# STUDY OF POSTURAL SAFETY AND MUSCLE ACTIVITY ANALYSIS FOR DEADLIFT EXERCISE IN GYM

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***ABSTRACT:*** *In exercise or workouts, postural safety and ergonomics are some of the factors that need to look into for the safety of humans or athletes. Good postural safety of an athlete can reduce accidents and injury. The lack of postural safety and ergonomic features could result in negative effects, especially on athletes' physical and mental health. To evaluate the posture problem due to comfortability and ergonomics, a survey has been conducted. This was implemented by distributing questionnaires sheets for athletes to find out their experience and opinions regarding uncomfortable feelings and injuries. Ergonomic and injury problems commonly arise due to bad posture. The purpose of this study is to determine the postural safety problems and risk assessment while deadlifting among student-athlete in the gym. It also to study the back muscle activity analysis for three types of position and best angle while deadlifting. The surface electromyography (EMG), Kinovea software and Matlab software were used in this research to assess potential risk areas that occur during deadlifting. This study shows that deadlift in posture can be improved by ensuring the back and shoulder posture is in the proper position. The result shows that the deadlift position of straight shape of leg position with 105$^o$ angle is the less time to complete the exercise with less muscle activity for 10 repetitions. Therefore, further study on different deadlift exercises can be done in the future to indicate the postural safety of an athlete.*

**Keywords:** Postural Safety, Muscle activity, Electromyography (EMG), Gym, Deadlift

## 1. INTRODUCTION

Weightlifting is one form of exercise to build muscles. A good form of weight lifting and give good benefit to the sportsman or athlete. Other that than, doing exercise also can give good health and look younger. As an example of exercise doing sitting and standing with proper posture will physically look 10 years younger and 10 pounds lighter [1]. Nowadays more people are concerned about their good health and good body posture. Therefore, more people love to work out whether at the gym or at-home training. There are many exercises and weightlifting exercises such as deadlift and free weight exercise.

The deadlift exercise is often referred to as the King of Exercises because it develops so many muscles in the body and is so grueling to perform [2]. There are 4 types of deadlift variations which are Sumo Deadlift, Trap Bar Deadlift, Stiff-legged Deadlift and Romanian Deadlift [3]. In order to start deadlift, position for the deadlift is starting with the lifter in a squat position with the knees and hips flexed approximately 80–100°, while the arms must be at straight and pointing down, and an alternating hand grip used to hold a barbell positioned in front of the athlete [4]. The deadlift is a strength-building exercise that is stable for powerlifters and other athletes looking to get stronger. However, many athletes get injured when doing deadlifting because the majority of them have insufficient knowledge about the correct posture of the deadlift.

Some study shows that deadlift mainly activates muscle on the hamstrings and lower back of the athlete [5]. This is where the muscle of an athlete is mostly exposed while doing deadlift exercise. Another study shows that range of motion and peak acceleration during the deadlift and squat exercises when athletes doing stance-width [6]. As we know, the mechanical characteristics of the deadlift, include the ability to recruit significant muscle groups in the leg and back area, at high contraction rates while it is being used [7]. This is why deadlift can be the King of Exercise due to the muscles that are activated while performing it. In other words, deadlift possesses good health and vital power development for an athlete promising kinetic profile that allows for continued acceleration through the continuous acceleration of significant lifting exercise [8]. Proper posture and good position of the deadlift, will give significant benefit to an athlete. This will lead to increase performance and reduce injury while performing this exercise. By using electromyography, muscles activity can be determined to monitor and reduce injury [9].

Thus, there is limited study on postural safety and back muscle activity analysis among athletes in Malaysia gym. As the general study indicates there are safety issues related to sports that need to be looked into more seriously. Therefore, the purpose of this study is to the postural safety of deadlift exercises and study the muscle activity while doing deadlift exercises in a different position.

## 2. METHODOLOGY

In this study, the discomfort injuries, pains and stress of athletes in the gym are going to be identity. Investigating and improving the current way on how to minimize the risks of potential injury and accidents towards people and athletes is one of the better ways. This can be done by acquiring better knowledge on how posture affects occupational safety, health and performance levels of people in the gym and athletes.

This study has been done in the selected gym. For this study deadlift was the only exercise to be the focus.

### 2.1 Questionnaires

In this study, data were collected via anonymous questionnaires. The questionnaires consisted of two sections. Section 1 is about the athlete's personal detail which was to determine the weight, height and current health. While in section 2, the questions were more focused on ergonomic which is determining the cause of discomfort and injuries body parts.

### 2.2 Sample Size

For the sample size, there are 50 respondents (people using the gym) are required to answer the questionnaire survey. As for this experimental research, 30 subjects per group is often cited as the minimum [9]. While for this objective measurement, there are 10 athletes were selected to fulfill the experiment which is about 20% of the respondents. As cited by other researchers, state that 10 is the minimum number for a pilot study [10].

