

Resisting Arrest: Analysis of Different Prone Body Positions on Time to Stand and Engage

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Abstract: An isolated police officer executing an arrest can be placed in a dangerous situation should the subject become non-compliant. Further research is needed to ascertain the position that a subject can be placed in that takes the longest time to rise from the ground. Twenty-four college-aged participants (15 men, 9 women) were recruited for this study. Four prone positions were examined in one session: hands hidden under the chest (PHC); arms perpendicular to the torso and palms of the hand facing up (PPU); arms perpendicular to the torso, palms of the hand facing up, with ankles crossed on the ground (PPUAC); and arms perpendicular to the torso, palms of the hand facing up, with ankles crossed but elevated toward the lower back (PACKB). The order of these positions was randomized amongst participants. Participants were instructed to rise to an athletic position from each position as quickly as possible, with the movements recorded by a video camera. Times were calculated via a frame-by-frame analysis using motion analysis software from movement initiation until participants were standing. A 2 (sex) x 4 (position) repeated measures ANOVA with Bonferroni post hoc calculated between-position differences. There was a significant ANOVA for position ($p = 0.003$) but not sex ($p = 0.415$). The PACKB position was significantly slower than the PHC and PPUAC positions ($p \leq 0.045$) and had the slowest movement time to stand (~2.019 s). As reaction time could influence an officer's safety, the PACKB position required the most time for a subject to stand and potentially engage an officer.

Keywords: apprehension, civilian, detainee, law enforcement.

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INTRODUCTION

A police officer is required to complete many essential job tasks. Some of these tasks include patrolling assigned areas to ensure civilians are adhering to the law, investigating crimes or accidents, and effecting arrests (Decker et al., 2022; Decker et al., 2016; McKinnon et al., 2011). One of the more dangerous activities required of officers is effecting an arrest of a subject. Depending on the actions of the subject, the health and safety of the officer, subject, and the general population can be put at risk. According to data released from the Federal Bureau of Investigation (FBI) from 2021, 43,649 police officers were assaulted while performing their duties (Law Enforcement Bulletin, 2023). The number of assaults was an 11.2% increase from 2020 (Law Enforcement Bulletin, 2023). Moreover, the estimated number of police officers who sustained at least one injury from an assault increased by 18.3% from 2020 to 2021 (Law Enforcement Bulletin, 2023). In an Australian state police force, arresting an offender was the leading cause of injury (31.2%) for general duties police at a rate three times higher than the next most frequent cause of injury (Orr et al., 2023). These data would suggest that further research is needed to support arrest techniques in situations that could place the officer in danger, while still maintaining safety of the subject and general population.

As part of their academy training (Lockie et al., 2020a), in addition to specific educational courses (e.g., patrol school following a period working in custody) (Baran et al., 2018; Lockie et al., 2019; Lockie et al., 2020b), police personnel will learn defensive tactics and arrest techniques. Generally following a directed and specific curriculum when learning arrest techniques, there are some important factors that must be considered by the officer when effecting an arrest (Peace Officer Standards and Training, 2022). Some of these factors include, but are not limited to:

- Maintenance of a proper distance from themselves to the subject, being aware of the subject from head to foot and of any body movement which may indicate any offensive movement;
- Being aware of the location of the subject's hands;
- Potential escape routes for the subject;
- Positioning and balance, and ensuring the gun side is away from the subject;
- General control and influence the officer has over the subject, and physical control they may need to exert; and,
- Protection of areas of the body that require maximum protection during an attack (e.g., face/head, neck/throat, heart, spine, kidneys, groin, joints).

Single officer patrols are common around the world (Anderson & Dossetor, 2012), although an isolated officer interacting with a subject could invite a situation of increased risk. Before any physical interactions with a subject, the officer should establish their presence and communicate clearly with the subject (Berrien County Sheriff's Department, 2003; Peace Officer Standards and Training, 2022). To ensure greater safety, the officer should be in a position of advantage relative to the subject (Berrien County Sheriff's Department, 2003). An example position of disadvantage for a subject is if they are prone with their feet spread wide, toes out and arms out to the side with his palms up (Berrien County Sheriff's Department, 2003). This is because it should be more difficult for the subject to create any offensive movement from this position before the officer can react.



Nonetheless, further research is needed on disadvantageous positions given they can influence the time an officer has to react should the subject become non-compliant. As a starting point for this type of analysis, documenting the time required to rise from the ground from different positions into a position where the subject could react (i.e., flee or physically engage the officer) is needed. These data would provide support for the use of certain positions that would provide the greatest advantage to the officer.

