

Fitness Training and Assessment Performance at Air Force Basic Military Training in 2021

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Introduction:

US Air Force (USAF) Basic Military Training (BMT) is the initial entry point and training course for all enlisted USAF recruits and occurs at Joint Base San Antonio-Lackland, TX. Physical fitness training is vital to the BMT curriculum and an opportunity to teach our newest Airmen the “Air Force way” to exercise in order to pass their fitness tests and improve their health and wellness for the rest of their careers. With an increasingly sedentary and unfit population from which to recruit Airmen, preparing trainees to acquire the requisite fitness to pass BMT is a tall task from both fitness adaptation and injury risk perspectives.

Per the 737th Training Group (TRG) (737th Training Group, 2020) fitness standards (which differ from fitness standards the rest of the USAF is held to in Air Force Instruction (Air Force Manual (AFMAN), 2020) for BMT graduation in 2021 were the following:

Table 1: BMT Physical Training Standards (737th Training Group, 2020)

	1.5 mile run	Push-ups	Sit-ups
Males			
<30 years old	13 min:36 sec	33	42
30-39 years old	14 min:0 sec	27	39
Females			
<30 years old	16 min:22 sec	18	38
30-39 years old	16min:57 sec	14	29

A need to innovate

Prior to the COVID-19 outbreak and pandemic of 2020, the BMT fitness program (737th Training Group, 2018) consisted of a monotonous regimen of alternating running (steady state runs) and strength workouts; such an outdated program was thought to lead to overuse injuries and poor fitness

performance, resulting in time out of training, delayed graduation, and attrition. The physical distancing considerations and shortening of BMT duration from 8.5 weeks to 7.5 weeks mandated by COVID-19 made continuing the existing BMT physical training (PT) program unwise from fitness adaptation, disease spread, and injury risk perspectives. This prompted an urgency and opportunity for collaboration between the multidisciplinary VIPER (Versatile Injury Prevention and Embedded Reconditioning) sports medicine team, the 323rd Training Squadron, and the 737th TRG to innovate, optimize, and overhaul the BMT PT program. Joint efforts between line and medical assets of BMT quickly developed a modernized and COVID-friendly fitness program which would increase fitness, reduce injuries, and improve on-time graduation rates.

The VIPER sports medicine team sought to maximize the new program's incorporation of evidence- and science-based principles for injury prevention in military and fitness training such as increased exercise variety, reduced training loads and running mileage, progressive and periodized training, and individualized run pace (Chalupa, Aberle, & Johnson, 2016) (Pope, 1999) (Scott, et al., 2012) (Sell, et al., 2016) (Santtila, Pihlainen, Viskari, & Kyrolainen, 2015) along with modern fitness training principles (Kasper, 2019). Additionally, incorporation of interval training throughout the program was inspired by the myriad evidence of the effectiveness of interval training both for expedited cardiorespiratory adaptation as well as enhancements in muscular strength and endurance for individuals starting an exercise training program (Gibala, Gagnon, & Nindl, 2015) (Santtila, Pihlainen, Viskari, & Kyrolainen, 2015) as opposed to short-term regimens that focus on continuous steady-state exercise (like the pre-COVID BMT fitness program).

A novel fitness program

The program (TRG OI, 2020) that was produced incorporates interval, aerobic, and strength training that took into consideration restrictions of movement, limitations to track running due to spacing requirements, and truncated BMT training time.

