



AFRL-RH-WP-TR-2021-0013

**Months of Mission-Ready Service:
Refinement of a Criterion Measure for a
Modernized Selection and Classification System**

**Miguel Gonzalez
Natasha Haight
Luisa Martinez**

Operational Technologies Corp

**February 2021
Interim Report**

DISTRIBUTION STATEMENT A. Approved for public release

**AIR FORCE RESEARCH LABORATORY
711TH HUMAN PERFORMANCE WING,
AIRMAN SYSTEMS DIRECTORATE,
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE**

NOTICE AND SIGNATURE PAGE

Using Government drawings, specifications, or other data included in this document for any purpose other than Government procurement does not in any way obligate the U.S. Government. The fact that the Government formulated or supplied the drawings, specifications, or other data does not license the holder or any other person or corporation; or convey any rights or permission to manufacture, use, or sell any patented invention that may relate to them.

This report was cleared for public release by the Air Force Research Laboratory Public Affairs Office and is available to the general public, including foreign nationals. Copies may be obtained from the Defense Technical Information Center (DTIC) (<http://www.dtic.mil>).

AFRL-RH-WP-TR-2021-0013 HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION IN ACCORDANCE WITH ASSIGNED DISTRIBUTION STATEMENT.

//signature//

THOMAS R. CARRETTA, PhD
Work Unit Manager
Performance Optimization Branch
Airman Biosciences Division

//signature//

R. ANDY MCKINLEY, DR-III, PhD
Airman Readiness Optimization CRA
Performance Optimization Branch
Airman Biosciences Division

This report is published in the interest of scientific and technical information exchange, and its publication does not constitute the Government's approval or disapproval of its ideas or findings.

REPORT DOCUMENTATION PAGE					Form Approved OMB No. 0704-0188	
The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.						
1. REPORT DATE (DD-MM-YY) 26-02-21		2. REPORT TYPE Interim		3. DATES COVERED (From - To) 15-06-18 to 26-02-21		
4. TITLE AND SUBTITLE Months of Mission-Ready Service: Refinement of a Criterion Measure for a Modernized Selection and Classification System				5a. CONTRACT NUMBER FA8650-14-D-6500 FA8650-18-F-6828		
				5b. GRANT NUMBER		
				5c. PROGRAM ELEMENT NUMBER 62202F		
6. AUTHOR(S) Miguel Gonzalez, Natasha Haight, & Luisa Martinez				5d. PROJECT NUMBER 5329		
				5e. TASK NUMBER 09		
				5f. WORK UNIT NUMBER H0SA (543909TC)		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Operational Technologies Corporation 4100 N.W Loop 410 Suite 100 San Antonio, Texas 78229				8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Materiel Command Air Force Research Laboratory 711 th Human Performance Wing Airman Systems Directorate Airman Biosciences Division Performance Optimization Branch Wright-Patterson AFB, OH 45433				10. SPONSORING/MONITORING AGENCY ACRONYM(S) 711 HPW/RHBC		
				11. SPONSORING/MONITORING AGENCY REPORT NUMBER(S) AFRL-RH-WP-TR-2021-0013		
12. DISTRIBUTION/AVAILABILITY STATEMENT Distribution Statement A: Approved for public release.						
13. SUPPLEMENTARY NOTES MSC/PA-2021-0103; AFRL-2021-1014, Cleared 7 April 2021 Work performed under subcontract number FPH02-S027, PO 181462. Report contains color.						
14. ABSTRACT Months of Mission-Ready Service (MM-RS) is an indicator of the amount of time in the first four years of service for which an Airman is mission capable. The calculation of MM-RS was updated to standardize it across Air Force Specialties (AFS), and then a series of variables were evaluated to determine if it could be predicted. These variables included aptitude, enlistment demographic, and personality factors. Both Air Force wide and individual AFS data were analyzed. Results indicated that these variables accounted for a small proportion of the variance in MM-RS for the Air Force overall. The best predictors of MM-RS across AFSs were education, term of enlistment, and age. While MM-RS is not a statistically strong criterion, it could be useful for selection and classification and the mitigation of adverse impact.						
15. SUBJECT TERMS Personnel selection, job performance, regression analysis						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT: SAR	18. NUMBER OF PAGES 66	19a. NAME OF RESPONSIBLE PERSON (Monitor) Thomas R. Carretta 19b. TELEPHONE NUMBER (Include Area Code) N/A	
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified				

TABLE OF CONTENTS

Section	Page
LIST OF FIGURES	ii
LIST OF TABLES	ii
LIST OF EQUATIONS	ii
ACKNOWLEDGEMENTS	iii
SUMMARY	1
1.0 INTRODUCTION	2
1.1 Background	2
2.0 APPROACH AND METHODOLOGY	4
2.1 Refining the MM-RS Criterion	4
2.2 Study Sample.....	6
2.3 Predictors.....	7
2.4 Analyses	10
2.4.1. AFS Specific Regressions.....	10
2.4.2. Air Force Wide Regressions	12
2.4.3. TAPAS Regressions.....	12
3.0 RESULTS AND DISCUSSION	14
3.1 Relationship of Individual Predictors and MM-RS _{EFF}	16
3.1.1. ASVAB (MAGE).....	16
3.1.2. Education	17
3.1.3. Age.....	18
3.1.4. Education and Age Interaction.....	18
3.1.5. Enlistment Type	21
3.1.6. Term of Enlistment	24
3.1.7. Accelerated Promotion.....	25
3.1.8. Waiver.....	26
3.1.9. Personality (TAPAS)	27
3.2 Predicting MM-RS	30
3.2.1. Air Force Wide Analyses.....	30
3.2.2. ASVAB Composite Analyses	32
3.2.3. AFS Specific Analyses	33
3.3 Incremental Validity of Personality (TAPAS)	34
3.4 Range Restriction	36
4.0 IMPLICATIONS AND FUTURE DIRECTIONS	38
4.1 Pre- and Post-Enlistment Person Job Match Systems	38
4.2 MM-RS: A Possible Paradigm Shift	39
4.3 A Research Focused Database	40
4.4 Meaningful, Measurable, Practical.....	40
5.0 REFERENCES	41
APPENDIX A – Variable Cleaning and Context	43
APPENDIX B – AFS MAGE Groups	48
APPENDIX C – Descriptive Statistics of Predictors.....	54
APPENDIX D – Age Scatterplot 1T0X1.....	56
APPENDIX E – TAPAS Version and MM-RS _{EFF} Correlations for Select AFSs	57
APPENDIX F – Correlation Table for MM-RS Predictors Except TAPAS	58
LIST OF SYMBOLS, ABBREVIATIONS, AND ACRONYMS.....	59