Therefore, the purpose of this study was to determine differences in the time to rise from the ground from four prone positions into a standing athletic position (being a position which would theoretically prepare the individual to physically engage with, or run from, the officer) (Lockie et al., 2014). The four positions were: prone position with hands hidden under the chest (PHC); prone position with arms perpendicular to the torso and palms of the hand facing up (PPU); prone position with arms perpendicular to the torso, palms of the hand facing up, with ankles crossed on the ground (PPUAC); and prone position with arms perpendicular to the torso, palms of the hand facing up, with ankles crossed but elevated toward the lower back (PACKB). It was hypothesized that the PACKB position would result in a significantly slower movement time into the athletic position compared to all other positions.

METHODS

EXPERIMENTAL APPROACH TO THE PROBLEM

This cross-sectional study involved ascertaining the differences in the time to rise from the ground from four prone positions (PHC, PPU, PPUAC, and PACKB) into a standing athletic position. Male and female civilian participants completed the movements, and time was measured via a video camera and associated software. A 2 (sex) x 4 (position) repeated measures analysis of variance (ANOVA), with Bonferroni post hoc for multiple comparisons, calculated the between-position time differences.

PARTICIPANTS

Twenty-four college-aged civilian participants were recruited for this study; nine participants were women (age = 23.11 ± 2.20 years; height = 164.4 ± 4.4 cm; body mass = 63.60 ± 8.70 kg) and 15 were men (age = 26.33 ± 6.43 years; height = 175.4 ± 7.5 cm; body mass = 79.90 ± 13.32 kg). Participants were selected to ensure a wide variety of individuals from the general population to help determine best practice, and all participants were able to perform the required movements in the study without any pain or significant risk of bodily harm. The institutional ethics committee approved the study (IRB-21-546). This research also conformed to the Declaration of Helsinki recommendations (World Medical Association, 1997).

MEASUREMENTS AND PROCEDURES

The study involved one testing session. Participants first arrived to the human performance laboratory where they completed the required paperwork (confirmation that the partic-



ipant did not have COVID-19 symptoms as defined by the Centers for Disease Control and Prevention COVID-19 fact sheet, informed consent, physical activity readiness questionnaire). Following this, height was measured using a stadiometer (Detecto, Webb City, MO, USA), while body mass was measured via an electronic digital scale (Model HBF-510, Omron Healthcare, Kyoto, Japan). Participants then walked to the gymnasium where they completed the four prone-to-standing positions on rubber flooring. A square of tape measuring 1 meter (m) by 1 m was placed to serve as a fixed starting point for all trials.

As shown in Figure 1, the four prone-to-standing positions, chosen to allow an officer to move away from a subject if a threat were detected (i.e., they are not in physical contact with the subject), were:

- PHC: Participants laid on the ground face down with their hands underneath their chest and palms on the floor with their feet turned out (external rotation at the hips);
- PPU: Participants laid on the ground face down with their arms spread and palms facing up with their feet turned out (external rotation at the hips);
- PPUAC: Participants laid on the ground face down with their arms spread and palms facing up with their ankles crossed; and
- PACKB: Participants laid on the ground face down with their arms spread and palms facing up with their ankles crossed and knees flexed to elevate the ankles.

