



**MOUNTAIN
TACTICAL
INSTITUTE**

The Effect of Trigger Pull Weight on Marksmanship

MOUNTAIN/TACTICAL

MISSION-DIRECT RESEARCH



The Effects of Trigger Pull Weight of Marksmanship

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OBJECTIVE:

The purpose of this study was to evaluate the effect of trigger-pull resistance (poundage) during non-stressed and stressed marksmanship drills with tactical law enforcement officers.

METHODS:

Ten part-time members of a medium-sized city SWAT team (ages 32-45) participated in the study. Participants were all experienced marksmen with an average 15.2 years of law enforcement experience and 7.2 years on the department's SWAT team. All subjects completed a series of 2 identical marksmanship trials, each comprised of 30 events. During the first trial (events 1-30), all athletes used their stock Colt A4 triggers. During the second trial (events 31-60), athletes were randomly divided into Control and Treatment Groups - where the Treatment Group received new, lighter-resistance triggers. Both trials consisted of events at three distances: 15 yards, 50 yards and 100 yards and included both stressed and non-stressed shooting. Subjects fired a total 180 rounds during the non-stressed events and 180 rounds during the stressed trials for a 360 rounds total. Participants fired at Law Enforcement B-29 paper qualification targets. Accuracy was measured using a modified target scoring system. Differences between the two groups (Control and Treatment) was assessed to determine the effect the new, lighter trigger-pulls had on marksmanship performance.

KEY FINDINGS:

- In general, this study found that a lighter trigger-pull (a reduction of approximately 32% in the study's Treatment Group) had little to no direct effect on marksmanship performance.
- Trigger pull resistances below the US Army Small Arms Branch recommendation of 6.5 to 12.3 pounds for M4 Carbines might actually be advantageous to marksmanship (11). Based on results from this study, trigger pull resistances as low as 4.7 pounds seem to be safe and effective.
- The study did not find any support for the perceived safety concerns often attributed to lower trigger resistance (6-9). The study found no indication that trigger-pull resistance as low as 4.7 pounds might lead to increases in accidental discharges or other safety related instances.

RECOMMENDATIONS:

The findings from this study can be used to help tactical professionals make better educated decisions on equipment requirements and purchasing.

Although the study did not find support for lighter trigger-pull resistance as a means of improving tactical marksmanship, the study did challenge the perceived safety concerns often attributed to lower trigger resistance (6-9). Thus, it seems that tactical professionals who struggle with marksmanship because of trigger control might find it helpful to experiment with lighter triggers - with little to no impact on safety.

Lastly, the current study could also be used to help refine the 20+ year old, US Army recommendation of 6.5 to 12.3 pounds of trigger-pull resistance for M4 Carbines (11). Based on results from this study, trigger pull resistances as low as 4.7 pounds seem to be safe and effective.

1. INTRODUCTION

1.1. Previous Research.

Trigger-pull resistance or trigger-pull weight is the amount of force required to release or “break” a trigger, causing the hammer or striker to release and fire the weapon (10). The general consensus among experts seems to be that lighter trigger pull poundages can aid in marksmanship (6-8). Two pieces of anecdotal evidence are often cited for this conclusion: First, lighter triggers are almost universally preferred by the best competitive marksman (7). Second, and more generally, lighter resistance should, according to most marksmanship professionals, lead to easier manipulation of the fine motor skills involved in trigger control (4-6, 10). However, to the researcher’s knowledge, no formal study has yet directly examined the effect of trigger pull resistance on marksmanship performance.

According to a 1993 Study by the US Army Small Arms Branch, based a 1% failure rate, the recommended trigger-pull resistance of a M16A2 rifle is between 5.5 to 10.0 pounds. Based on the same study and same failure rate, the recommended trigger-pull resistance for a M4 Carabines is between 6.5 to 12.3 pounds (11).

Trigger-pull resistance variation among handguns is typically slightly lower. Most handguns come with a factory-designed trigger resistance somewhere between 5.5 and 7.5 pounds (but some may be as high as 12 to 13 pounds) (8). On the other hand, competition shooters often select triggers with as little as 2 pounds of resistance (10). And typically, any trigger-pull which is lighter than 3.5 pounds is, for whatever reason, anointed a “competitive trigger” (8).