The first 2 weeks of BMT now consist of alternating days of strength training and cardiovascular interval training (CIT). This approach permits cardiovascular adaptations helpful for passing a fitness assessment without endurance running. Subjecting trainees to endurance running without preparation to run (now achieved with strength training, CIT, and gait training) was perceived as a significant risk factor for injury. There are 2 CIT and 2 strength workouts to add variety and avoid excessively overloading tissues with repeated similar movements. Strength workouts consist of bodyweight movements to facilitate resistance training and revolve around foundational movement patterns of push, squat, lunge, twist, and thoracic extension. CIT builds upon these foundational movements but performs them in circuit fashion. During weeks 1-3 of physical training, CIT consists of a 2:1 work-rest ratio with 20 seconds of work followed by 10 seconds of rest (this 2:1 work-rest ratio has been shown to increase core muscular endurance, among other fitness variables, with negligible resultant muscle damage or inflammation (Posnakidis, et al., 2020)). After completion of 1 full cycle, an extended rest period of 30 seconds is allowed for extra recovery and hydration time. This circuit is repeated until 6 cycles have been completed.

Weeks 3-5 of the current BMT fitness program alternate strength, CIT (starting in week 4, work-rest ratio is progressed to 3:1 for 30 seconds of work followed by 10 seconds of rest, and, after completion of 1 full cycle, an extended recovery period of 40 seconds occurs), and running workout days. During the 24 minutes of running on a (typically asphalt) track, trainees are assigned to lanes based on run times on

their initial fitness assessments and encouraged to run a “push pace” (a faster than sustainable pace) on straightaways and “steady pace” (a sustainable/recovery pace) on the turns (thus incorporating interval training to induce greater endurance adaptation). Full-body warm-ups and cool-downs are conducted before and after exercise respectively.

Fitness training supplementation

In addition to the core fitness program, trainees perform additional push-ups and sit-ups in their dorm room via “one-by-threes” in which trainees will perform three sets of one-third of their maximum repetitions. While proper exercise technique is taught by military training instructors (MTI), trainees may seek further guidance regarding their form from embedded VIPER athletic trainers (AT) and exercise physiologists (certified strength and conditioning specialists, CSCS). Trainees identified as high risk for failing the push-up and/or sit-up components of their final fitness assessment may also be subjected to “supplemental PT” following certain PT sessions, which is a circuit of 3 cycles of 5 exercises; these exercises are performed for 45 seconds each with approximately 15 seconds of rest after each set.

Gait training

Additionally, in the Fall of 2020, the members of the VIPER Sports Medicine team (exercise physiologists and athletic trainers) began gait training three flights of BMT trainees (~150 trainees) in a single session to introduce trainees to strategies to improve running efficiency and, as preventive medicine, to avoid running-related pain and injury. This mass gait training endeavor leverages motor learning theory to sequence and scaffold progressive exercises so as to permit somatization and adoption of optimized run biomechanics that reduce factors associated with injury and poor performance, such as ground reaction forces, skeletal loading impulses, knee adduction moments and time in foot pronation. This 45-minute program was maintained throughout 2021 and every flight of trainees was taught foundational running efficiency concepts in this manner.

Trainees noted to have dysfunctional run forms despite this initial group session, those recovering from a running related injury or pain, and those requesting may undergo one-on-one gait training with a VIPER AT or CSCS. These hour-long sessions utilize a pressure-plate embedded treadmill and 3D kinematics to objectively measure inefficiencies. Trainees are then guided through individualized exercises to optimize their run form, with the gait analysis repeated to demonstrate improvements in key areas such as peak forces, step cadence, knee flexion and foot placement at initial contact, and hip extension.

Fitness Assessments

Trainees are subject to fitness assessments 3 times over their first 5 weeks of training and must meet age and gender-specific standards in order to proceed past the fifth week of training (WOT) and ultimately graduate; those who do not meet standards are “recycled” (moved back) usually 2 weeks in training to try again 2 weeks later once they progress back into the 5th WOT. If they fail to meet standards again, they may be separated from the USAF.

Injuries

When a trainee sustains an injury while in training, efforts are made to keep the individual in training as long as it is safe to do so and training accommodations can be made to permit injury recovery. These

trainees are prescribed alternative/adaptive fitness training (i.e. stationary bikes) with VIPER ATs to help safely sustain and improve their fitness until they are healed and cleared to return to unrestricted training. In the event that an injury or pain precludes them from taking/passing their 5th WOT assessment, the trainee is normally placed in medical hold status, in which they are removed from training until they recover enough to return to training/take a fitness test; this rehabilitation is overseen by USAF sports medicine physicians, VIPER ATs, and CSCSs.

