activity between the first and second halves. The decreases in ME scores for the post-tests may have resulted from this restriction. The exclusion criteria for the study are another drawback. Students who had prior injuries within the prior five years were excluded based on the criterion. Excluding this group certainly could have limited the data on symmetry differences as well as the information on muscle and movement deficiencies.

Fusionetics has shown reliability in assessing movement efficiency (Cornell & Ebersole, 2018) and injury prevention (Chaikovskaya *et al.,* 2022), and it showed suitable as a screening tool to identify ME issues in sedentary individuals enrolled in university physical activity classes. To assess improvement in ME, future studies should concentrate on developing a more regular activity plan, a broader inclusion criterion, and a more targeted intervention strategy to raise ME scores.

5. Conclusion

Physical activity courses in the university setting are important in providing valuable information on health and fitness to the students. Physical activity courses may benefit from activities focused on movement and muscular deficits seen in individual students to improve ME. By improving ME, students will have more opportunities to enjoy lifelong fitness outside of the course and university. Also, Fusionetics Movement Efficiency Test could be used not only for movement screening and injury prevention but also to assess the effectiveness of lifetime fitness (LF) course activities in sedentary university students.

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Author Contribution Statement

Sarah Ruckman: Conceptualization, Investigation, Writing original draft. **Jaeho Shim**: Conceptualization, Supervision, Methodology, Validation, Data curation, Writing original draft. **Yunsuk Koh**: Conceptualization, Review and editing. **Teresa Backman**: Writing, Review and editing. All the authors read and approved the final version of the manuscript.

Ethics Approval Statement

The study was approved by the Institutional Review Board (IRB).

Biographical Note

Sarah Ruckman is a Master of Science student in exercise physiology and teaches lifetime and fitness classes as an instructor.
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Informed Consent

The consent form was signed before the commencement of the study.

Conflict of Interest

The authors declare that there was no conflict of interest.

Does this article pass screening for similarity?

Yes

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