The argument against lighter trigger resistance is almost universally centered around the perceived safety concerns of the lower resistance (6-9). These concerns are what led New York City law enforcement officers to carry sidearms with a 12-pound trigger (7,10). A June 2015 article from the Los Angeles Times seems to support this change. According to the author, L.A. Country sheriff’s deputies have experienced a nearly two-fold increase in accidental gunshots since switching to firearms with a lighter trigger-pull resistance. Many individuals inside the department directly attribute the increase in accidental discharges to the new weapon’s lower trigger pull weight (12).

Despite the changes made by New York City law enforcement and the criticism offered by the LA Country sheriff’s deputies many experts point to a lack of training as the real cause for safety concerns - specifically in terms of trigger discipline and trigger control (6,7). Some experienced marksman claim that heavier triggers are actually more dangerous because the increased resistance negatively effects trigger control and accuracy (6,7).

According to United States Marine Corps Reference Publication (MCRP 3-01A), Rifle Marksmanship, “Trigger control is the skillful manipulation of the trigger that causes the rifle to fire without disturbing sight alignment or sight picture. Controlling the trigger is a mental process, while pulling the trigger is a mechanical process.”

The importance of trigger control in marksmanship performance is cited everywhere from the US Army, to the US Marine Corps, to the Federal Law Enforcement Training Center (FLETC) (1-4, 6). MCRP 3-01A identifies it as one of three major factors which contribute to marksmanship: “the fundamentals of marksmanship are aiming, breath control, and trigger control” (2). Although it would seem to align, whether or not lighter trigger-pull resistances could contribute to trigger control has yet to be determined in a scientific study.

Most previous scientific studies on marksmanship have focused on “aiming” aspect of accuracy. This includes a study from the US Army Aeromedical Research Laboratory which found that visual skills and attention were the most important contributors to marksmanship (3). Other studies have also found that eye dominance and hand dominance can effect marksmanship (4), as can grip strength (13) and physical stress (5).

Interestingly, the same LA Times article which cited the increases in accidental discharges also reported significant increases in accuracy measures during trainee qualifications (12). Prior to changing to the new weapon, some recruit classes saw as many as 60% of their trainees requiring additional firearms training to meet the accuracy standard. Training with the previous weapons also resulted in 10 out of 80 cadets flunking out because of firearms failures. With the new weapon both of those numbers have dropped - only about 17% are now requiring additional training and less than 3 are flunking out because of firearms failures (12).

1.2. Mission Direct Approach.

For this study stress was applied through a single drill which manipulated four variables: (1) Physical Activity, (2) Time, (3) Limited Resources (ammunition) and (4) Competition. These four variables were selected because they can easily and safely be adjusted by tactical professions. These variables can also be scaled for an individual athlete and progressed as a means of training.

2. METHODS

2.1. Subjects.

Ten healthy male subjects (32-45 years) who were all full-time Law Enforcement officers and part time SWAT team members of a mid-sized city (Fresno, CA) SWAT team participated in the study. Participants were all experienced marksmen with at least 0 years of LE experience and a minimum of 2.5 years of SWAT experience.

TABLE 1: Subject Data

	Average	SD
Age (years)	41.1	+/- 4.72
Tactical Team Experience (years)	7.2	+/- 5.62
LE Experience (years)	15.15	+/- 4.31

Study participants were randomly separated into two groups of five: (1) Control, and; (2) Study.

TABLE 2: Subject Data by Group

	Control Group		Treatment Group	
	Average	SD	Average	SD
Age (years)	39.8	+/- 5.22	42.4	+/- 4.34
Tactical Team Experience (years)	4.4	+/- 3.17	10.0	+/- 6.44
LE Experience (years)	12.7	+/- 7.90	7.4	+/- 0.72

2.2. Marksmanship Trials.

All subjects completed a series of 2 identical marksmanship trials, each comprised of 30 events. During the first trial (events 1-30), all athletes used their stock Colt A4 triggers. During the second trial (events 31-60), athletes were randomly divided into Control and Treatment Groups - where the Treatment Group received new, lighter-resistance triggers.