LIST OF FIGURES

	Page
Figure 1. Conceptual MM-RS.....	5
Figure 2. MM-RS _{WTS} and MM-RS _{EFF} plotted by Length of Training.....	14
Figure 3. Distribution of MM-RS _{EFF} Scores Overall.....	15
Figure 4. MMRS _{EFF} and MAGE Scatterplots	16
Figure 5. MM-RS _{EFF} Distributions by Education	17
Figure 6. MMRS _{EFF} and Age Scatterplot.....	18
Figure 7. Age Trend Lines for Education Categories	20
Figure 8. MM-RS _{EFF} Distributions by Open and General Enlistment.....	22
Figure 9. MM-RS _{EFF} Distributions by Enlistment Type.....	23
Figure 10. MM-RS _{EFF} distributions by TOE	24
Figure 11. MM-RS _{EFF} Distributions by Accelerated Promotion Status	25
Figure 12. MM-RS _{EFF} Distributions by Waiver Status.....	26
Figure 13. MM-RS _{EFF} and Achievement Scatterplots by TAPAS Version.....	28
Figure 14. MM-RS _{EFF} and Non Delinquency Scatterplots by TAPAS Version.....	29
Figure 15. MM-RS _{EFF} and Order Scatterplots by TAPAS Version.....	30

LIST OF TABLES

	Page
Table 1. Predictor Variable Comparison	9
Table 2. Dummy Coding for Regressions.....	11
Table 3. Trend Slopes	19
Table 4. Education Level Slope Contrasts.....	20
Table 5. TAPAS and MM-RS Efficiency Score Correlation.....	27
Table 6. Regression Statistics for Air Force Wide Sample	31
Table 7. Important Predictors for Air Force Wide Sample.....	31
Table 8. Important Predictors ASVAB Requirement Groups	32
Table 9. Regression Statistics for AFSs.....	33
Table 10. Important Predictors for MM-RS	33
Table 11. Important Predictors Across TAPAS Versions	35
Table 12. Regression Development and Hold-Out Sample Replication: TAPAS Included.....	36
Table 13. Changes in <i>R</i> after Corrections for Range Restriction.....	37

LIST OF EQUATIONS

	Page
Equation 1. MM-RS _{WTS} Calculation.....	6
Equation 2. MM-RS _{MAX} Calculation	6
Equation 3. MM-RS _{EFF} Calculation.....	6

ACKNOWLEDGEMENTS

We sincerely thank the following individuals for their valuable contributions to this effort:

C. Wayne Shore, Ph.D.

Daniela Peña

Ken Schwartz

Johnny Weissmuller

Thomas Carretta, Ph.D.

Katie Gunther, Ph.D.

Brian Chasse

Clarence Johnson

John "JJ" Batdorf

Malcolm James Ree, Ph.D.

Sean Robson, Ph.D.

Ben Fairbank, Ph.D.

Darien Wolliston

SUMMARY

Months of Mission-Ready Service (MM-RS) combines the periods that Airmen spend at different skill levels during a fixed period (i.e., four years) as an indicator of their job performance qualifications. The potential benefit of measuring and studying MM-RS is that it could serve as a long-term criterion which could improve the Air Force selection and classification process. The intent of the current study was to assess the usefulness of using data routinely collected data at time of enlistment to predict MM-RS.

The current study is a replication and extension of Halper et al. (2010) with a larger and more current sample. An additional objective was to determine if personality measures can provide incremental validity beyond that provided by the predictors investigated by Halper et al.

The initial goal of a direct replication of Halper et al. (2010) was modified by improvements in the calculation of MM-RS and the unavailability of predictors used in the original study. The data available for the study required extensive cleaning and not all original variables could be satisfactorily salvaged. The calculation of MM-RS also was adapted so that it represented a standardized measure of mission-readiness such that the measures were more comparable across Air Force Specialties (AFSs) than had been possible in earlier studies.

Descriptive and inferential statistics were used to determine the extent to which MM-RS could be predicted by the available variables. Hierarchical regression was used to determine the incremental validity of personality. The regressions were corrected for range restriction. Results indicated that even with range restriction corrections applied, models showed poor goodness-of-fit across AFSs. Personality variables did not contribute to the model's prediction. Despite these findings, MM-RS could provide substantial benefit when applied to a large sample.

Recommendations include using MM-RS as an added consideration for classifying Airmen into positions in which they will be most successful or in which the projected need of the Air Force is greatest. Further recommendations include adjusting the definition of MM-RS so that it focuses on setbacks in career progression instead of qualified time. Such an adjustment should reduce the error variance in the measure and improve its accuracy. Finally, alternative variables may better predict MM-RS, such as attributes commonly measured in the Department of Defense (DoD). Consideration of these predictors has the potential to further enhance the selection and classification of Air Force personnel.

1.0 INTRODUCTION

Improving selection and classification is a continuous process. Efforts to add incremental validity generally consist of modifying or supplementing existing predictors: entrance requirements, tests, and other applicant data that relate to future success. An alternative or supplemental approach is to modify the measure of success: the criterion. Traditionally this success is operationalized as completion of technical training. A comprehensive criterion measure can better determine which predictors are useful. A perfect measure of job success is possible only theoretically, but a challenge remains to identify an assessment that is meaningful, measurable, and which possess practical possibilities for affecting the selection and classification process.

This study investigates a criterion measure of success that has potential to meet all three criteria, referred to as MM-RS. The underlying assumption is that the level of success can be measured by the amount of time spent at higher skill levels. An Airman's time at a 5-skill level can be considered more valuable than time at a 3-skill level, and time at a 3-skill level more valuable than time at a 1-skill level. Quantifying this value results in a measure that is an indicator of mission-readiness, and by extension the potential for increased productivity. A study of the relationship of pre-enlistment applicant data with eventual MM-RS offers an opportunity to investigate MM-RS's ability to provide an improvement to the Air Force selection and classification process. This study continues refinement and evaluation of MM-RS as a meaningful, measurable, and practical criterion.

1.1 Background

In 1982, the RAND Corporation produced a method for measuring the number of months an individual spends during U.S. Army service for which they scored at the "qualified" level on a test of job skills (Armor, Fernandez, Bers, Schwarzbach, Moore, & Cutler, 1982). This measure was named Qualified Man-Months (QMM), and further developed a method used in an unpublished study by Steadment. QMM as defined by Armor et al. (1982) included attrition, training success, and performance on the Army Skill Qualification Test (SQT). The SQT was an objective measure of proficiency in tasks representative of Army jobs. The total QMM for a group was calculated by multiplying the number of individuals who completed Basic and Advanced training by the number of months they remained in service and the pass rates of these individuals on the SQT. Armor et al. calculated QMM for groups of accessions and used it to provide input needed to develop a more refined recruiting and selection strategy.

A later RAND study completed by Fernandez and Garfinkle (1984) combined attrition with scores on the SQT to balance the importance of predictors for each outcome (i.e., while attrition likelihood was predicted by high school graduation, SQT performance was better predicted by scores on military tests). Fernandez and Garfinkle adjusted QMM as the expected number of qualified months of effort an enlistee would contribute so that the measure could be used as a prediction of service rather than solely as an explanatory tool. Fernandez and Garfinkle considered QMM as the probability that a recruit would be in service (after training) and performing at a level above a pass on the SQT in a given month.