### 2.3 Observation Using Video Motion Analysis

Throughout the observation, analysis can be made for the wrong posture. The video has been taken by digital camera to indicate athletes postural during deadlift to complete the exercise. Kinovea software has been used for motion capture with X-coordinate and Y-coordinate of the athlete for further analysis.

### 2.4 Electromyography

In this study, surface EMG has been used to study the muscle activity of the athlete while deadlifting. The surface EMG sensor electrodes are placed over the back of the athlete, then the ground electrode is placed over a bony area shown in figure 1.

**Fig 1: Surface EMG position on athlete back**

## 3. RESULTS AND DISCUSSION

This study was conducted in UNIMAS Gym in Kota Samarahan, Sarawak, Malaysia. The selected gym is under University Management that can be used by students and staff. This study mostly discussed the result of postural safety, muscle activity, best angle position and position of deadlift exercise.

### 3.1 Questionnaire results

From a total of 50 respondents, all of them at least have experience in the gym and doing deadlift exercises. In this study, identifying the sources of injury will help to get a clearer picture of where the health problem originates and the nature of it as well as how to deal with the problem and necessary recommendations to be considered when solving those problems. Table 1 shows the summary sources of injury according to the 50 respondents.

**Table 1: Source of Injuries**

| No. | Sources of Injury | Rating | | | Total (no. of respondents) |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | |
| 1 | Lift overload dumbbell | 14 | 18 | 18 | 50 |
| 2 | No idea on how much load need to lift according to your weight | 13 | 20 | 17 | 50 |
| 3 | Lack of safety equipment | 15 | 20 | 15 | 50 |
| 4 | No idea on how to do the correct posture | 9 | 16 | 25 | 50 |
| 5 | Lack of rest time for each repetition | 16 | 23 | 11 | 50 |
| 6 | Does not warming up before exercise | 14 | 17 | 19 | 50 |
| 7 | Lack of sleep | 17 | 16 | 17 | 50 |

**Ratings:**

| 1 | 2 | 3 |
|---|---|---|
| None | Rarely | Often |

In table 1, shows the rating of none, rarely and often for all sources of injury listed. Most of the respondents are actively working out in the gym. This table, shows the injuries are mostly related to overload weight lift, wrong posture, and not warming up before exercise. Whereby the fewer injuries were lack of rest time for each repetition. These common injuries also may occur higher if the student is new to doing a deadlift. Figure 2 shows the percentage of rating 3 of the source injury.

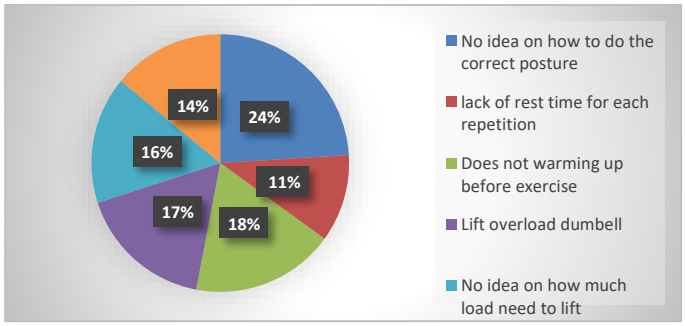



**Fig 2: Percentage rating 3 injury**

From figure 2, there is the majority of 24% are no idea how to do the correct posture. The second highest is does not warm up before exercise while lack of rest time for each repetition is the lowest rate. Thus, the correct posture is the most serious problem among student-athletes.

### 3.2 Deadlift Posture

In this result, figure 3 shows bad posture while doing deadlift exercises. The athlete has done poor back posture during deadlifting. The deadlift places significant stress on the back muscle, if athletes perform the wrong posture, this will

increase the risk of hurting the lower back. This led to back pain injuries if an overload of lifting without correct posture.


**Fig 3: Poor back posture**

While figure 4 shows the poor shoulders postures. Shoulders must be in front of the bar when set up for the deadlift. Shoulders above the bar or back of the bar don't work because it puts hips too low. Knees and shins will come too far forward. The athlete will hit the bar on the way up. Correct shoulder posture will prevent knee injury and improve performance.