Events were divided into two categories: (1) Non-stressed and (2) Stressed. Each event consisted of one magazine of 6 rounds (5.56mm). Subjects fired a total of 180 rounds during the non-stressed events and 180 rounds during the stressed events (360 total rounds).

Three Distances:

Subjects shot 10 events each (non-stressed and stressed), 20 events total at two B-29 Law Enforcement Targets from three distances, 15 yards, 50 yards and 100 yards.

Marksmanship category type:

1. Each Non-Stress drill required athletes to assume a standing position (15 and 50 yards) and kneeling position (100 yards) and fire 3 rounds each at two B-29 targets, separated by 3 feet. The drill was not timed.
2. Each Stress drill required athletes to complete two 15-yard shuttle runs, retrieve their weapon from a tabled location, assume a standing position (15 & 50 yards) or kneeling position (100 yards) and fire 6 rounds and fire 3 rounds each at two B-29 targets, separated by 3 feet. Time limit varied by distance: 15-yards (20 seconds); 50-yards (25 seconds); 100 yards (30 seconds).

Triggers and trigger pull weight:

1. Each group (Study and Control) completed the first 30 events with stock triggers. Stock trigger pull weights were measured using a Lyman Electronic Digital Trigger Pull gauge. Each trigger was measured three times, and the three measurements were averaged. Standard issue military and law enforcement carbine trigger pull weights are generally 7.5-9.5 pounds. As well, stock triggers are two-stage.

TABLE 3: Stock Trigger Pull Weight

	Average	SD
Control Group	7.9	+/- 0.44
Study Group	7.4	+/- 0.72

2. Both groups (Study and Control) completed the first set of 30 trials (non-stressed and stressed, all 3 distances 15/50/100 yard) with stock triggers. Next, the stock triggers for the Study Group were replaced with Hiperfire “Hipertouch EDT2” triggers. According to the trigger manufacturer, the EDT2 triggers are single stage triggers with a pull weight of 4.5-5.5 pounds. Triggers were installed into the Study Group weapons by SWAT armorers following the manufacturer’s instructions. Following the trigger installation, the study group triggers were measured using a Lyman Electronic Digital Trigger Pull gauge. Each trigger was measured three times, and the three measurements were averaged.

TABLE 4: Replacement Trigger Pull Weight

	Average	SD
Control Group	5.05	+/- 0.26

3. Following the light trigger install into the Study Group’s weapons, both Study and Control Groups shot 30 rounds at 15 yards into B-29 Targets. This was to allow the Study Group to become familiar with the light triggers.
4. Next, both groups (Study and Control) completed the second set of 30 events (non-stressed and stressed, all 3 distances 15/50/100 yards). Thus, the study group shot the second trial using the light, Hiperfire triggers. The Control group shot the trials using stock triggers.

2.3. Weapons.

All subjects used their issues long rifles during the study - Colt A4’s (5.56mm). There were no research controls applied to individual weapons. Athletes were allowed to use their preferred configurations and optics.

2.4. Data Collections.

Study participants scored their marksmanship based on bullet hits on the B-29 targets following each trial. After each trial, the study participants scored their hits, and the used targets were replaced with fresh B-29 targets.

2.5. Analytical Method.

All data analytics and statistical modeling were completed using Apple Numbers 2015 (3.5.3 - 2150), Microsoft Excel Online 2016 (15.14.0), released 15 September 2015 and IBM Watson Analytics Online Program 2015.

3. RESULTS

3.1. 15-Yard Trials (Stressed and Non-Stressed).