The QMM models used by Armor et al. (1982) and Fernandez and Garfinkle (1984) were used as the basis for a similar criterion developed for the Air Force by OpTech: MM-RS (Alley, Pacheco, & Birkelbach, 2007). These researchers noted that the QMM was useful because the data needed to develop it were widely available and easily aggregated, could be related to background factors for recruits, and acted as a summation of the value and tenure of individuals in service.

These were also characteristics that the new measure, MM-RS, possessed. MM-RS included an Airmen's level of technical achievement (i.e., skill level) and attrition in the first term of service. Each skill level was given a weight in accordance with the amount of mission-readiness associated with it. The 1-skill level was weighted at 0, because at this level, Airmen are still in training. The 3-skill level was weighted as 0.5, as Airmen at this level are considered apprentices, but they still provide some productivity. Airmen at the 5-skill level of service were given full weight (i.e., 1.0), as individuals at this level are mission-ready. Alley et al. found significant effects on MM-RS based on aptitude (i.e., scores on the Armed Services Vocational Aptitude Battery; (ASVAB)), age at entry, education, gender, ethnic group, term, type of enlistment, waiver category, and occupational specialty. Models for predicting MM-RS based on these demographic variables were produced, and simulations were run to explore the use of the models in selection and classification.

A later study investigated individual differences influencing MM-RS on a sample expanded to all Air Force recruits for the enlistment start dates ranging from January 2000 to October 2005 (Halper, Goodman, & Alley, 2010). The procedure for calculating MM-RS was refined, and predictive models were produced based on the expanded sample for the AFSs and groups of AFSs. Some of the results from this study differed from past research. For instance, individuals who had not earned a high school diploma prior to accession were found to have higher MM-RS than those that did, a finding inconsistent with other studies (e.g., Hooper, Paullin, Putka, & Strickland, 2008; Knapik, Jones, Huaret, Darakjy, & Piskator, 2004). There were also conflicting findings for age. Both Alley et al. (2007) and Halper et al. (2010) found a positive and roughly linear relationship between age at entry and MM-RS, as opposed to past findings that high and low age extremes had the highest attrition rates (e.g., Fischl & Blackwell, 2000; Hooper, et al., 2008). There were conflicting findings concerning differences between males and females as well (see Alley et al., 2007; Halper et al., 2010; Hooper et al., 2008). Halper et al. theorized the inconsistency in findings between their study and Alley et al. was due to their access to a much larger sample. Inconsistencies across studies could be due to sampling error or real differences across time and settings.

Alley et al. (2007) and Halper et al. (2010) both concluded that MM-RS had potential for use in the Air Force, and proposed implementation. MM-RS has not been used operationally, but the Air Force interest in the criterion measure remains high. As part of the Air Force's Testing Modernization effort, MM-RS was further investigated in the current study, by which its usefulness in a modern sample is assessed.

2.0 APPROACH AND METHODOLOGY

The initial approach was to assess MM-RS by replicating Halper et al. (2010) with a more recent sample. An added objective was to investigate the role of personality as a predictor via the Tailored Adaptive Personality Assessment System (TAPAS), which was administered experimentally to a subset of recruits starting in 2009 before Air Force wide administration which began around 2011. Four dataset files were combined to form a dataset usable for the purpose of the current study. This required additional data cleaning and aggregation efforts because of incompleteness, inconsistencies, and other data flaws. Much of the data missing from the final dataset is the result of a merged dataset created to serve three unrelated studies that contained overlapping variables. The final dataset contained over 200,000 cases and 500 variables.

Despite the extraneous variables, an exact replication of the previous MM-RS study was not possible as some variables could not be located and others were changed to facilitate a better understanding of the relationship between MM-RS and predictors. Halper et al. (2010) investigated whether job assignment influenced MM-RS by including AFS as a predictor in regression analysis, concluding that the relationship between days of training and MM-RS was not impactful. This study makes a refinement in how MM-RS is computed by accounting for the differences between AFSs in amount of time nominally spent in training.

Conceptually, the first four years of an Airman's career can be split into training and qualified job performance, that is, mission-readiness or MM-RS. Time in training (including basic military training) varies from two and a half months to over two years, which given the limited time in which MM-RS can be earned, would necessarily impact MM-RS based on job assignment. Our approach accounted for the wide variability of technical school training times by standardizing the MM-RS metric so that scores could be comparable across jobs.

2.1 Refining the MM-RS Criterion

The core of MM-RS relies on the idea that a person can provide capability, or mission-readiness, to an AFS they are qualified to perform. This qualification is obtained after successful completion of technical training and award of a 3-skill level in an AFS. While trainees are learning, they are not performing, and thus they are not providing any mission-readiness for that specialty. To standardize measurement, MM-RS is calculated for the first 48 months after an individual enters active duty, regardless of their term of enlistment. For this study, the first 48 months of an Airmen's career was divided into four sections: Basic Military Training (BMT), technical training, 3-skill level, and 5-skill level. Credit was awarded for time spent providing readiness. MM-RS is *not* a direct measure of productivity, rather it is the *potential* to perform at a particular level of proficiency. Time spent during BMT and technical training were awarded no points. After graduation from technical training, Airmen start contributing to the readiness of their AFS. However, they are still gaining experience and receiving on-the-job training (OJT). This is reflected by weighting 3-skill level time half as much as 5-skill level time. Adding the weighted 3- and 5-skill level time in months produces MM-RS as calculated in previous studies. The only data needed to calculate MM-RS were entered active duty date, 3- and 5-skill level dates of award, and the date of separation (DOS) or the date 48 months after entering active duty, whichever came first. Figure 1 conceptualizes MM-RS within the first 48 months of an Airmen's career. The gradient present in 3-skill level time acknowledges an Airmen's gradual transition from a purely training role to self-sufficient mission-readiness.



Figure 1. Conceptual MM-RS

MM-RS is constrained to a fixed total amount of time, so any change in length of time for one of the four blocks results in at least one other block being affected. Scheduled technical training length will fluctuate due to curriculum changes and as much as two to three weeks can be added due to holidays in the middle of scheduled training. BMT can also vary from six to eight weeks. In the sample for this study, BMT switched from six to eight weeks in 2009. It is common practice to standardize test scores with z-scores when various assessment measures need to be compared or combined. We ruled out this method of standardizing MM-RS because normative differences exist at the individual level, not the job level. A trainees' efficiency at career progression should be measured against a theoretical perfect version of themselves, that is, a recruit who spends the minimum time in training and the maximum possible time at a 5-skill level.

The speed and efficiency by which Airmen progress through training impacts the amount of time they spend providing mission-ready capability to the Air Force. High MM-RS scores should be indicative of individuals who have the aptitude, personality, and drive to progress through BMT and technical training with minimal recycling through courses and training blocks, as well as timely completion of their Career Development Courses (CDCs) in upgrade training during 3-skill level time. Minimizing time spent in BMT, technical training, and 3-skill level, will maximize an Airman's MM-RS score. We can use this maximum potential MM-RS score (MM-RS_{MAX}) to standardize MM-RS by comparing an Airman's calculated MM-RS score using the weighted equation (MM-RS_{WTS}) to their maximum potential. Dividing MM-RS_{WTS} by MM-RS_{MAX} shows us what percentage of an Airman's potential maximum they were able to achieve. An MM-RS Efficiency Score (MM-RS_{EFF}) indicates their efficiency at advancing through training. The relationships among MM-RS Weighted Score, Max Potential, and Efficiency Score are illustrated in equations 1 through 3.