Training outcomes

Despite a majority of incoming trainees unable to achieve a passing score on the initial fitness assessment upon arrival and only 5 weeks to prepare trainees to pass a fitness evaluation, remarkable fitness and performance improvement and fitness test pass rates have been achieved. The current fitness program, based on modern fitness training principles, is permitting these rapid fitness adaptations despite COVID restrictions. Although high fidelity data regarding fitness results and delays in training and separations due to fitness are not available prior to implementation of this program (robust BMT fitness assessment result tracking and longitudinal capture was first implemented by the VIPER sports medicine team at the same time as fitness program change), this report seeks to review and evaluate the results of this fitness program in 2021 for the year as a whole and will seek temporal and season trends therein.

Study Design:

This study was a retrospective evaluation of regularly-collected and existing fitness data that the VIPER Sports Medicine team collects and assesses. The data was accessed for the year of 2021 and analyzed for descriptive statistics of average count and passage rate for each fitness assessment component and overall test passage. Data analyzed from the VIPER fitness tracker was gender, age, height, weight, BMI, date of test, run time and score, sit-up count and score, push-up count and score, and overall score and grade (satisfactory or unsatisfactory) for 1st WOT, 3rd WOT, and initial 5th WOT BMT fitness assessments. These were then used to evaluate pass rates for the testing components and overall tests for the year as a whole, quarterly, and bi-monthly to assess for temporal trends and differences.

Results:

Initial fitness assessment

For the entirety of 2021, the average pass rate of the initial (1st week of BMT) fitness assessment (before fitness program implemented) was 49% for males and 37% for females (46% overall). Among all BMT trainees, 71% passed the run, 60% passed sit-ups, and 76% passed push-ups.

On this initial test, which captures trainee performance at baseline, among male basic military trainees, 73% passed the run, 64% passed sit-ups, and 78% passed push-ups). Among female basic military trainees, 64% passed the run, 42% passed sit-ups, 69% passed push-ups).

Third week fitness assessment

In 2021, following 2 weeks of training 6 days per week with alternating days of strength and interval training workouts (no endurance running), 76% of males passed and 61% of females passed (72% overall). Among all BMT trainees, 87% passed the run, 81% passed sit-ups, and 91% passed push-ups.

Among male basic military trainees, 89% passed the run, 83% passed sit-ups, and 91% passed push-ups). Among female basic military trainees, 81% passed the run, 69% passed sit-ups, 88% passed push-ups).

Final fitness assessment (fifth week of training)

For the year, on their first attempt at the final, graduation requirement fitness assessment, 95% of males passed and 87% of females passed (93% overall). Among all BMT trainees, 97% passed the run, 96% passed sit-ups, and 99% passed push-ups.

Among male basic military trainees, 98% passed the run, 98% passed sit-ups, and 98% passed push-ups. Among female basic military trainees, 94% passed the run, 93% passed sit-ups, 99% passed push-ups.

The following figure illustrates overall pass rates across the 3 fitness assessments of BMT:

Figure 1: Overall Fitness Assessment Pass Rate, 2021

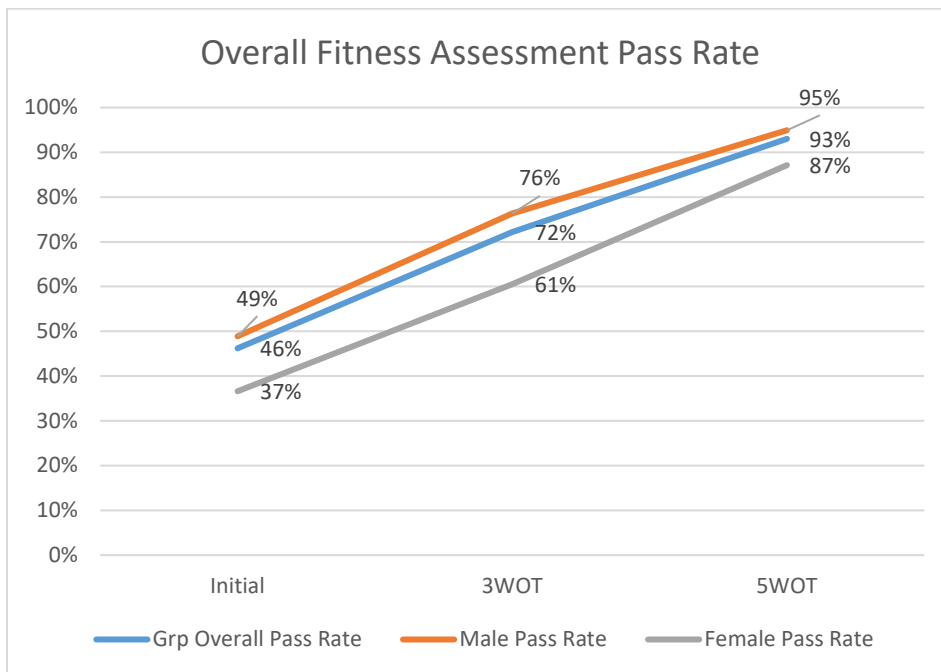
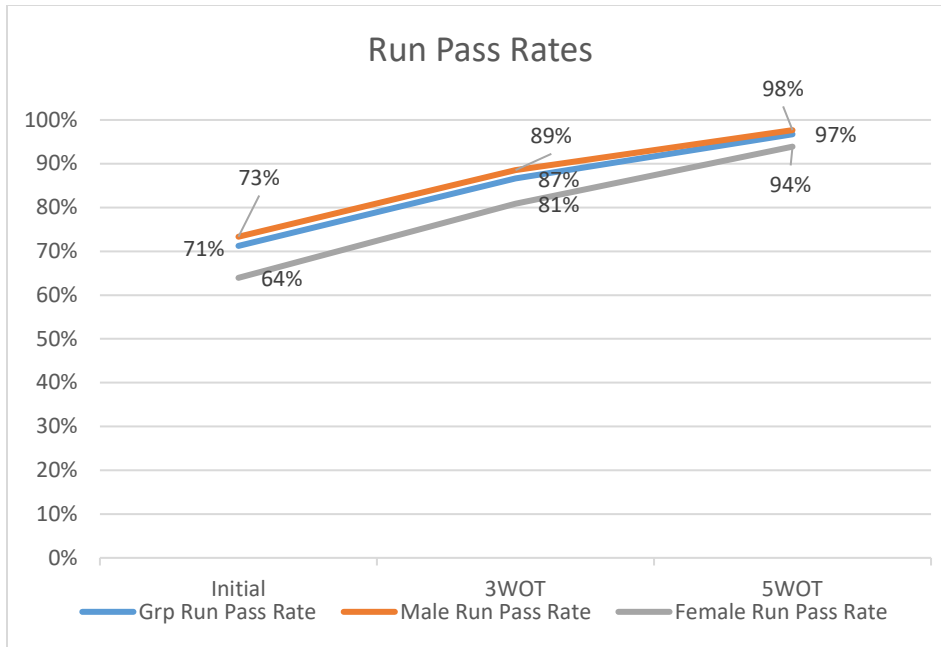


Figure 2: Run Pass Rates, 2021



Assessment results by quarter

The following table below shows pass rates for males and females by quarter of 2021.

