

Effects of Agility Training on Soldiers in a Warrior Transition Battalion: A Proof of Concept Study

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Abstract

Background: Soldiers are returning from military service with physical and/or emotional injuries that impair health and overall physical functioning. To address this limitation these Soldiers are assigned to Warrior Transition Battalions (WTB).

Objectives: This proof of concept study evaluated the impact of an individualized Agility Program (AP) on the physical functioning of 11 Soldiers assigned to a WTB at a Midwest military base.

Methods: A pre-post design was used that assessed four fitness domains (cardiovascular function, agility, mobility and balance) before and after six weeks of two days per week training. Cardiovascular (CV) function was measured by the 6-Minute Walk test, agility by the Illinois Agility test, mobility with the Up and Go test, and balance by Single Leg Stance test. Modifications for the AP were individualized for each participant based on their medical history and current health status.

Results: Results indicated significant improvements in the 6-minute walk test ($P = 0.05$), Illinois Agility test ($P = 0.022$), Up and Go test ($P = 0.002$), and single leg stance test ($P = 0.027$). Soldiers assigned to a WTB may see physical fitness improvements through participation in an individualized AP.

Conclusions: This improvement in CV function, strength, agility and balance has the potential to result in better health and improved overall physical functioning.

Keywords: Physical Fitness, Warrior Transition Battalion, Soldier Training

1. Background

In the Vietnam conflict approximately 24% of United States Soldiers died from combat injuries. With technological advances in Soldier protection and medicine only 10% of US Soldiers in Operations Iraqi Freedom and Enduring Freedom who were injured in combat have died (1). Of the more than 2.2 million US troops deployed as of 2010 (2) over 400,000 service members have been diagnosed with Post Traumatic Stress Disorder (PTSD), more than 320,000 service member have been diagnosed with a Traumatic Brain Injury (TBI) and 51,000 service members were wounded (3). The Army's wounded and injured (both mentally and physically) service members are referred to as Warriors in Transition (WiT). According to the Warrior transition unit consolidated guidance, March 20, 2009, the WiT's mission is:

I am a Warrior in transition. My job is to heal as I transition back to duty or become a productive, responsible citizen in society. This is not a status but a mission. I will succeed in this mission because I am a Warrior.

In 2007, the Army established the comprehensive care plan (CCP) which utilizes a holistic approach within the four life domains: physical, mental, social, and spiritual (4). As part of the CCP, thirty-five Warrior transition battalions (WTB) were created and geographically dispersed throughout the US. The WTB are units designed to assist the recovery of a soldier with the goal of either, returning them to their units or their discharge into civilian life. The WTB has served over 10,000 service members who received medical treatment (4). During their time in the WTB, soldiers work on predetermined goals such as stress management, physical fitness, and occupational training as determined by the soldier and their medical team for successful transition (5). One of the functional components of the CCP is recreation and leisure which includes adapted physical activity. Adapted physical activities are formally provided through the Soldier Adaptive Rehabilitation Program (SARP) by military medical personnel and contracted outside agencies. SARP activities vary by geographical location but include sitting volleyball, archery, cycling, wheelchair basketball, bowling, golf, and chess.

Individualized adaptive agility programs (AP) have also provided group fitness instruction and one-on-one fitness training. Fitness professionals implement these programs which assist WiT in coping with transition back to civilian life (5).

Studies examining the effects of injury to Soldier's have been focused on rehabilitation and treatment (6-8). While rehabilitative research is extensive (3), data on the complementary areas of physical functioning and fitness are lacking.

2. Objectives

The purpose of this study is to quantify physical fitness changes that an individualized AP could provide to soldiers enrolled in a WTB. Using a pre- post-test design, the authors hypothesized that Soldiers participating in the individualized AP would see significant improvement in cardiorespiratory fitness, agility, mobility, and balance.