Equation 1 remains unchanged from previous studies. It is how MM-RS was calculated in Halper et al. (2010). Valuing time in 3-skill level with a 0.5 weight works well enough currently, but leaves room for fine tuning MM-RS, most likely by AFS, in potential future iterations of the criterion. Equation 2 calculates an Airmen's maximum potential MM-RS based on scheduled training times. First-term Airmen must spend 12 months in OJT while qualified as a 3-skill level before upgrading to a 5-skill level. The final step is Equation 3, which divides the actual accrued time by the maximum potential for the efficiency score.

$$MM-RS_{WTS} = \left(\frac{3\text{-skill Level}}{\text{Months}} \right) \left(\frac{3\text{-skill Level}}{\text{Weight}} \right) + \left(\frac{5\text{-skill Level}}{\text{Months}} \right) \quad (1)$$

$$MM-RS_{MAX} = 48 \text{ months} - \left(\frac{\text{BMT} + \text{Technical Training}}{\text{Months}} \right) - \left(\frac{\text{Required OJT}}{\text{Months}} \right) \left(\frac{3\text{-skill Level}}{\text{Weight}} \right) \quad (2)$$

$$MM-RS_{EFF} = \frac{MM-RS_{WTS}}{MM-RS_{MAX}} \quad (3)$$

2.2 Study Sample

Our sample included those individuals with entered active duty dates from 2005 to 2014, giving ample time for Airmen to complete 48 months of service. Prior-service Airmen were excluded from the study, as the prediction formulas would be most useful for first-term Airmen.

Each individual in the dataset was assigned an AFS. Guaranteed Training Enlistment Program (GTEP) recruits were assigned the AFS for which they were contracted. Open AI (Aptitude Indicator) enlistees were assigned their first attempted technical training program. If AFS award and course data suggested a trainee had been reclassified, they were removed. Reclassified trainees could not be assigned to a single AFS, which is required for $MM-RS_{MAX}$ calculation. Assigning the trainee to the first AFS would not have been appropriate, as any theoretical $MM-RS$ earned would be for the reclassified AFS after passing tech training. Assigning the trainee to the reclassified AFS is also inappropriate as the timeframe in which to earn $MM-RS$ is shortened by the reclassification decision. There is no process which would correct for this and estimate the $MM-RS$ that would be earned had the trainee originally been classified in the second AFS.

Any event that would influence $MM-RS$ that was independent of an Airman's competencies or attributes would disqualify that case from inclusion in the study. Some cases had unusually long stretches of time between entering active duty and their BMT start date. Any case with more than 21 days was removed from the study. Only a portion of the dataset had BMT information so this could not be done for every case.

Individuals who did not complete at least 48 months of service were removed as well. While some cases showed separation dates prior to the 48 month after the entered active duty date cutoff, there were no variables in data available to us that could inform the reason for separation. With no way to identify valid separation reasons potentially related to our predictors (e.g., behavioral or performance based) from reasons beyond an Airman's control (e.g., military hardship, convenience of the government) all cases with early separations were eliminated.

A portion of the cases contained information about technical school training course performance. Trainees with failure codes associated with events beyond an Airman's control (e.g., medical reasons) were removed from the dataset.

The 2019 October version of the Air Force Enlisted Classification Directory (AFECD) was consulted to remove Air Force Specialty Codes (AFSCs) that were no longer in use. We did not track old AFSCs that had been merged into newly created specialties because the transitional period of technical training curriculum and changing job duties had the potential to suppress our findings with AFS-specific regression equations. Only those cases with current AFS codes from start to finish through their career progression were kept for analysis.

Cases were removed if they had inconsistencies in the necessary dates for MM-RS_{WTS} calculation. These inconsistencies were commonly 3-skill level dates of award that occurred at the same time as BMT completion dates, 5-skill level dates that occurred at the same time as 3-skill level dates, and 5-skill level dates that were not at least 12 months after 3-skill level dates. If researchers could not be certain the dates present in an Airman's career progression were within reasonable limits, the case was removed from the study.

The dataset contained 129,439 cases after all disqualifying criteria were applied on the original study file. Remaining was a collection of AFS samples that were current and comprised of Airmen who passed the first technical training course they attempted. Every effort was made to be reasonably sure variance in career progression for every Airman in the sample was due to individual differences in recycling through BMT, progressing through technical training blocks, and time spent upgrading from 3- to 5-skill level. Unfortunately, the variance due to attrition from early separation was not able to be captured because of missing information on the cause of attrition.

2.3 Predictors

Because of the combination of multiple study file data requests, most predictor variables had many repeat instances in the final dataset. These instances were collapsed and reconciled into a single usable variable. If the data from multiple sources were inconsistent or ambiguous and could not be collapsed successfully, data for that case was considered missing and deleted. The coding of most variables were changed from previous studies to improve our understanding of how predictors affected MM-RS. This contributed to the impossibility of establishing a direct replication of previous studies.

The ASVAB composite variables were the only predictors to remain substantially unchanged from previous studies. Scores are updated within some sources so testing dates were used to establish the earliest scores. Every effort was made to retain scores that would likely have been available to recruiters at time of enlistment.

The Education predictor variable was made more meaningful by examining the effect of completion of any post-secondary education. The current study distinguished those who attended higher education from those that completed a higher education program, while Halper et al. (2010) combined these two groups into one. Completion of a program could be the attainment of an Associate's, Bachelor's, Master's, Doctorate, or any other professional certification.

Age at time of enlistment was kept as a continuous variable instead of being converted to categorical as in Halper et al. (2010). Halper et al. recoded age to account for nonlinear relationships between age and MM-RS. Preliminary analysis of age with MM-RS_{EFF} in our sample showed a linear relationship so there was no need to recode.

The previous Enlistment Type variable was a composite of multiple characteristics (i.e., GTEP, Open AI designations, Term of Enlistment, Bonus status) that was split into its constituent parts for the current study. GTEP and Open AI designations were retained as the Enlistment Type variable.

Term of Enlistment (TOE) was pulled out of the Halper et al. (2010) Enlistment Type variable but retained the four- and six-year enlistment categories. TOE variables appeared multiple times in the dataset and were difficult to collapse into one usable predictor. First-term selections could be overwritten by re-enlistments and contract extensions with no discernable pattern in the different sources. Slightly more than 20 percent (%) of TOE data were deleted due to ambiguity over which selection would have been available at time of enlistment when prediction equations would be most useful.

Instead of being included with Enlistment Type, as in Alley et al. (2010), Accelerated Promotion was formed into its own variable. It was recoded and reconciled from the Enlistment Option variables.

Two separate variables record data for delayed enlistment program (DEP) and Accession Waivers. It was established that the current data could not be used to analyze Waiver Type as in the previous study, and that, at most, the level of specificity achievable was limited to whether a recruit had received any waiver or none at all.