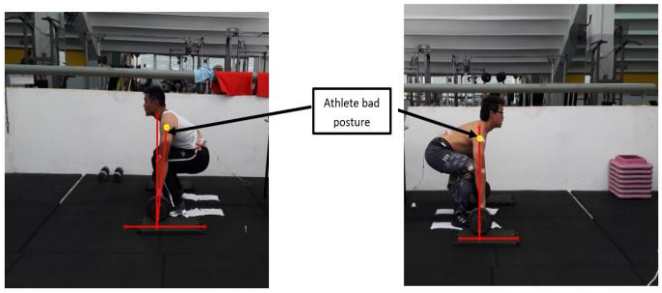
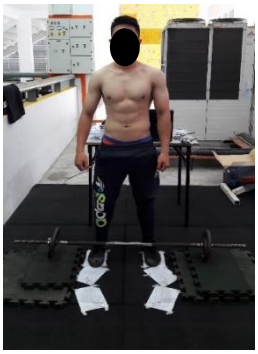



**Fig 4: Poor shoulder posture**

### 3.3 Deadlift Foot Posture

In this study, we focus on deadlift foot posture to discover the comparison of time to complete repetition for each foot posture and angle. Figure 5 (a) shows the normal position of the athlete standing before doing the deadlift. The athlete will do a deadlift and then back to the normal position for 10 repetitions. Figure 5 (b) shows straight shape foot posture, figure 5 (c) shows 'V' shape foot posture and figure 5 (d) shows 'A' shape foot posture.



**(a) Normal Standing Position (b) Straight shape foot posture**

**(c) 'V' Shape foot posture (d) 'A' Shape foot posture**

**Fig 5: Deadlift posture (a, b, c, d)**

For time to complete deadlift repetition, there are 3 angle positions selected which are 65º, 90º and 105º, and shown in figure 7, figure 9 and figure 11 respectively. While in figure 6 show the comparison of the average time to complete 10 repetitions deadlift position.

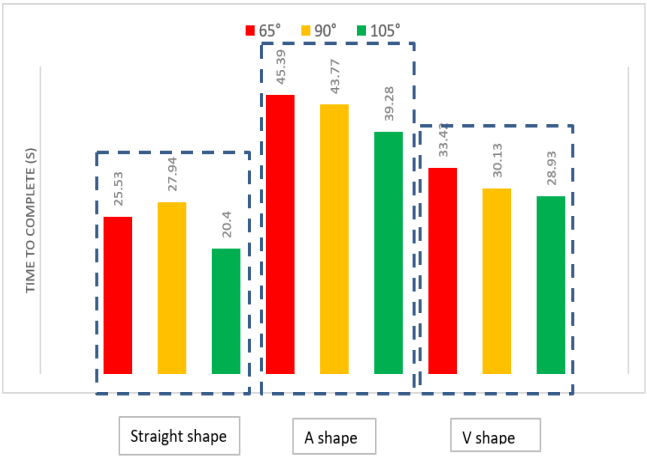



**Fig 6: Average time to complete 10 repetitions deadlift position**

Figure 6 shows that there is a significant time comparison from different positions of the athlete to complete deadlift repetitions with a different angle. It shows that the straight leg position has a less average time to complete compared to the shape leg position. While bend of leg degree of angle shows that 105º degree has a less average time to complete for all position of leg shape.

### 3.4 Deadlift Angle and Electromyography analysis

Most of the athlete shows the average time to complete is easier and less discomfort at an angle of 105º. This is the leg bending over with the correct angle with gives less harm to the back of the athlete. In this study, there are three angles have been investigated with electromyography (EMG). This EMG gives the reading of the back muscle activity of an athlete while deadlifting. Figure 7 till figure 12 shows the results and findings were discussed.

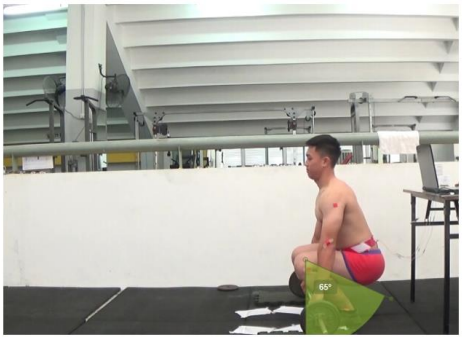



**Fig 7: Angle of 65º deadlift**

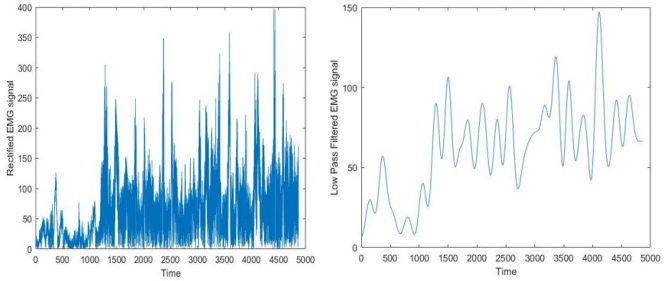



**Fig 8: Angle of 65º deadlift (a) Rectification EMG (b) Linear envelope EMG**

Figure 7 shows the athlete angle of 65º before doing the deadlift for 10 repetitions. While figure 8 shows the back muscle activity generated from Surface EMG analysis. Figure 8 (a) shows the rectification of the EMG Signal with the back muscle activity showing about 50mv up to 400mv. For low pass filtered EMG Signal shown in figure 8 (b) give the linear envelope increasing and inconsistent reading of back muscle activity. This shows that the back muscle needs to work hard and lift the weight at a 65º angle. It also may be due to the discomfort of the athlete to lift at that angle position.