3. Methods

3.1. Participants

Participants were recruited from Soldiers within a WTB stationed at a Midwest military base with participation in the individualized AP serving as part of their mandatory activity schedule. Eleven Soldiers (10 male, 1 female) completed pre- and post-testing at the beginning and end of a six-week, twice weekly, training program. Although each service member had different physical injuries or mental limitations, all were dealing with multiple areas of concern. Soldier demographics as well as medical limitations are listed in Table 1. Eight had PTSD, TBI and/or emotional traumas. Additional concerns included eight lower limb, three upper limb, and five lower back injuries.

This study was approved by a university-based Institutional Review Committee as well as the Research Review Committee of a Midwest army base that complies with all federal regulations concerning the ethical use of human volunteers for research studies. Informed consent was obtained from each Soldier prior to beginning the individualized AP.

3.2. Testing Procedures

An individualized AP encompassed four areas of physical fitness. These four areas; cardiovascular fitness, agility, mobility, and balance, were assessed before and after a 6-week individualized AP. Due to assessments taking place at the military base without the use of a laboratory field based assessments were utilized. All assessments utilized have been shown to be reliable and valid. Assessments

were performed in an indoor basketball gymnasium with a regulation-sized wooden court. The order of tests were consistent with the American College of Sports Medicine (ACSM) guidelines (9) and consisted of anthropometric measures (height, weight), measures of cardiorespiratory fitness (6-minute walk test), agility (Illinois agility test), mobility (8 foot up and go test), and balance (single leg stance). Pre- and post-testing measures were taken by the same investigator to provide consistency of measurement. A familiarization session was performed before each test. Testing sessions lasted approximately 25-30 minutes.

3.3. Cardiovascular Function

3.3.1. Six-Minute Walk Test (6MWT)

The 6MWT (10) has been shown to be reliable in assessing cardiorespiratory capabilities for individuals of varying ages (11-14) as well as different types of disabilities (13, 15). Investigators administered a modified 6MWT in which subjects walked successive laps around a regulation sized basketball court (16). Soldiers were instructed to walk as many laps as possible within the six-minute period. Each Soldier proceeded at their own pace, either a walk, jog or run. They started the test where the basketball court's baseline met the sideline. Cones were placed at the corners of the court to ensure each participant walked around the entire playing surface. Upon the command "go" Soldiers began the test. Investigators gave verbal cues at the 4-minute mark, 5-minute mark, and 5:30-second mark, followed by a 10-second countdown. Upon completion of the test, Soldiers were requested to "stop". The number of laps was tallied and the investigators recorded the distance to the nearest 0.1 of a lap.

3.4. Agility

3.4.1. Illinois Agility Test (IAT)

The IAT (17) was selected to measure the ability of a soldier to accelerate, decelerate, and change directions (17, 18). Investigators administered the IAT using a protocol shown to be reliable and valid in previous studies (17-20). The goal of this test was to complete the course as quickly as possible. The course was 9.75 m long by 4.85 m wide with 4 cones placed 3 m apart in a straight line with the first cone being the starting point. Prior to the start of the test, investigators gave verbal instructions explaining the procedures, a separate instructor gave a demonstration, and an untimed walk-through trial was allowed for each subject. Soldiers began from a standing position. Upon the command "go" the timer would begin, and the Soldier completed the course by zig zagging between cones. Investigators stopped the timer when the Soldier stepped across the finish line. No cones were allowed to be touched or

Table 1. Demographic Information and Injuries of Soldier Athletes Participating in the Individualized AP

Soldier	Age (years)	Height (inches)	Weight (pounds)	Summary of Injuries
1	26	68	225	Lower limb injury, PTSD
2	35	69	290	Lower limb injury, PTSD
3	56	67	284	Lower limb injury, PTSD
4	53	72	272	Lower limb injury, low back injury, PTSD
5	59	73	225	Upper body injury, PTSD
6	45	69	218	Upper body injury, PTSD
7	40	69	238	Upper body injury, PTSD
8	55	73	261	Upper body injury, PTSD
9	33	72	238	Lower limb injury
10	48	70	266	Lower limb injury, low back injury
11	35	70	210	Lower limb injury, low back injury

moved during the test. Upon completing one successful test, investigators recorded the time. Measurements were recorded to the 1/100 th second.