Personality was assessed using the TAPAS, administered operationally at Military Entrance Processing Stations (MEPS). The TAPAS has 21 facets that have been administered in different combinations over five different versions. The TAPAS test developers advised the Air Force not to combine the same facets from different versions for analysis. We deferred to the original developers' expertise and analyzed facets by version. Nevertheless, unless there is a serious flaw in the construct definition or test development, we assume there is a strong relationship between measures between two versions that share the same construct name.

The requirements of the study explicitly excluded analyses by gender and race/ethnicity. Information about signing bonus was never located and so it could not be used as a variable in the study.

Table 1 shows a comparison of predictor variables used in Halper et al. (2010) and the current study. More detailed information for all variables can be found in Appendix A.

Table 1. Predictor Variable Comparison

	Halper et al. (2010)		Current Study	
	Variable	Levels	Variable	Levels
Aptitude	ASVAB	Mechanical	ASVAB	Mechanical
		Administrative		Administrative
		General		General
		Electronics		Electronics
	Education	Less than High School	Education	Less than High School
		Alternate High School Certificate		Alternate High School Certificate
		High School Diploma		High School Diploma
		More than High School		Some College
				College Degree or Professional Certificate
Enlistment Demographics	Age at time of Enlistment	Discrete categories 17 to 28 years with final category 29+	Age at time of Enlistment	Continuous Variable
	Enlistment Type	GTEP, 4yr TOE, Bonus	Enlistment Type	GTEP
		GTEP, 4yr TOE, No Bonus		Open AI
		Open AI, 4yr TOE, No Bonus	Term of Enlistment	6 year
		GTEP, 6yr TOE, Bonus, Accelerated Promotion		4 year
		GTEP, 6yr TOE, No Bonus, Accelerated Promotion	Accelerated Promotion	Yes
				No
			Bonus	A suitable variable was never located
	Waivers	Number of Dependents	Waivers	Any waiver(s)
		Mental		
		Physical		No waivers
		Moral		
		Other Waiver		
		No Waiver		
	AFSC	Coded based on recorded 5 level CAFSC or 3 level CAFSC	None	
Personality	None		TAPAS	21 Facets from 5 different versions
Demographics	Gender	Male	None	
		Female		
	Race/Ethnicity	Hispanic	None	
		Asian		
		African-American		
		Caucasian		
		Other		

Note: CAFSC = Control Air Force Specialty Code

2.4 Analyses

Analysis of the assembled dataset started with investigations of each predictor's relationship with MM-RS_{EFF}. Descriptive statistics, correlations, and visual inspection of scatter plots were utilized for analyses. Welch's 2-sample *t*-tests (Welch, 1947) were conducted to compare the differences in mean MM-RS_{EFF} among the following predictors: Enlistment Type, TOE, Accelerated Promotion, and Waiver. Welch's *t*-test assumes unequal variances among the samples so was deemed most appropriate.

Regression analysis was used to determine whether the variables ASVAB composite, Education, Age, Enlistment Type, TOE, Accelerated Promotion, and Waiver could predict MM-RS_{EFF} both Air Force wide and at the AFS level. TAPAS scores were used to assess the incremental validity of personality in predicting MM-RS_{EFF} Air Force wide and for groups of AFSs with the same ASVAB MAGE (Mechanical, Administrative, General, and Electronics) area requirement.

2.4.1. AFS Specific Regressions

To address whether MM-RS_{EFF} can be predicted for individual AFSs, regression models were calculated for each AFS for which 100 or more cases were available. Regressions were also conducted for jobs grouped by MAGE area requirement. A list of the AFS groups used in this study can be found in Appendix B. Table B-2 provides detailed results of the regression analyses by AFS. Linear multiple regression was used to produce prediction models. The forced entry regression method in SPSS was used for predictors: ASVAB, Education, Age, Enlistment Type, Term of Enlistment, Accelerated Promotion, and Waiver. Except for ASVAB and Age, variables were dummy coded. Table 2 presents variable coding structure for each level. Education and Enlistment Type had more than two levels each, requiring that a level for each be chosen as the reference in each so that they could be dummy coded for regression analysis. For Education, high school diploma was designated as the reference variable because it was the largest across the sample. For Enlistment Type, GTEP was designated as the reference variable because it represents a natural comparison to the Open AI enlistment types.

Table 2. Dummy Coding for Regressions

Variable		Coding	
	Categories	0	1
Education	HSL	Not HSL	Yes HSL
	HSA	Not HSA	Yes HSA
	SC	Not SC	Yes SC
	CD	Not CD	Yes CD
	HSD	-	-
Enlistment Type	OPM	Not OPM	Yes OPM
	OPG	Not OPG	Yes OPG
	OPE	Not OPE	Yes OPE
	OPA	Not OPA	Yes OPA
	GTEP	-	-
TOE	-	4-year	6-year
Acc Prom	-	Not Accelerated	Yes Accelerated
Waiver	-	No Waivers	Any Waiver(s)

Note: HSL = less than high school diploma; HSA = alternative high school diploma; HSD = high school diploma; SC = some college; CD = college degree; OPM = open mechanical; OPG = open general; OPE = open electronics; OPA = open administrative; GTEP = guaranteed training enlistment program; TOE = term of enlistment; Acc Prom = accelerated promotion.

Since we expected that not all of these variables would contribute to the final model, reduced models were produced in addition to full regression models. Backward entry aided in determining which predictors were not substantially contributing to the model. Backward entry in SPSS is a stepwise method that initially computes a model with all variables, and then removes variables that contribute least to the model one at a time. This method of regression modeling allows the researcher to determine if variables that are not significant in the full model are important predictors when other variables are not included.

Backward entry also aids in dealing with multicollinearity issues present in ASVAB composite MAGE variables. The MAGE composites include overlapping subtests which results in high and unavoidable multicollinearity. These issues do not impact the fit of the overall model, but they do impact the magnitude and direction of coefficients for the collinear variables. Because of this, it was deemed acceptable to include all MAGE variables in the full regression models. For reduced models, only the MAGE variable with the highest standardized coefficient was kept. Stepwise methods can be used to aid in this selection (Herzberg, 1969). Multicollinearity was low among the other variables. MAGE composites were also excluded from the reduced equation if they were found to have a negative correlation with MM-RS_{EFF} that remained negative when all other predictors were controlled.

A concern when using stepwise methods is that the final reduced model reports *p* values that are too low. Because stepwise methods allow the computer to decide which predictors are retained, it depends on qualities of the specific sample instead of theory. The operations of stepwise regression also deflate *p* values through repeated significance testing (Whittingham, Stephens,

Bradbury, & Freckleton, 2006). This creates models that do not generalize well and include unimportant predictors (Smith, 2018). Cautions were taken to reduce the risks of stepwise regressions. First, almost all the full models were highly statistically significant, which reduces the risk of Type I error in the reduced equations. Out of 107 regressions, 7 were not statistically significant. Further, the final model produced by stepwise methods was not accepted as the final regression equation; it was merely used as a source of information. Zero-order correlations between the predictors and criterion, coefficients significant in the full model, and adjusted coefficient of multiple determination (R^2) values were also considered when identifying important predictors. Using zero-order correlations in conjunction with stepwise regressions and not allowing the final model to be selected by the statistics program are some of the recommendations for effective stepwise use (Thayer, 2002). Finally, backward regression was used instead of alternate methods that start with the constant and add in variables one at a time. The backward method avoids suppressor effects, where variables are overlooked if they are only significant when other predictors are controlled. Roecker (1991) claimed that stepwise approaches are reasonable when the goal is to produce parsimonious and predictive models.