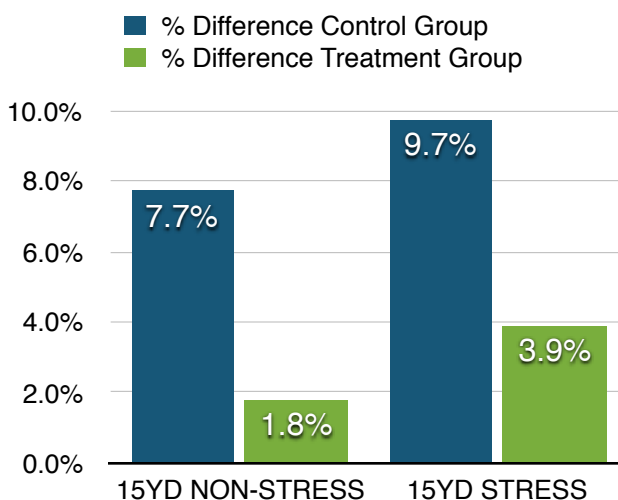
Control and Treatment Group performances were nearly identical during the first trials of non-stressed and stressed marksmanship. During the second set of trials (post treatment) both groups showed moderate improvements. However, although the control group showed more improvement, based on a paired T-Test analysis neither group changes were statistically significant ($p>0.55$ and $p>0.45$, respectively).

TABLE 5: 15-Yard Stressed and Non-Stressed Trials

	15-Yard Non-Stress		15-Yard Stressed	
	Trial 1	Trial 2*	Trial 1	Trial 2*
Control Group	111.2	119.8	98.6	108.2
Treatment Group	111.0	113.0	97.8	101.6

* Trial 2 = after treatment

FIGURE 1: 15-Yard Percent Differences between Trail 1 and Trial 2 (post-treatment)



3.2. 50-Yard Trials (Stressed and Non-Stressed).

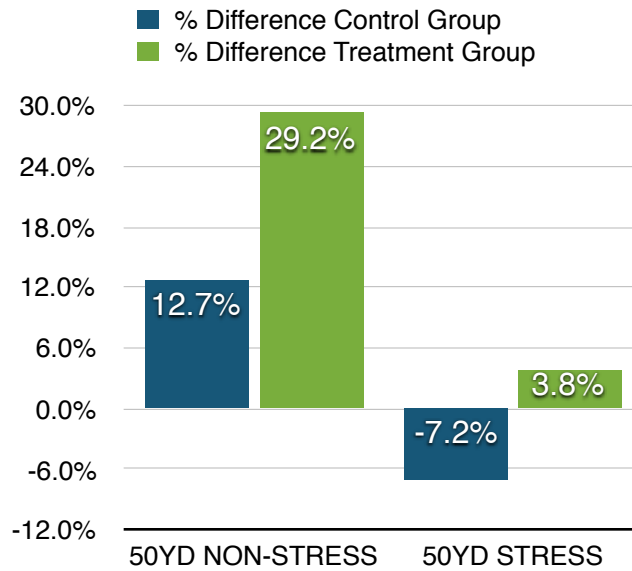
As with the 15-yard trials, Control and Treatment Group performances were nearly identical during the first set of non-stressed and stressed trials. During the second set of trials (post treatment) the treatment group improved in both stressed and non-stressed shooting (+29.2% and +3.8%, respectively). The control group experienced improvement during non-stressed shooting, but decreased performance during stressed shooting (+12.7% and -7.2%, respectively). At the 50-yard interval the treatment group (treated with a lighter trigger pull) saw much great improvements in marksmanship when compared to the control group. However, based on paired T-Test analysis neither group changes were statistically significant ($p>0.70$ and $p>0.55$, respectively).

TABLE 6: 50-Yard Stressed and Non-Stressed Trials

	50-Yard Non-Stress		50-Yard Stressed	
	Trial 1	Trial 2*	Trial 1	Trial 2*
Control Group	42.6	48.0	44.4	41.2
Treatment Group	42.4	54.8	42.4	44.0

* Trial 2 = after treatment

FIGURE 2: 50-Yard Percent Differences between Trial 1 and Trial 2 (post-treatment)



3.3. 100-Yard Trials (Stressed and Non-Stressed)