3.5. Mobility

3.5.1. 8-Foot Up and Go Test (U>)

The U> (10) was used to assess mobility, balance and lower body strength (21-24). The test was administered according to a standard protocol consistent with previous studies that demonstrated reliability and validity (24-26). Verbal instructions, a demonstration, and a practice walk-through was performed prior to testing. The goal of this test was for the Soldier to rise from the chair without the use of their arms, round the cone placed 2.5 meter in front of the chair, and sit back in the chair as quickly as possible. Soldiers began from a seated position in the chair with their arms to the side, not touching their legs to ensure that their arms could not be used to assist them in reaching a standing position. Upon the command “go” the Soldier rose to a stand, rounded the cone, walked back to the chair, turned around, and returned to a seated position in the chair. Once the Soldier had returned to the seated position, investigators stopped the timer. Each Soldier completed one successful test. Disqualification and re-testing occurred in the event of any of the following: arm-assisted standing, moving the cone during the test, or failing to round the cone. Upon completion of one successful test, investigators recorded the time to 1/100th of a second.

3.6. Balance

3.6.1. Single Leg Stance Test (SLST)

The SLST (10) has been shown to be a reliable and valid measure of balance in various populations (15, 27, 28). Prior

to beginning the test, investigators gave verbal instructions and a demonstration of the procedure. The goal of this test was to balance on one leg for as long as possible. Upon the command “go”, the timer started, and the Soldier lifted the leg of choice to balance on the one supporting leg. Hands were placed on the hips, and the lifted leg made contact with no other part of the body or surrounding structures. Investigators stopped the timer and the test concluded in the event of any of the following: one or both of the hands were removed from the hips, the lifted leg touched the support leg or any surrounding structure, the Soldier began to lean or tilt, thus demonstrating loss of balance, and/or any form of hopping or movement of the support leg. Each Soldier was tested on preferred leg first, followed by rest, and then non-preferred leg. Following the completion of the test, investigators recorded the stance leg of choice and balance time to 1/100 th of a second.

3.7. Individualized Agility Program (AP)

The individualized AP utilizing the guidelines of the American college of sports medicine exercise prescription protocols. Sessions consisted of 60 minutes of training, 2 days per week for six weeks targeting cardiorespiratory fitness, agility, mobility, and balance of Soldiers assigned to the WTB. All training sessions began with a 5-10 minute warm up, then individualized exercises, followed by a 5-10 minute stretch and cooldown. Modifications of exercises of the individualized AP were determined by a Certified Athletic Trainer to accommodate various injuries and limitations (Table 2). Soldiers were divided into an advanced group requiring fewer modifications and an intermediate group requiring a greater number of modifications in training. Participants in the advanced group were able to

jog/run while participants in the intermediate group were able to walk only. Modifications included the advanced group performed the exercises along the full length of a regulation basketball court, while the intermediate group utilized a half-court length as a complete repetition; range of motion (ROM) exercises were limited to just below the point of discomfort; depth of squats was limited by knee joint ROM and/or use of wall sits instead. Soldiers with TBI/PTSD focused on balance related activities such as one legged stance with arm lifts, while soldiers with lower extremity injuries focused on core strength and strengthening injured limbs. Exercise programs were individualized for each Soldier and daily progression of exercises was based on their performance the previous training session and how they were feeling that day (Table 3).

3.8. Data Analysis

All statistical tests were performed using SPSS v.21 (IBM, Inc., Chicago, IL). Paired t-tests were utilized to determine differences before and after training with significance level set at $P \leq 0.05$. No corrections were made for multiple t-tests due to this research being a pilot (proof of concept) study (29). Normality of distribution was assessed utilizing the Shapiro-Wilk test.