Both the full and reduced regressions were corrected for range restriction using Lawley's (1943) multivariate correction. This method allows for simultaneous correction of direct selection on multiple variables and indirect selection on others. In the current sample, direct selection occurred on the ASVAB composites. In addition to the direct and indirect range restriction from selection on ASVAB composites, an unknown amount of range restriction was also produced during data cleaning. Many cases had to be discarded due to uncertainty of the accuracy of the dates required for MM-RS_{WTS} calculation as well as technical training failures resulting in reclassification events and those who separated prior to 48 months after entering active duty. The necessary data to perform corrections for this restriction were unavailable, so corrections for this undefined range restriction were impossible to calculate or even estimate reliably.

2.4.2. Air Force Wide Regressions

To address whether MM-RS_{EFF} can be predicted by routinely collected variables, Air Force wide, regressions were conducted using the full sample. Regression models were developed on a stratified random half of the sample ($N = 40,140$) and confirmed on the other half ($N = 40,366$). Half of each AFS was sampled randomly from the full dataset and assigned to the development sample with the remainder making up the hold-out sample. One of the samples is slightly larger because the halves were delineated by the rank of a randomly assigned integer; greater than 50% or lower or equal to 50%. The two samples had very similar MM-RS_{EFF} means (Development = 79.41; Hold-out = 79.38) and standard deviations (Development = 8.07; Hold-out = 8.09). The use of a hold-out sample helps model how well results may generalize to the population of recruits, adding confidence to the conclusions based on our results.

2.4.3. TAPAS Regressions

To address whether personality can incrementally predict MM-RS_{EFF} over the existing variables, hierarchical regressions were conducted with TAPAS facets. The sample sizes for each TAPAS version were too small to conduct hierarchical regressions for each AFS (i.e., most AFSs had $n < 100$ in all TAPAS versions). To overcome this obstacle, AFSs were grouped by MAGE composite area, with regression analysis conducted using each TAPAS version with at least 100 cases in the four MAGE group samples. Appendix B reports the MAGE groupings. Using this method, adequate sample sizes were available for each cross section of MAGE requirement and

TAPAS version except TAPAS version 3. TAPAS version 3 had an $n < 100$ for all MAGE composite area groupings. The smallest sample size for regression analysis was $n = 171$ for individuals with A composite jobs who took the TAPAS version 8. The regression procedure mirrored individual AFS regression analysis, except hierarchical regression was employed for the full equations. All predictors other than the TAPAS facets were included in the first step of the regression, and all facets in a TAPAS version were included in the second step.

Development and hold-out samples were also used for each TAPAS version. The regression model was developed in the first half of the sample for all individuals who took a given TAPAS version and confirmed on the other half. The TAPAS facets appearing in both development and hold-out samples provides further information on the effectiveness of personality adding incremental validity to the predictive models.

3.0 RESULTS AND DISCUSSION

We first evaluated the effectiveness of MM-RS_{EFF} at removing the effect of training months on MM-RS. Figure 2 shows the unstandardized MM-RS_{WTS} in the scatterplot on the left in comparison to the standardized MM-RS_{EFF} scatterplot on the right. MM-RS_{EFF} was successful in removing the effect of training length on MM-RS for those jobs with less than 15 months of scheduled training (BMT and technical training combined). Data points at the far right hand side of the graph are all a part of the 1Z1X1 (Pararescue) AFS. Because of the two-year training time only a few trainees upgraded to a 5-skill level prior to 48 months after entering active duty. More experimentation is needed to determine the best method for standardizing specialties with very long training times. Because 1Z1X1 was an outlier in the dataset, we calculated the overall and ASVAB composite area equations both with and without it. 1Z1X1 did not change the test statistics, so it was excluded in the final reported regressions.

The AFS with the next lowest MM-RS_{EFF} was Airborne Intelligence Surveillance and Reconnaissance Operator (1A8X2; $M = 67.79$) then Airborne Missions Systems Specialist (1A3X1; $M = 72.87$). The AFS with the highest MM-RS_{EFF} was Cardiopulmonary Laboratory (4H0X1; $M = 86.48$). The average MM-RS_{EFF} was 79.47.

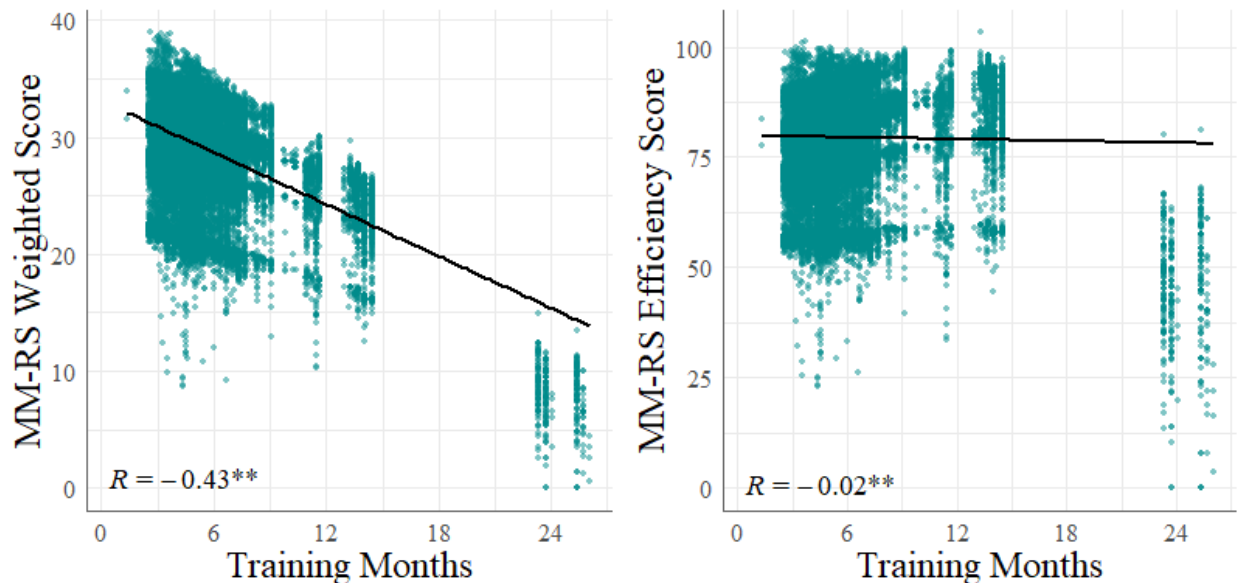


Figure 2. MM-RS_{WTS} and MM-RS_{EFF} plotted by Length of Training

Figure 3 shows the distribution of MM-RS_{EFF} across the entire sample. There are four noticeable peaks in the data at 57, 73, 82, and 90 MM-RS_{EFF}. The lowest peak at 57 sees Airmen spending most of their time qualified at a 3-skill level. Below a score of 60, 94% of Airmen do not upgrade to a 5-skill level within the first 48 months after entering active duty. The remaining peaks correspond to Airmen upgrading to a 5-skill level in six-month increments; 30 months, 24 months, and 18 months for 73, 82, and 90 MM-RS_{EFF} respectively. While the peaks are not wholly comprised of these upgrade training times, they are most prevalent.