Table 2: Pass rates by quarter

		Quarter 1 (January-March)			Quarter 2 (April-June)			Quarter 3 (July- September 2021)			Quarter 4 (October- December 2021)		
		Initial	3WOT	Final	Initial	3WOT	Final	Initial	3WOT	Final	Initial	3WOT	Final
% Pass Total	Overall	46%	72%	93%	42%	71%	93%	39%	68%	93%	37%	67%	92%
	Males	49%	76%	95%	46%	74%	94%	43%	72%	95%	41%	72%	94%
	Females	37%	61%	87%	31%	61%	90%	28%	58%	89%	24%	52%	84%
% Pass Run	Overall	71%	87%	97%	70%	88%	98%	74%	88%	98%	72%	90%	97%
	Males	73%	89%	98%	73%	89%	98%	76%	90%	98%	74%	92%	98%
	Females	64%	81%	94%	61%	86%	97%	66%	84%	96%	63%	87%	94%
% Pass Sit-Up	Overall	60%	81%	96%	53%	77%	95%	51%	76%	96%	49%	75%	95%
	Males	64%	83%	98%	57%	79%	96%	56%	80%	97%	53%	79%	96%
	Females	42%	69%	93%	41%	67%	92%	38%	66%	92%	33%	59%	89%
% Pass Push-Up	Overall	76%	91%	99%	76%	92%	99%	73%	91%	99%	73%	93%	99%
	Males	78%	91%	98%	79%	91%	99%	77%	91%	99%	76%	93%	99%
	Females	69%	88%	99%	69%	91%	100%	63%	89%	99%	63%	91%	99%

The figures illustrate pass rates for males and females by quarter of 2021.