4. Results

Participant demographics are listed in Table 1. Nineteen Soldiers agreed to take part in the study, with 11 soldiers completing all pre- and post-testing. The relatively high attrition rate was due in part, to Soldiers returning to their unit, sent home for recovery, or medically discharged from the military. Soldiers who completed all assessments completed an average of 8.4 training sessions (5-11 sessions) out of 12. Reasons for not attending sessions were doctor appointments and therapy sessions.

Non-significant Shapiro-Wilk tests were found for the 6MWT ($P = 0.216$), U> ($P = 0.358$), and SLST ($P = 0.097$) indicating data were normally distributed. Significant Shapiro-Wilk test results were non-significant for the IAT ($P = 0.010$) indicating this data distribution was non-normal.

Significant improvements from pre- to post-testing were noted in all parameters tested (Table 4). The 6MWT increased from 8.9 laps to 9.8 laps improving an average of 80%, IAT decreased from 33.8 seconds to 28.9 seconds improving an average of 14.5%, U> decreased from 5.9 seconds to 4.6 seconds improving 21.4% and the SLST went from 58.4 seconds to 80.8 seconds, an improvement of 41%.

5. Discussion

This proof of concept study determined the impact of an individualized AP on the physical functioning of Soldiers assigned to a WTB. Although unable to control for outside factors such as medication change or other therapies, results indicated that the Soldiers increased their cardiovascular fitness, improved their agility, mobility, and balance after participating in a six week, twice weekly individualized program consistent with the hypothesis of the investigators.

The WTB exist within the military to provide injured soldiers with appropriate medical care and to ensure the soldier is able to return to duty or be medically discharged and return to civilian life (30). Previous studies evaluating soldiers within a WTB have examined a number of treatments and outcomes relating to PTSD and TBIs (8, 31). One study used cognitive therapy and neurofeedback training to provide Soldiers with a better understanding of their body's physiological reactions to stressors, and how to better control these responses (8, 32). Another study examined rehabilitative techniques designed to assist the Soldier with a TBI as they moved to independent living (6). The researchers provided holistic services to veterans returning to civilian life with the focus of this program being full continuum of care - physical, occupational, social, psychological.

Both studies reviewed above utilized wounded veterans who were in physical rehabilitation programs and collaborations between the WTB and local universities (similar to the current study). The current study evaluated Soldiers who were in the post-rehabilitation phase but not yet physically qualified to return to duty or be discharged home consistent with the definition of WiT. This program was designed to fill the gap between the time period between the end of formal physical rehabilitation and either return to duty or return to civilian life. Prior to this type of program the WiT needed to devise a fitness program on their own which is not optimal for recovery. The individualized AP provided the Soldiers an opportunity to continue physical activity in a supervised and progressive fashion in accordance with the American College of Sports Medicine (ACSM) guidelines and consistent with their needs. Injured Soldiers who cannot perform standard military physical training (PT), have generally been left to develop their own fitness program (31). The individualized AP evaluated in the current study provided Soldiers with a training protocol that accommodated their pain and functional limitations. The supervised training encouraged confidence in injured Soldiers as they were provided the opportunity and guidance to, as one Soldier-athlete stated, "learned I am not going to break".

Table 2. Modifications Made to Each Exercise Included Limiting Speed and Range of Motion (ROM) to a Pain Free Range, All Exercises Focused on Proper Mechanics and Balance

Exercises	Modifications
Sprint breathing/arm mechanics	
Butt Lifts (slow, med pace, sprint)	Limit ROM to just below discomfort
Wall Drill/Knee Drive (w/resist.)	Limit ROM to just below discomfort, walk pace slowed
False step	Modified squat decreased depth based on discomfort
Get Up's (starting prone, to 1 foot)	Walk pace slowed, focus on mechanics
Lean starts	Walk pace slowed, focus on mechanics
Cone start drill	Walk pace slowed, focus on mechanics
Abs/core	Can be done on bench or medicine ball
Stork Stand w/Arm Mechanics	Walk pace, focus on mechanics
Lateral Walks w/ bands	Modified squats or on wall
Squat Jumps (zig-zag, 6 cones)	Modified squats or on wall
Tuck jumps	Modified squats or on wall
Scissor jumps	Modified squats or on wall
One Leg Squat w/ Medicine ball	Modify step height, focus on mechanics
Step Ups w/ Arm Mechanics	Can be done on bench or medicine ball
Abs/core	Can be done on bench or medicine ball