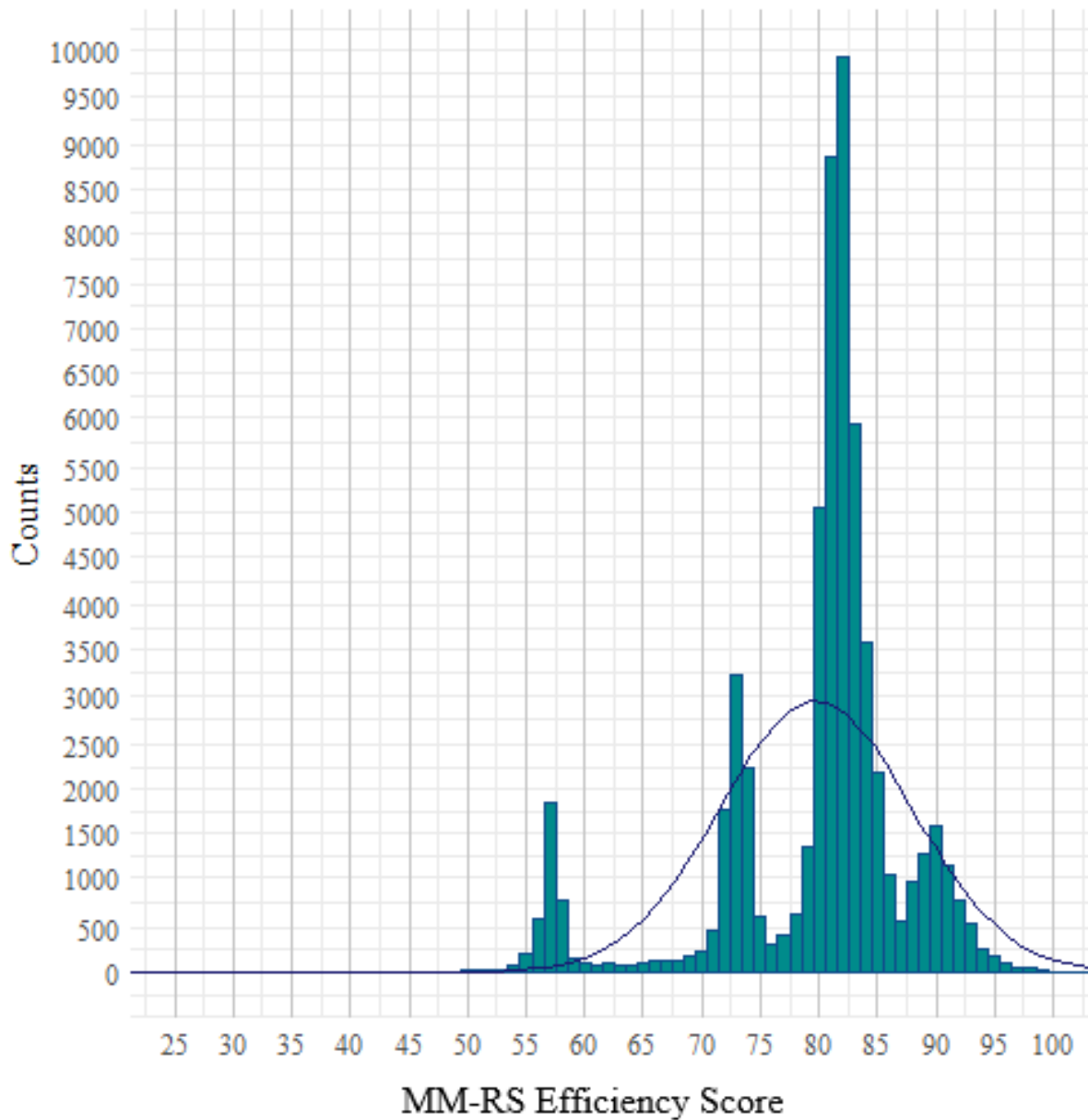


Figure 3. Distribution of MM-RS_{EFF} Scores Overall

3.1 Relationship of Individual Predictors and MM-RS_{EFF}

3.1.1. ASVAB (MAGE)

Figure 4 shows scatterplots, correlations, and lines of best fit between MM-RS_{EFF} and each ASVAB composite. Correlations for all were low but statistically significant ($p < .01$). When corrected for range restriction, these correlation coefficients improved, but not drastically ($M = .08$, $A = .10$, $G = .09$, $E = .09$). The apparent vertical gaps in the scatterplots are an artifact of the unobtainable percentile MAGE composite scores.