Figure 3: Overall Pass Rates, by quarter

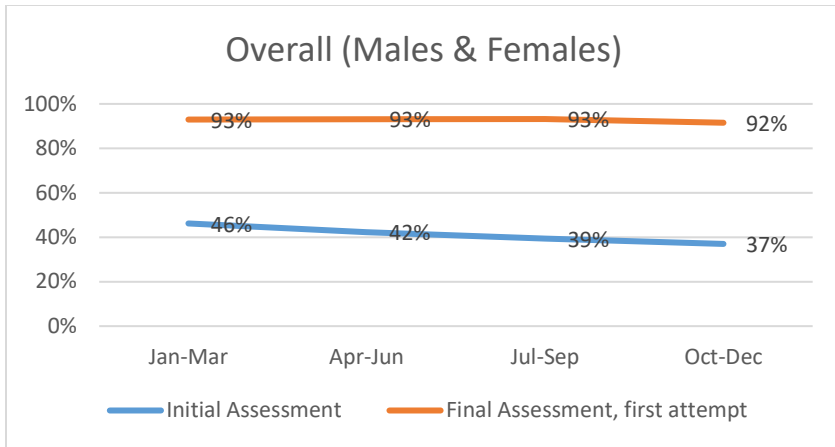


Figure 4: Male Pass Rates, by quarter

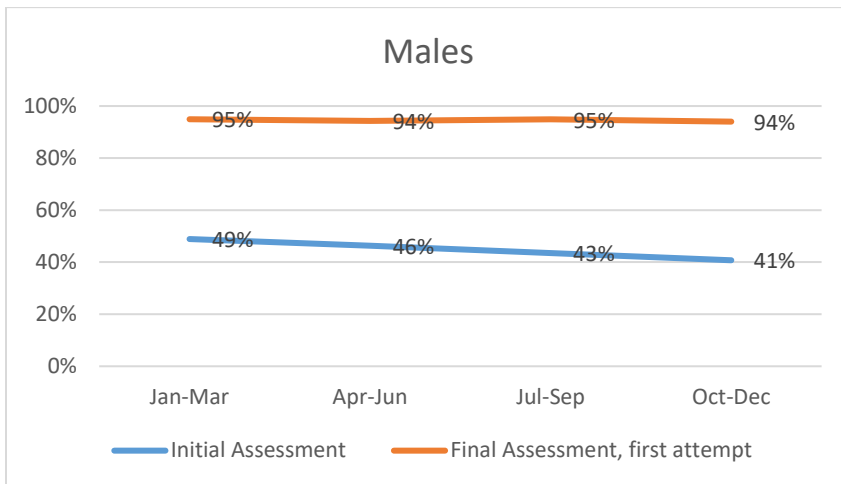
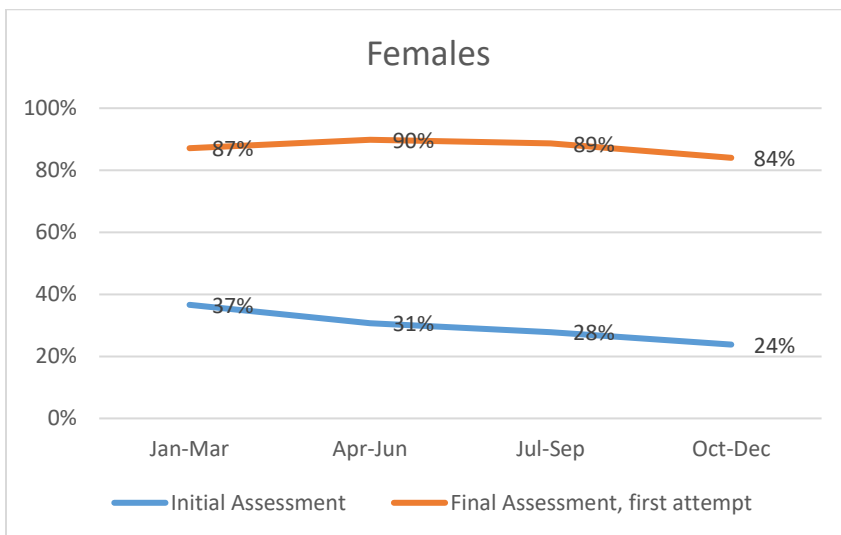


Figure 5: Female Pass Rates, by quarter



Separation rates for fitness assessment failures

In 2021, 32,006 trainees started BMT. 630 trainees (2.0%) were recycled to an earlier WOT (i.e would not graduate BMT on time) due to fitness assessment performance failures and 160 trainees (0.5%) were separated from USAF due to continued failures. The following table shows recycle and separation rates due to fitness failures from BMT by 2021 calendar year quarter.

Table 3: Recycle and Separation rates due to fitness failures

		Quarter 1 (Jan-Mar)	Quarter 2 (Apr-June)	Quarter 3 (July-Sep)	Quarter 4 (Oct-Dec)
Starting # of trainees		6267 (4769 M, 1498 F)	9270 (6820 M, 2450 F)	8619 (6379 M, 2240 F)	7850 (6020 M, 1830 F)
Recycled for fitness failure	Overall	90 (1.4%)	166 (1.8)	199 (2.3%)	175 (2.2%)
	Males	45 (0.9%)	93 (1.4%)	106 (1.7%)	95 (1.6%)
	Females	45 (3.0%)	73 (3.0%)	93(4.2%)	19 (1.0%)
Separated for fitness failure	Overall	29 (0.5%)	48 (0.5%)	42 (0.5%)	41 (0.5%)
	Males	15 (0.3%)	27 (0.4%)	31 (0.5%)	22 (0.4%)
	Females	14 (0.9%)	21 (0.9%)	11 (0.5%)	19 (1.0%)

USAF/BMT costs incurred by delayed graduation due to BMT fitness failures

At \$384.33 per calendar day while at BMT (internal BMT data), a 2 week delay in graduation due to being recycled for fitness failure, amounts to \$5,380.62 per occurrence. This was the case for 630 trainees in 2021, amounting to \$3.39 (\$3,389,791) million in additional costs.