Table 4. Pre- and Post-Test of Significance of 4 Physical Fitness Domains After 6 Weeks Participation in the Individualized AP

Variable	Pre	Post	Average Improvement	SD	95% CI	P Value
6 Minute walk test (laps)	8.9	9.8	0.8	1.2	-1.63-10.00	0.05
Illinois agility test (seconds)	33.8	28.9	4.8	5.8	.86 - 876	0.022
Up and go test (seconds)	5.9	4.6	1.2	0.98	0.61 - 1.93	0.002
Single leg stance test (seconds)	58.4	80.8	22.4	28.67	-41.67 - 3.14	0.027

Despite small numbers due to high attrition (which is expected from a transitional unit), this proof of concept study provides evidence that an individualized AP could result in physical benefits to injured Soldiers. Additional data needs to be collected to strengthen the initial findings to ensure these results can be achieved at other WTB across the country.

A second novel finding lies with the individualized exercises given to each soldier and the supervised environment in which they were carried out. Within the WTB, soldiers received a variety of therapy services which provided specific physical exercises, guidance, and motivation. The time period between discharge from rehab services and return to duty or return to civilian life can last days or months and leaves the individual Soldier to continue their physical fitness program on their own. The individualized AP evaluated in the current investigation gave Soldiers another avenue to continue to increase their levels of physi-

cal activity and improve their physical fitness in a safe and supervised environment. Pain-free range of motion was stressed during all training sessions and the exercises were continually modified to ensure the session was challenging for each Soldier.

Limitations of this proof of concept study include the use of a pre-post design of the study, which lacks a control group, and a small sample size. A Soldier's time spent assigned to a WTB is decreasing, with faster transitions to return to duty or discharge making adherence for an adequate amount of time to get quantifiable results difficult. The variability of the individualized training did not allow standardization of the training effect.

The positive impact of physical training on quality of life (QOL) has been demonstrated in individuals with SCI (33), multiple sclerosis (34), and older adults (35). A QOL assessment would ensure the overall health of a soldier has improved, not just their physical fitness. Additional

testing, such as the functional movement screening (FMS)² would also be beneficial to provide not only another possible measure of fitness but to also add to the current FMS literature regarding reliability and validity of the test.

In conclusion, for any Soldier needing a variation to the standard morning PT for injuries both mental and physical, an individualized PA program should be considered. Individual exercise professionals have an opportunity to utilize their expertise for the benefit to the military as a whole by serving the wounded veterans through a SARP program.

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Table 3. Example of an Individualized AP

Day	Condition
Day 1	
Exercises	SetsxReps
Kick Outs w/Theraband	2x10 (ea)
Partner squats	2x10
Skipping drill/kick-outs	2x20yd
Lean starts	2x4
Cone start drill	2x4
40 yard sprints	5x
Crossover Runs into Sprint (no behind step)	2x20yd
(Lateral, diag. Crossover, forward sprint)	
Box Drill Sprints (10 feet)	X2
Abs/core	4x25
Day 2	
Ladder (run through (1 ft/2ft), high knees, Skips, Lateral high knees/skips, skip 1, Shuffle (forward, back), hops)	2x ea
Slalom Run (5 cones, 5 ft apart)	3x
4 cone agility drill	2x ea (10yd)
(Complete Rest before next sprints)	
Sprints	
100 yd (work = 110%, rest = 20 sec)	6x
50 yd (work = 110%, rest = 15 sec)	4x
Abdominals/core	4x25
Day 3	
Cone Jumps (double/single leg)	2x10 (ea)
Hurdles (Single/Double run, Dead leg run, Skips, Single/double hop, Up 2/back 1, Sprints into/Out of Hurdles)	2x (ea)
Depth Pushups (feet on step)	1x ea(above)
Broad Jumps (5 cones) sideways, zigzag	3x8
Plyo's (use bleachers)	4x ea
Depth Jumps (increase rebound speed)	1x:20 (ea)
Jump Up & onto step, sideways)	
Abdominals/core	4x25
Day 4	
Lunges	3x20yd
Burpies (stand-pushup-jump = 1)	3x5
Leg cycle drill	2x10
Wall drill	2x6