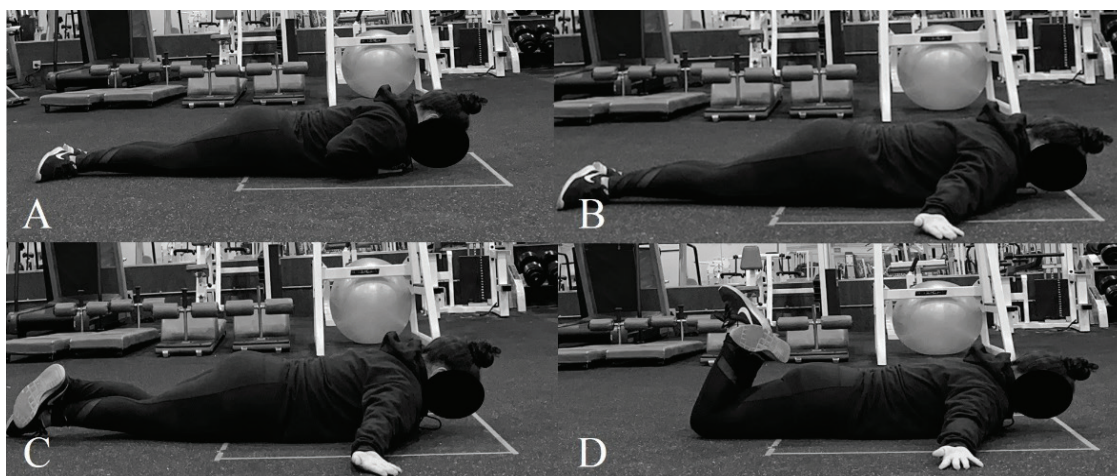


Figure 1. (A) *Prone Position with Hands Hidden under the Chest (PHC)*; (B) *Prone Position with Arms Perpendicular to the Torso and Palms of the Hand Facing Up (PPU)*; (C) *Prone Position with Arms Perpendicular to the Torso, Palms of the Hand Facing Up, with Ankles Crossed on the Ground (PPUAC)*; and (D) *Prone Position with Arms Perpendicular to the Torso, Palms of the Hand Facing Up, with Ankles Crossed and Elevated Toward the Lower Back (PACKB)*

From each position, participants were instructed to stand as quickly as possible and assume an athletic position (Figure 2). The athletic position involved participants standing in a quarter squat position with the head and chest up, and hips and knees flexed (Lockie et al., 2014). This position is a universally accepted position whereby the participant should be ready to move in any direction (i.e., flee from an officer), or move towards and physically engage with an officer (Frost et al., 2008; Johnson et al., 2010; Lockie et al.,

2014). Participants had the four positions explained to them, were given a visual demonstration, and then were placed in each position so they understood the expectations.



Figure 2. *The Athletic Position Participants Were Required to Maintain Once They Explosively Popped Up from the Ground from Various Prone Positions*

Prior to completing the prone-to-standing positions, a black marker with white background was placed on the greater trochanter of the femur (hip) of the participant, which was determined via palpation. A video camera (HDR-PJ200, Sony, Tokyo, Japan), with a frame rate of 30 Hertz, recorded the movements. Similar cameras have been used in the analysis of human movement with motion analysis software (Nor Adnan et al., 2018; Shishov et al., 2021). The camera was positioned on a tripod and placed 5.08 m perpendicular to the outer edge of the square. For each participant, a 1-m long vertical scale was recorded first, followed by the participant standing in the athletic position. The participant then completed two trials each of the four prone-to-standing movements (eight trials total) in a randomized order. They were instructed to assume the athletic position to complete each trial.

The recordings from the camera were analyzed within motion analysis software (BinaryVideoX, Binary Sports, Sliáč, Slovakia). The 1-m long scale was used to provide the reference distance within the field of view (Lockie et al., 2012a). Similar software to that used in this study have been found to be reliable when measuring distance (Puig-Diví et al., 2019) and time (Balsalobre-Fernández et al., 2014) in human movement research. The first recording of the athletic position was used to measure the participant's hip height when standing in this position. This hip height was used to confirm that the participant had finished the movement after they stood up from the prone position and was displayed through the rest of the footage to provide a reference. For each trial, initiation of movement was visually determined from the video footage (Gruen, 1997; Lockie et al., 2012b). Once the initial frame of movement was noted, the stopwatch application was used to measure the time in seconds (s) from the first movement until the participant was stationary and within 5% of their hip height as measured during their reference athletic position. This 5% range was adapted from studies that measured time to stabilization (Ebben et al., 2010; Flanagan et al., 2008; Lockie et al., 2016), as the participant was expected to be stable in their standing athletic position. Once the participant was stationary and attained this

height, they were determined to have completed the movement and time was recorded via the stopwatch application.

STATISTICAL ANALYSES

Statistical analyses were processed using the Statistics Package for Social Sciences (Version 29; IBM Corporation, New York, USA). Descriptive statistics (mean \pm standard deviation [SD]; 95% confidence intervals [CI]) were derived for time to rise for each prone position. A 2 (sex) \times 4 (position) repeated measures ANOVA, with Bonferroni post hoc for multiple comparisons, calculated the time differences for the different prone positions (PHC, PPU, PPUAC, and PACKB). Significance was set as $p < 0.05$. Sex was considered within the ANOVA as there are differences in body size (Centers for Disease Control and Prevention, 2017) and muscle mass (Janssen et al., 2000) between men and women which could influence their time to rise from the different prone positions. However, if the ANOVA output indicated no significant differences between the sexes, then all data would be combined for the post hoc analysis. Effect sizes (d) were also calculated for the between-position comparisons, where the difference between the means was divided by the pooled SD (Cohen, 1988). Absolute values were used in this research, with a d less than 0.2 considered a trivial effect; 0.2 to 0.6 a small effect; 0.6 to 1.2 a moderate effect; 1.2 to 2.0 a large effect; 2.0 to 4.0 a very large effect; and 4.0 and greater an extremely large effect (Hopkins, 2004).