USAF costs incurred by separation due to BMT fitness failures

The 160 trainees who were ultimately separated following a recycle, incurred additional costs to the USAF (beyond the \$5,380 due to being recycled). Recruiting, medically clearing, and shipping a trainee to BMT costs \$22,898 per recruit, and \$384.33 per day for the 5 1/2 weeks to first fitness failure and additional 2 weeks at BMT awaiting separation paperwork to be finalized (after the 2 week recycle and subsequent repeat fitness failure) (53 days, or \$20,369) plus an average \$300 for airfare home costs the USAF approximately \$43,567 per trainee, or \$6.97 (\$6,970,798) million of additional cost to USAF due to fitness failure without the production of an Airman. Including \$860,899 cost of 2 weeks for recycling for these trainees, these 160 separations in 2021 amounted to around \$7.83 million in spent by the USAF that was not effective in producing an Airman.

Total USAF costs incurred due to BMT fitness failures

In all, fitness failures resulted in \$10.31 million additional costs to BMT operations; this effort (additional 1,580 trainee weeks) yielded just 470 additional USAF Airmen (at an additional cost of \$22,044 per Airman produced).

Discussion:

This reveals an astounding increase in fitness assessment performance (102% increase in pass rate) over a very short period of time (less than a month) as a result of the innovative program, which, based on modern fitness training principles and promoting efficient run and exercise form, is permitting these rapid fitness adaptations despite COVID restrictions. No doubt, a large part of this improvement is familiarization with the component exercises and the proper form and strategy to produce one's best score. Unfortunately, because data regarding fitness results and delays in training and separations due to fitness was not reliably tracked prior to implementation of this program, current results cannot be directly compared to results prior to its implementation. Nevertheless, current excellent results stand on their own, and the program should be shared with other military training and fitness locations so that they may be further studied and replicated.

Improved running without running

Despite not specifically training with endurance running between the initial and third week of training fitness assessment (they had all been instructed on efficient run form in flight gait training), overall pass rates for the 1.5 mile run component increased from 71% to 87%. This demonstrates the value of the program's intention to "prepare trainees to run" over that period of time with gait training and alternative cardiovascular training via interval training. Seeking to improve running performance without running seems to be an effective training strategy and is also believed to reduce common running-related injuries in trainees. Indeed, it is known that resistance and core strength training can improve run times, likely by enhancing running economy and/or increasing lactate threshold (Jung, 2003) (Sato & Mokha, 2009).

Degradation of performance on initial fitness assessment over the year

As 2021 progressed, trainees passed their initial fitness assessment at decreasing rates (46% in Q1, 42% in Q2, 39% in Q3, 37% in Q4), and this seemed to be mostly a reflection of trainees' corresponding worsening performance on the sit-up component of this assessment (60% in Q1, 53% in Q2, 51% in Q3, and 49% in Q4) as other components did not have a trend toward declining pass rates over time. This implies that trainee core fitness on arrival declined over the course of the year since no known changes to the fitness assessment itself changed over this time. Despite this, there was not a noticeable trend toward reduced pass rates on the final assessment over time. This is a testament to the BMT fitness program's success with helping trainees gain requisite fitness capacity despite worsening starting fitness; however, the program's ability to induce requisite fitness gains despite poor arrival fitness may have reached its limit in female trainees in the fourth quarter when female sit-up performance on all fitness assessments was noticeably lower (33% on initial, 59% on 3WOT, and 89% on final) which thus corresponded to lower fitness assessment pass rates (24% on initial, 52% on 3WOT, and 84% on final). With one-third of females arriving unable to complete the requisite number of sit-ups in one minute it is understandable that 4 weeks of training will not be enough for a significant proportion of this unfit group.

It is unknown whether the longitudinal decline in arrival and final fitness assessment pass rates of female trainees documented in this study should be expected to continue into 2022 or if it is related to quarter of the year and so should continue to be studied as conclusions would implicate future readiness and training concerns.

Opportunities to improve

Because the relative impact of specific component of the BMT fitness program cannot be determined by this retrospective study, efforts should be investigated in the future with prospective trials so that the program may be continue to be refined for optimal efficiency. Other areas for improvement would include individualizing training by targeting trainee-specific fitness deficits with specific and modified exercises and training volume and optimizing adaptations via enhanced work-rest ratios, recovery, and nutrition. These variables should be assessed for their effect on BMT performance.