Bounding (right,right,right,left,left,left, rrlrll, llrllr)	3x
Stride checker	4x
Sprints	
40 yd (work = 110%, rest = 20 sec)	6x
20 yd (work = 110%, rest = 15 sec)	10x
Abs/core	4x25
Suicide(ladder)/Mirror Drill (lateral slides)	3x
Abdominals/core	4x25
Day 5	
Ladders (2 ladders -straight & "L")	2ea
(Run through (1 ft/2ft), high knees, Skips, Lateral high knees/skips, skip 1, Shuffle (forward, back), hop)	
Cone zig/zag Jumps (2ft jump, Left/Right only, Jump from Left to Right ft)	2 (3x3)
Med Ball Squats & Throw into Sprint (20 yd sprint, :20 rest between reps)	3x5
Suicide(ladder)/Mirror Drill (lateral slides)	3x
Abdominals/core	4x25
Day 6	
Knee Drive (into partner's hands)	2x:15
Tuck jumps	3x8
Scissor jumps	3x8
3 hurdles	2x:20
Line Drill (stand behind line, Right/Left - Right/Left Touch line w/ each foot & back to start)	3x:20
20 yd Assisted Running w/ Tubing	3x5
20 yd Resisted Running w/ Tubing	3x5
40 yd Sprints w/o Tubing	2x6
Depth Jumps (increase rebound speed) Jump Up & onto step, sideways)	
Abdominals/core	4x25
Day 7	
Resisted pushups (with Theraband)	3x10
Funnel Drill (lateral slides, sprint)	2x (ea)
Assisted Jumping (w/ belts & tubing)	3x5
Resisted Jumping (w/ belts & tubing)	3x5
Jumping olympics (continuous) (10 standing long jumps, 10 "rebound" jumps, 10 scissors, 10 side/s line jumps, 10 diagonal jumps, 5 Right ft long jumps, 5 Left ft, 10 tuck jumps) -complete rest	
Sprint Square(basketball ct) (jog, sprint, jog, stride)	2x

Abdominals/core	4x25
Day 8	
Calf raises	3x12
Shuttle slides (10') (Beat previous count)	4x:20
Backwards Running (30ft)	3x
Hurdles(short into tall) (lined up end to end)	4x (ea)
Normal patterns; Jumping s/s, front/back	
Star Runs (start in middle of box, go To each corner & back) (10'x10')	4x
M Drill (12'x12') Sprint through (Middle of "m" is half distance of ends)	4x
Abdominals/core	4x25
Day 9	
Roller coasters	2x12
Single Leg squats (partner hold leg)	3x10
Line Jumps (2 ft, 1 ft, alternate) forward/back, side/side	2x:30
Box Jumps (2 feet, onto box, 1 ft landing)	3x10
Ladders w/ Belts & bungies	2x ea
Ladders into Stride Checker	4x
Band Hops (18" high) side/side, forward/back, alternate	3x:15
Sprints (rest = 15 seconds) 20 yards & 40 yards	3x ea
Abdominals/core	4x25
Day 10	
Partner Squats -1 leg	2x12
Single Leg box jumps (land in same position)	3x12
Body shape 8 Sprints (10' apart)	3x12
Obstacle course/relay race	4x
Hurdles into cones into ladder	
Abdominals/core	4x25