**Fig 9: Angle of 90º deadlift**

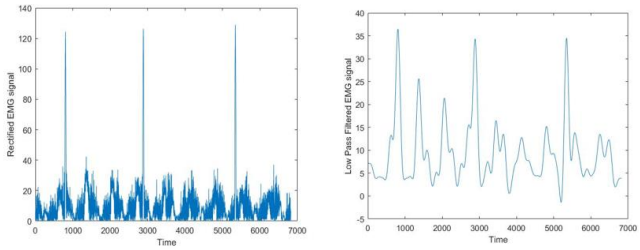



**Fig 10: Angle of 90º deadlift (a) Rectification EMG (b) Linear envelope EMG**

Another position of the athlete at an angle of 90º before doing the deadlift for 10 repetitions is shown in figure 9. Figure 10 shows the back muscle activity generated from Surface EMG analysis. Figure 10 (a) shows the rectification of the EMG Signal with the back muscle activity showing about 50mv up to 120mv. While for low pass filtered EMG Signal shown in figure 10 (b) give the linear envelope reading of back muscle activity between 5mv up to 35mv. This shows that less back muscle is needed to lift the weight at a 90º angle.

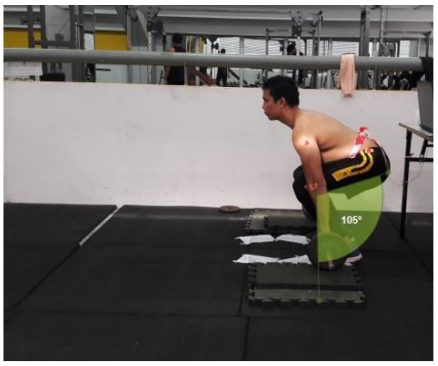



**Fig 11: Angle of 105º deadlift**

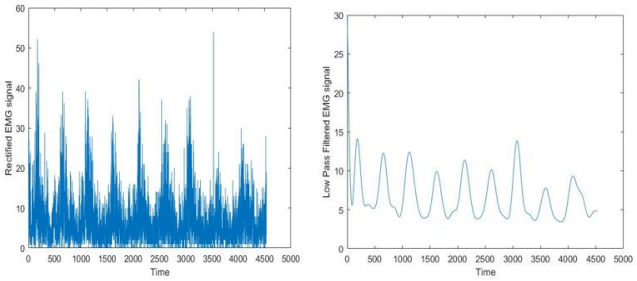



**Fig 12: Angle of 105º deadlift (a) Rectification EMG (b) Linear envelope EMG**

Figure 11 shows the athlete angle of 105º before doing the deadlift for 10 repetitions. Meanwhile, figure 12 shows the muscle activity generated from Surface EMG analysis. Figure 12 (a) shows the rectification of the EMG Signal with the back muscle activity showing about 10mv up to 50mv. Then the low pass filtered EMG Signal shown in figure 12 (b) gives the linear reading of back muscle activity about 5mv up to 15mv. This low reading of muscle activity shows that the back muscle needed very little to lift the weight at 105º angle compare to 65º and 90º.

From this result, it was shown that with the proper posture of deadlifting while ensuring injury and discomfort of an athlete can be reduced. Other than that, it also shows that back muscles activity is increasing due to the position of the foot, and the angle of deadlifting give a significant effect to an athlete. The previous study shows that myoware sensor can be used in EMG to evaluate muscles activity of workers in grocery at the lower back muscle [12]. Therefore, in this study EMG signals that are evaluated from the back muscle of an athlete can be used to investigate the discomfort and performance. However, another study also shows that

powerlifters are known to hyperextend the spine during a bench press [13]. This might give other muscles activation on the back. More studies on exercise that used big muscles area are needed to ensure the effectiveness of the deadlift in the future.

## 4. CONCLUSIONS

This study shows the importance of postural safety among athletes in the gym. This also can increase safety and reduce injury among sportsmen. The back muscles activity analysis from the EMG signal can be a preliminary study on how the deadlift affects the safety and performance of an athlete. A comprehensive study on other postural safety in various deadlift exercises with other angle positions would be needed to verify the initial results obtained in this study.

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