Basic Military Training should continue to monitor fitness results to track recruit fitness upon arrival and success of fitness programs and initiatives. The VIPER Sports Medicine team and 37th Training Wing Human Performance Program intends to maintain its data capture and analysis capabilities so that that training, fitness, and injury results may be further studied and improved upon.

It is noted above that 4-5 weeks of training is prohibitively short for many trainees who present to BMT unfit and unready. Though “recycling” trainees backward in training permits three quarters of these trainees to ultimate graduate BMT, efforts should be made to help recruits better prepare for BMT before coming to JBSA-Lackland as this would improve fitness assessment pass rates and thus on-time graduation rates (2.0% of trainees did not graduate as scheduled due to fitness issues in 2021) and fitness separation rates, thus reducing training and recruiting costs and optimizing the flow of the training pipeline.

Conclusion:

Although the majority of trainees enlisting in the USAF are unable to achieve a passing score upon initial entry, with under 5 weeks of training, remarkable performance improvements and pass rates are achieved by the current USAF BMT fitness program since being implemented in its current form near the end of 2020. Innovatively incorporating modern fitness training principles, mass gait training, and social distancing restrictions, this program should be compared to the fitness programs of other military training programs across the DOD and its components considered for adaptation and further studied and improved upon.

Definitions and abbreviation list:

AT- Athletic Trainer

BMT- Basic Military Training

CIT- Cardiovascular Interval Training

CSCS- Certified Strength and Conditioning Specialist, known as an exercise physiologist in USAF

Medical Hold- Trainees taken out of training until they are healthy enough to return to training

MTI- Military Training Instructor

PT -Physical Training

Recycled- moved back in training, typically 2 weeks

ROM- Restriction of Movement

USAF- US Air Force

VIPER- Versatile Injury Prevention and Embedded Reconditioning

WOT- week of training

References

- 737th Training Group. (2018). *BMT Physical Training Operating Instructions 36-2905*.
- 737th Training Group. (2020). *BMT Physical Training Operating Instructions 36-2905*.
- Air Force Manual (AFMAN). (2020). *Air Force Physical Fitness Program 36-2905*.
- Chalupa, R., Aberle, C., & Johnson, A. (2016). Observed Rates of Lower Extremity Stress Fractures After Implementation of the Army Physical Readiness Training Program at JBSA Fort Sam Houston.
- Gibala, M. J., Gagnon, P. J., & Nindl, B. C. (2015). Military applicability of interval training for health and performance. *29*.
- Jung, A. P. (2003). The impact of resistance training on distance running performance. *33*(7).
- Kasper, K. (2019). *Sports Training Principles*. *18*(4).
- Pope, R. (1999). Prevention of pelvis stress fractures in female army recruits. *164*(370.6).
- Posnakidis, G., Aphasidis, G., Giannaki, C. D., Mougios, V., Aristotelous, P., Samoutis, G., & Bogdanis, G. C. (2020). High-Intensity Functional Training Improves Cardiorespiratory Fitness and Neuromuscular Performance Without Inflammation or Muscle Damage.
- Santtila, M., Pihlainen, K., Viskari, J., & Kyrolainen, H. (2015). Optimal physical training during military basic training period. *29*.
- Sato, K., & Mokha, M. (2009). Does core strength training influence running kinetics, lower-extremity stability, and 5000-M performance in runners? *23*(1).
- Scott, S., Feltwell, D., Knapik, J., Barkley, C., Bullock, S., & Evans, R. (2012). A multiple intervention strategy for reducing femoral neck stress injuries and other serious overuse injuries in U.S. Army Basic Combat Training. *177*(9).
- Sell, T., Abt, J., Nagai, T., Deluzio, J., Lovalekar, M., Wirt, M., & Lephart, S. (2016). The Eagle Tactical Athlete Program Reduces Musculoskeletal Injuries in the 101st Airborne Division (Air Assault). *181*(3).