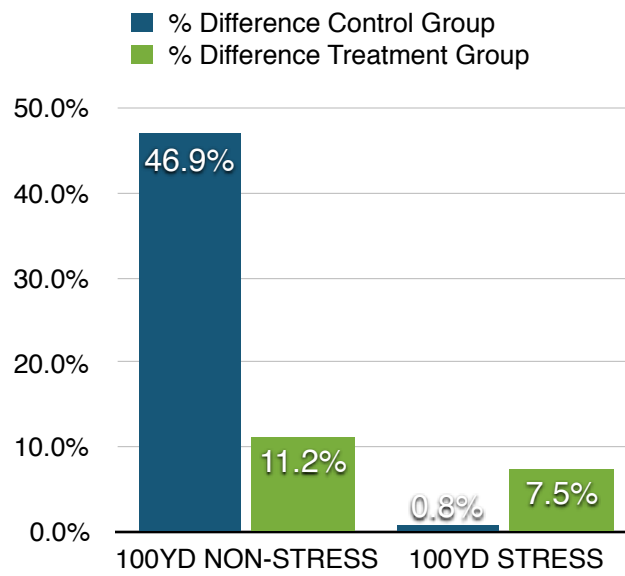
At the 100-yard interval, the Control group’s initial performance during non-stressed trials was significantly lower than the Treatment group (average scores were 16.2 versus 30.4, respectively). During the non-stressed trials, post-treatment trials both groups improved their marksmanship performance by a wide margin (+46.9% and +11.2%, respectively). During the stressed trials at 100 yards both groups had slight improvements between the first and second trials (+0.8% and +7.5%, respectively). None of the changes measured during the 100 yard trials were statistically significant.

TABLE 7: 100-Yard Stressed and Non-Stressed Trials

	100-Yard Non-Stress		100-Yard Stressed	
	Trial 1	Trial 2*	Trial 1	Trial 2*
Control Group	16.2	23.8	25.0	25.2
Treatment Group	30.4	33.8	26.6	28.6

* Trial 2 = after treatment

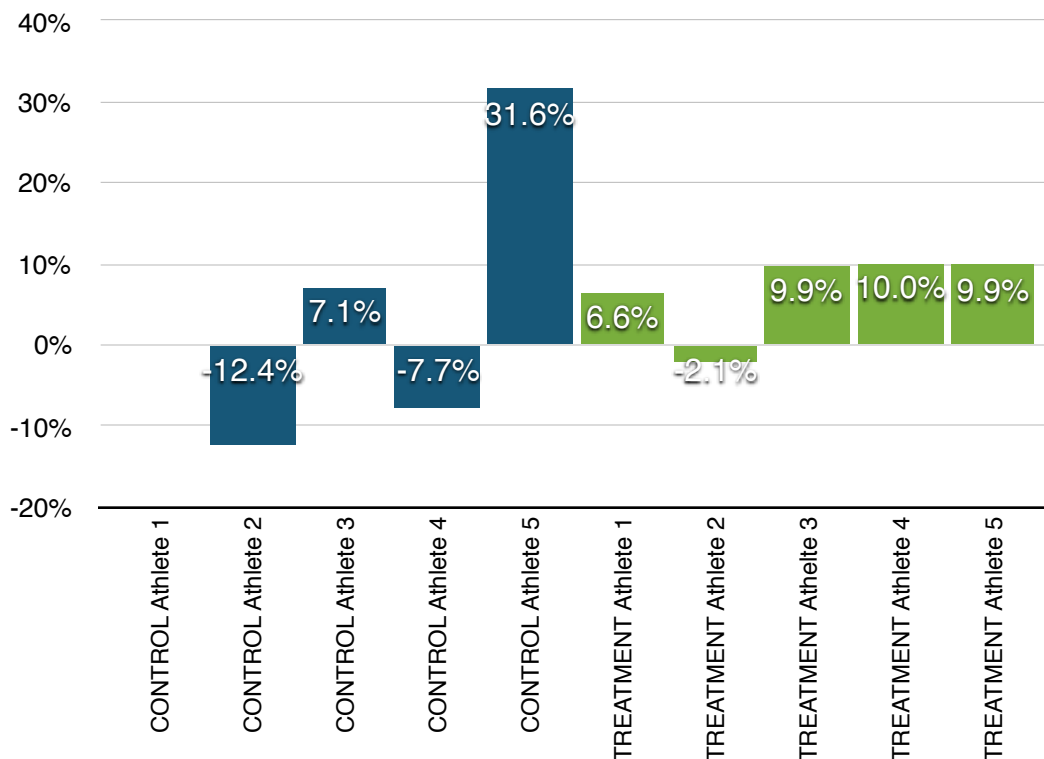
FIGURE 3: 100-Yard Percent Differences between Trail 1 and Trial 2 (post-treatment)



3.4. Gross Results - 15, 50 and 100 yard Trials (Stressed and Non-Stressed)

Across all distances and shooting types, 2 out of 4 athletes in the Control Group improved their marksmanship from trial 1 to trial 2 (Note: One athlete had to be removed from the data for failing to complete one event). In contrast, across all distances and shooting types, 4 out of 5 athletes in the Treatment Group improved their marksmanship from trial 1 to trial 2 (i.e. with a lighter trigger pull).