RESULTS

The descriptive data for time to rise from the four prone positions is shown in Table 1. Between-group comparisons are represented graphically in Figure 3, with effect size data displayed in Table 2. There was a significant ANOVA for position ($F_{(3,20)} = 6.741$, $p = 0.003$, $\eta^2 = 0.503$) but not sex ($F_{(3,20)} = 0.996$, $p = 0.415$, $\eta^2 = 0.130$). Post hoc analyses indicated that the PACKB position was significantly slower than the PHC ($p < 0.001$, $d = 0.903$, moderate effect) and PPUAC ($p = 0.045$, $d = 0.529$, small effect) positions and had the slowest time to reach a standing athletic position ($\sim 2.019 \pm 0.263$ s). Compared to each different prone position (PHC, PPU, and PPUAC), the PACKB was 9%, 3%, and 4% slower, respectively. There were no significant differences between the PHC, PPU, and PPUAC positions, all of which had trivial-to-small effects.

Table 1. Descriptive Data (Mean \pm SD; 95% CI) for Time to Stand from the PHC, PPU, PPUAC, and PACKB Positions

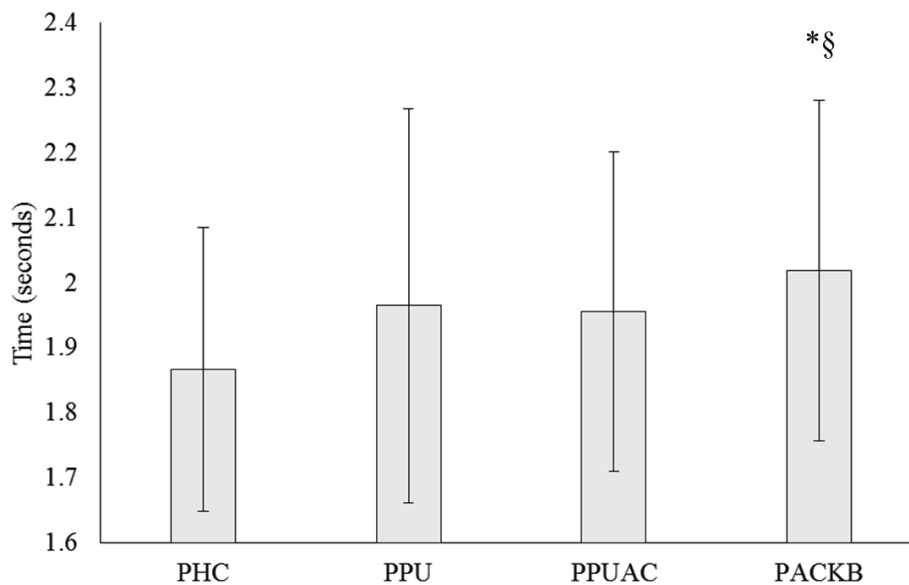
Prone Position	Mean \pm SD	95% CI
PHC	1.867 \pm 0.218	1.775-1.960
PPU	1.964 \pm 0.303	1.837-2.093
PPUAC	1.956 \pm 0.246	1.852-2.060
PACKB	2.019 \pm 0.263	1.908-2.130



Table 2. *Effect Size Data for the Comparisons between Time to Stand from the PHC, PPU, PPUAC, and PACKB Positions*

	PPU	PPUAC	PACKB
PHC	0.431	0.569	0.903*
PPU		0.047	0.292
PPUAC			0.529*

Note: * Effect size associated with a significant between-group difference.



* Significantly ($p < 0.05$) different from the PHC position.

§ Significantly ($p < 0.05$) different from the PPUAC position.

Figure 3. *Comparisons between Time to Stand (Mean \pm SD) from the PHC, PPU, PPUAC, and PACKB Positions*

DISCUSSION

The current study investigated the time to rise and stand in an athletic position from four different prone positions that could be used when detaining a subject. This research was conducted to inform police officers of potential positions of advantage for detaining a subject to ensure their safety (Berrien County Sheriff’s Department, 2003). If a particular prone position has a reduced movement time from the ground for the subject, and features disadvantageous conditions (i.e., the hands of the subject cannot be seen) (Berrien County Sheriff’s Department, 2003; Peace Officer Standards and Training, 2022), this will increase the risk for the officer, the detained subject, and the general public. It was hypothesized that the PACKB position would have the slowest movement time, and the results indicated this was the case. These results, in conjunction with wider police use of force considerations, could have implications for arrest techniques used by officers in the field.