FIGURE 4: Average Percent Change Across all Shooting Trials



At each individual distance (15, 50 and 100 yards) changes in performances were assessed between Trial 1 (all groups with stock triggers) and Trial 2 (lighter triggers for Treatment Group). Table 8 displays the average differences for the group at the identified distance and trail type.

TABLE 8: Percent Difference (Trial 1 to Trial 2) per distance, per trial type (Non-Stressed and Stressed)

	15yd	15yd	50yd	50yd	100yd	100yd	AVG
	Non-Stress	Stressed	Non-Stress	Stressed	Non-Stress	Stressed	Overall
Control Group	+7.7%	+9.7%	+12.7%	-7.2%	+46.9%	+0.8%	+11.8%
Treatment Group	+1.8%	+3.9%	+29.2%	+3.8%	+11.2%	+7.5%	+9.6%
Statistically Significant?	No	No	No	No	No	No	No
TTest p-value (0.05 = significant)	0.56	0.48	0.73	0.56	0.61	0.96	0.93

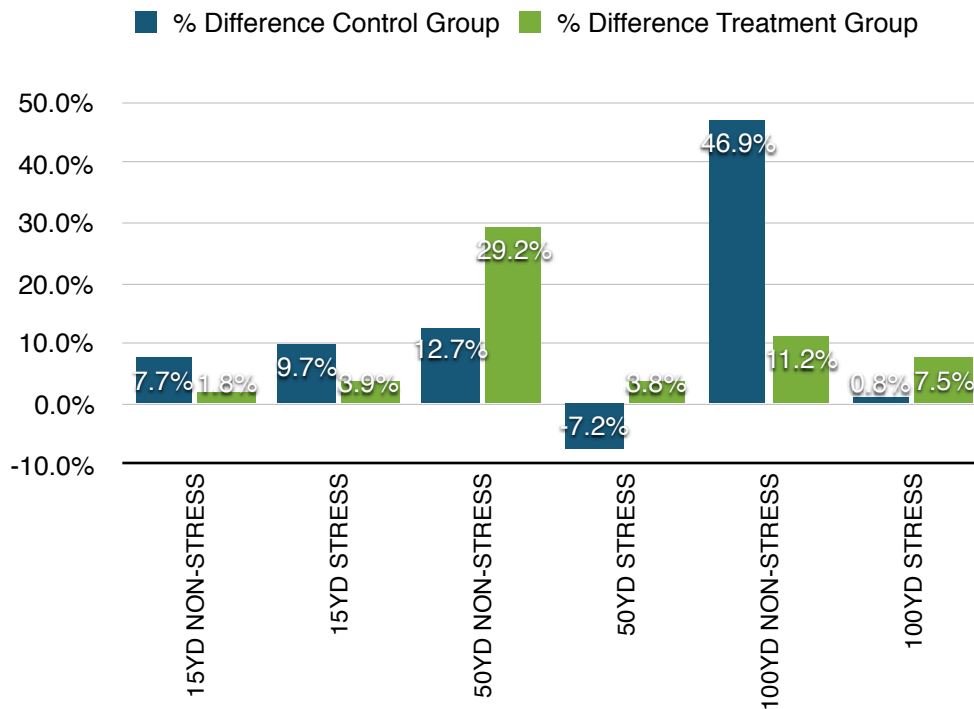
***BOLD** numbers indicate better performance improvement

The Control group showed more improvement during 3 of the 6 trial types (15-yard Non-Stressed, 15-yard Stressed and 100-yard Non-Stressed). The Treatment Group also showed more improvement during 3 of the 6 trial types (50-yard Non-Stressed, 50-yard Stressed and 100-yard Stressed).

Overall the Control Group averaged +11.8% improvement from Trial 1 (all groups with stock triggers) to Trial 2 (lighter triggers for Treatment Group).

Overall the Treatment Group averaged +9.6% improvement from Trial 1 (all groups with stock triggers) to Trial 2 (lighter triggers for Treatment Group).

FIGURE 5: Percent Difference (Trial 1 to Trial 2) per distance, per trial type (Non-Stressed and Stressed)

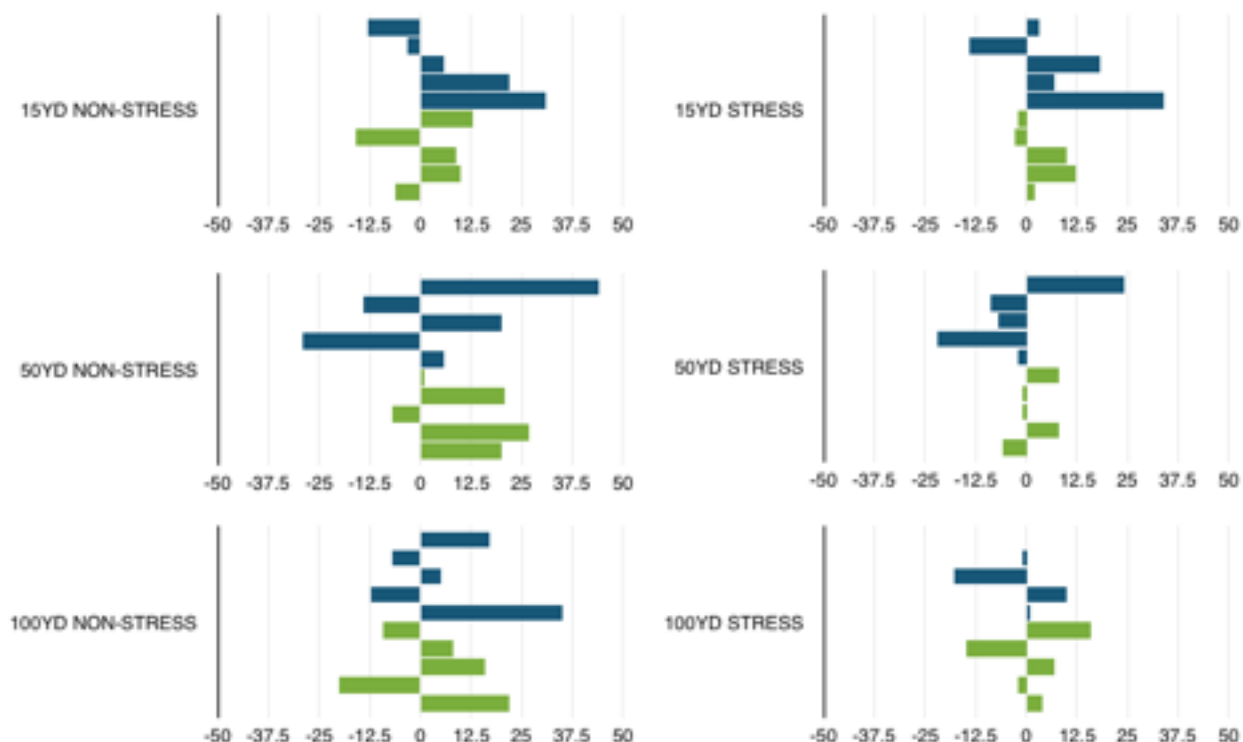


4. DISCUSSION

In general, this study found that a lighter trigger-pull (a reduction of approximately 32% in the study's Treatment Group) had little to no direct effect on marksmanship performance.

Neither group, Control or Treatment, experienced statistically significant changes in performance between trials. Figure 6 shows the random nature of the changes as measured for each of the participants. No patterns were found between distances or trial type (Non-Stressed or Stressed) for either group. Based on the large variations measured within the groups, the researchers do not believe that, even with a larger sample size, a significant relationship would be easily assessed.