Previous research suggests that the average time that it takes an officer to draw their weapon from their holster, depending on the holster, was approximately 1.78 s (Blake & Bartel, 2018) to 1.92 s (Campbell et al., 2013). Following a review of literature, Blake and Bartel (2018) found draw to fire one-round response times to range from about 1.52 s to 2.31 s. While this is not the only option available to officers when engaged with a subject and does represent the most extreme option (Blair et al., 2011; Eighth United Nations Congress on the Prevention of Crime and the Treatment of Offenders, 1990), this does illustrate the time stress placed on officers should a subject become non-compliant. Participants in this study were all able to rise from the four prone position variations on the floor to a standing athletic position in approximately 2 s or less. This demonstrates that the reaction time of subjects could be relatively fast despite the physical position that they are being held in. Accordingly, officers need to consider arrest techniques that provide them with the most time to make appropriate and safe decisions.

This study showed that PACKB position, with the palms of the hand facing up, with ankles crossed on the ground and elevated toward the lower back, required the most time (~2.019 s) for a subject to stand and potentially engage an officer. This position resulted in a movement time that was 3-9% slower than the other three variations from this research. Further, from a tactical perspective, the subject's hands could be seen at all times (unlike the PHC position). Informal discussions with officers suggested that although a position where the hands cannot be seen is not recommended (Berrien County Sheriff's Department, 2003; Peace Officer Standards and Training, 2022), there are situations where the officer may not have a choice (i.e., the subject is non-compliant and time is of the essence for gaining control of the subject). Nonetheless, the current data indicates that the PACKB position could potentially provide the greatest safety for the officer, public, and also the subject. The officer would be in a position of advantage (Berrien County Sheriff's Department, 2003), as the PACKB position requires the most movement (i.e., uncrossing the ankles extending the lower body, moving the arms and hands underneath the body to push themselves up) from the subject to get up into a standing athletic position. This is especially important in situations where an officer needs to detain a subject if they are patrolling alone or while waiting for backup (Anderson & Dossetor, 2012). The PACKB may provide an officer room to react and physically detain the subject should they choose to engage with the officer or run away. Indeed, future research should investigate the time to physically engage with an officer or to sprint a specific distance away following being placed in the different prone positions.

There are second order outcomes that come with increased officer control in these situations. Firstly, as noted, arresting an offender is a leading cause of injuries and instances of police officers being assaulted are increasing (Orr et al., 2023). Through improve safety when arresting a subject, officer injuries may be reduced. This reduction in injuries may bring with it lower rehabilitation costs, compensation costs, loss of work force, working shifts lost, and shift overtime to replace injured officers (Lentz et al., 2019; Mona et al., 2019; Orr et al., 2013). Secondly, the safer the officer when effecting an arrest and increase in time to make a tactical decision may provide the officer with more situational control. As such, the officer could have more use of force options, and thus hopefully reducing the requirement to employ their sidearm.

There are some limitations to consider for this study. The participants were all college-aged and were performing all the movements in a controlled environment. Offenders and sus-



pects may move differently in the field, and the locations and terrain will also be different from the inside of a gym. Indeed, environment, terrain, and weather conditions are points of consideration for officers when effecting a search or arrest (Berrien County Sheriff's Department, 2003; Peace Officer Standards and Training, 2022). Nonetheless, the researchers attempted to provide as little constraints to the participants as possible to allow for effective movement. In line with this, video camera and motion capture software were used to record time. Although similar software has been found to provide reliable and valid kinematic measurements (Balsalobre-Fernández et al., 2014; Puig-Diví et al., 2019), three-dimensional motion capture systems may provide more accurate results. The study used a convenience sample which was relatively small ($N = 24$). A larger sample size may produce different results, although it still would be expected that the PACKB would result in the slowest movement time. The current data should be interpreted with those limitations in mind.

CONCLUSIONS

Given the time pressure placed on an officer to react should a subject decide to become non-compliant, the officer should ensure they use the greatest position of advantage they can when interacting with a subject. From the four prone positions used in this study, the PACKB resulted in the slowest movement time. Within the context of the study limitations, officers could use this position to provide themselves with a position of advantage if they need to search and/or detain a subject. This position required the most movement to reach a standing athletic position, while also allowing the officer to see the subject's hands the whole time. Future studies could investigate the use of different prone positions and how long it would take a subject to either physical engage an officer, or sprint a specific distance away from the officer.

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