FIGURE 6: Changes in Marksmanship Performance (“Hits” Score) between Trial 1 and Trial 2
 Blue = Control Group
 Green = Treatment Group



When the study data was analyzed between individual trials the results were evenly split between the Control group and the Treatment Group. Both the Control Group and Treatment group each showed more improvement during 3 of the 6 trial types. For the Control Group those trials were: 15-yard Non-Stressed, 15-yard Stressed and 100-yard Non-Stressed). And the Treatment Group those trials were: 50-yard Non-Stressed, 50-yard Stressed and 100-yard Stressed.

Thus, half the time the Control Group (stock triggers) out performed the Treatment Group and half the time the Treatment Group (lighter trigger-pulls) out performed the Control Group. During no trials were any of these differences significant.

Overall the Control Group actually averaged a slightly higher improvement from Trial 1 to Trial 2: +11.8% improvement versus +9.6% for the Treatment Group. However, again, these differences were not statistically significant. Thus, the changes experienced by the participants were most likely the result of random factors, not the decreased trigger-pull poundages.

Finally, in all but one trial, trigger-pull weight had no significant correlation to marksmanship changes. The only exception was during the 15-Yard, Non-Stressed trial. During this trial, a Pearson Product Moment Correlation (r) value was found to be -0.96, $p < .05$. All other r-values were far below the threshold for significance.

These findings do not support the anecdotal evidence which were the basis of the study's hypothesis (6-10). Thus, the researchers must accept the null-hypothesis that a reduction in trigger-pull resistance (of approximately 32%) does not have a significant impact on marksmanship.

However, the current study did find that trigger pull resistances below the US Army Small Arms Branch recommendation of 6.5 to 12.3 pounds for M4 Carbines might actually be advantageous to marksmanship (11). Based on results from this study, trigger pull resistances as low as 4.7 pounds seem to be safe and effective.

Lastly, the study did not find any support for the perceived safety concerns often attributed to lower trigger resistance (6-9). The study found no indication that trigger-pull resistances as low as 4.7 pounds could lead to increases in accidental discharges or other safety related instances.

5. LIMITATIONS

The first major limitation of the study was the small sample size. Because each group only contained five tactical professionals the threshold to achieve statistical significance was extremely high. For correlations the requirement for statistical significance was over $r = 0.87$, which is extremely high.

Another limitation of the study was the large variability measured between athlete individual trials. This variation was particularly noticeable as distances increased. At the 50-yard intervals, scores ranged from 17 to 67 points (with a standard deviation of over 20) for Non-Stressed shooting. At the 100-yard intervals, scores ranged from 3 to 56 points (with a standard deviation of over 20). This large variation maybe it difficult to compare individual and group scores.

Significant limitations were also present in the athlete's equipment. All athletes used their individually issued Colt A4's (5.56mm). There were no research controls applied to individual weapons. Athletes were allowed to use their preferred configurations and optics. Thus, some athletes were using iron-sights while others used advanced optical systems.

Another limitation was the timeframe allowed for the Treatment Group to familiarize themselves with the new triggers. Following the lighter trigger installation the Treatment Group was only allowed to fire 30 rounds at 15 yards into B-29 Targets. It is possible that more familiarization time would have helped the Treatment Group's performance during the second trial of the study.

Lastly, the study only examined trigger-pull resistance in tactical assault rifles. It is likely that trigger resistance would have a much different effect on handguns due to the very different biomechanics support used to fire the weapon.

6. PRACTICAL APPLICATIONS

The findings from this study can be used to help tactical professionals make better educated decisions on equipment requirements and purchasing.

Although the study did not find support for lighter trigger-pull resistance as a means of improving tactical marksmanship, the study did challenge the perceived safety concerns often attributed to lower trigger resistance (6-9).

Thus, it seems that tactical professionals who struggle with marksmanship because of trigger control could experiment with lighter triggers with little to no increased safety concerns. In other words, lighter triggers may not necessarily help an individual improve their marksmanship, but they almost certainly wont hurt or create safety concerns for a trained tactical professional.

Lastly, the current study could also be used to help refine the 20+ year old, US Army recommendation of 6.5 to 12.3 pounds of trigger-pull resistance for M4 Carbines (11). Based on results from this study, trigger pull resistances as low as 4.7 pounds seem to be safe and effective.

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