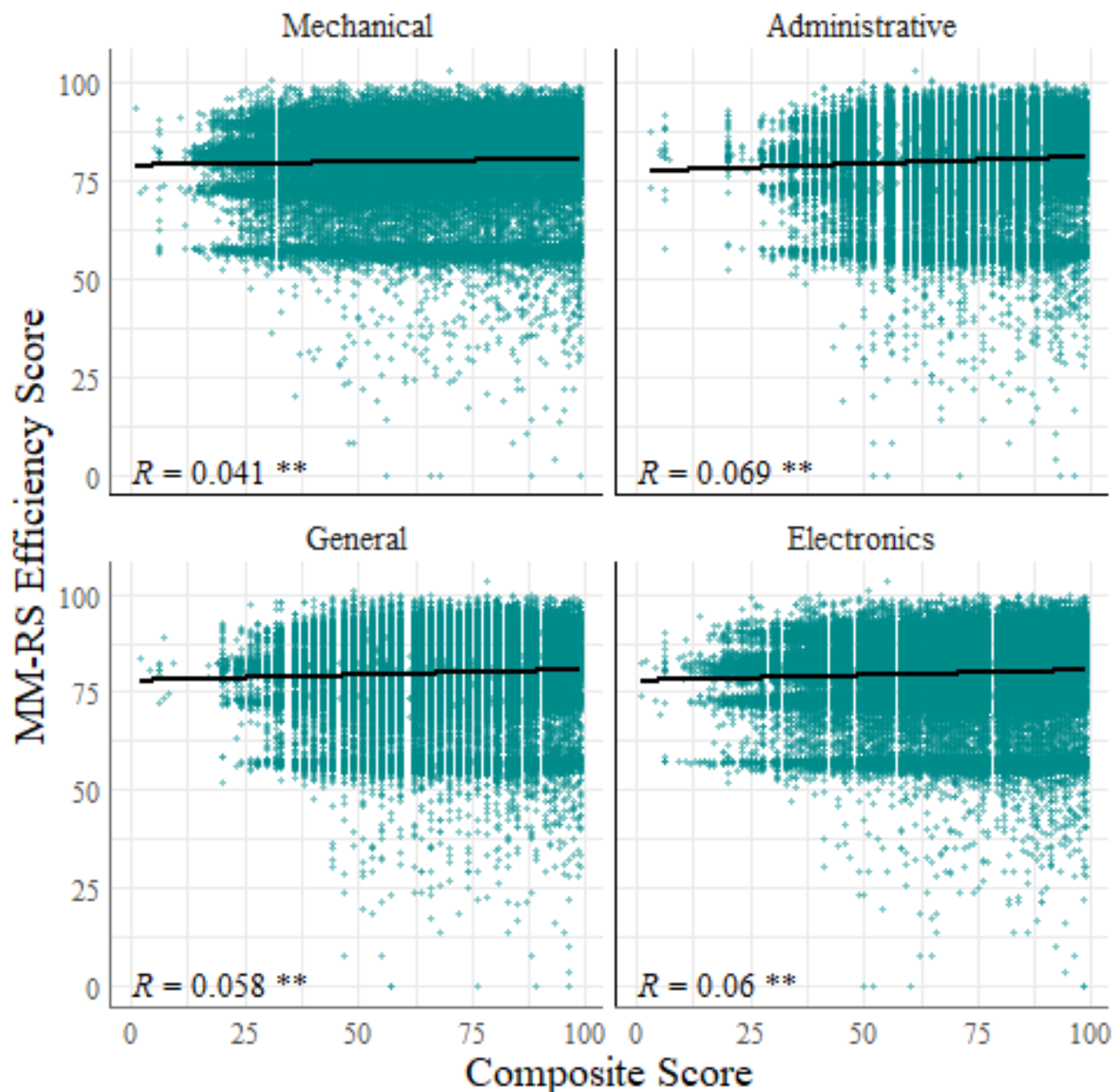


Figure 4. MMRS_{EFF} and MAGE Scatterplots

3.1.2. Education

Differences were observed in $MMRS_{EFF}$ between Education levels with the College Degree or Professional Certificate (CD) group having higher scores on average. The placement of peaks shown in Figure 5 indicate the majority of the CD group completed upgrade training to a 5-skill level in 24 months or less. All other groups had the expected peak at 73 $MM-RS_{EFF}$ indicating some Airmen spending at least 30 months in a 3-skill level. Levene's test of homogeneity of variance indicated that the variances in the Education categories differed significantly, $F(4,120624) = 12.655, p < .001$, so a Welch's F was most appropriate. The Welch's F test revealed a significant difference among mean $MM-RS_{EFF}$ across education levels $F(4, 5481.7) = 259.75, p < .001$. Full descriptive statistics can be found in the Appendix Table C-2.

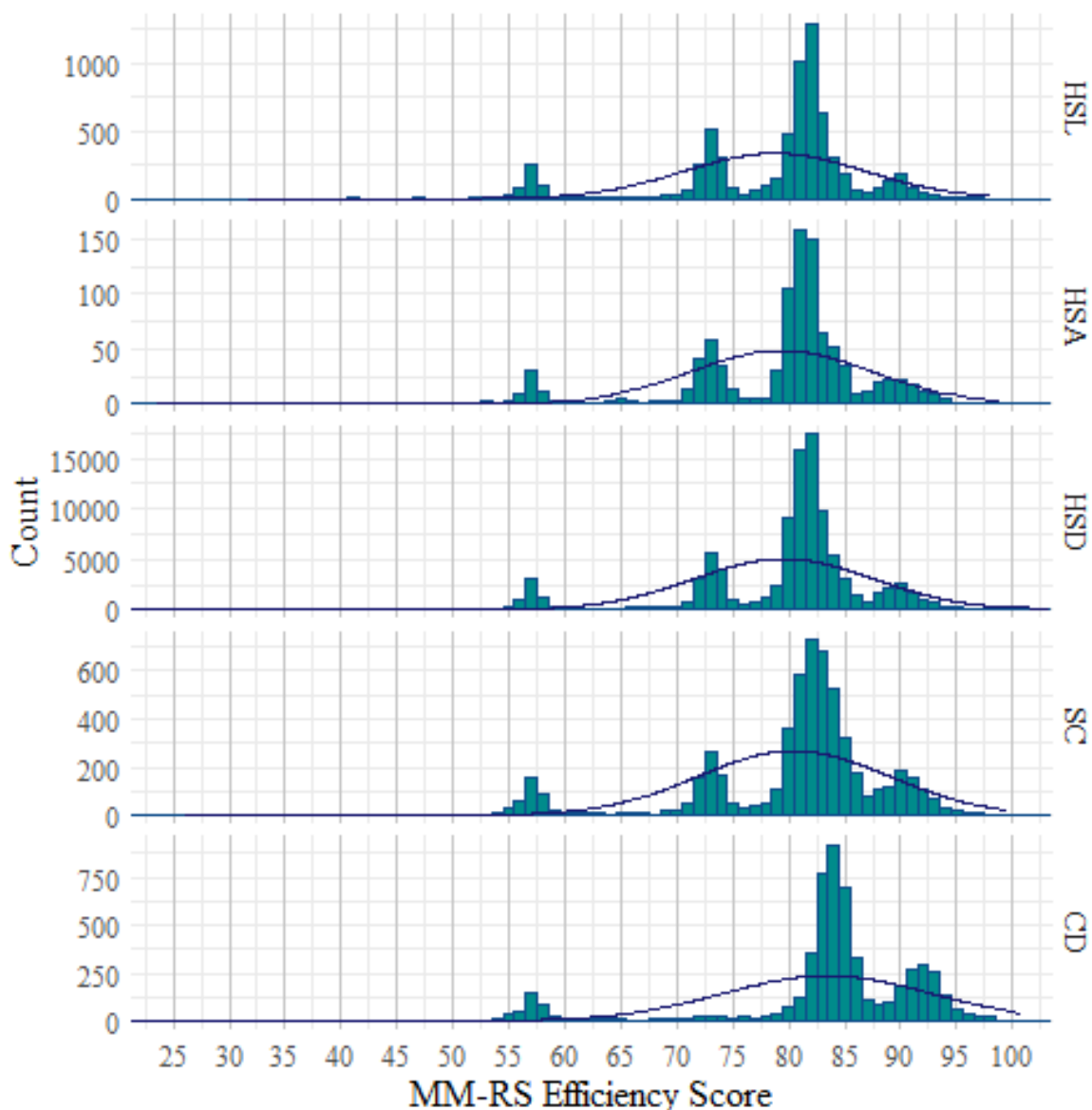


Figure 5. $MM-RS_{EFF}$ Distributions by Education

3.1.3. Age

Figure 6 shows the linear relationship between MM-RS_{EFF} and Age. The correlation is statistically significant ($p < .01$) but has a low effect size ($R = .11$).

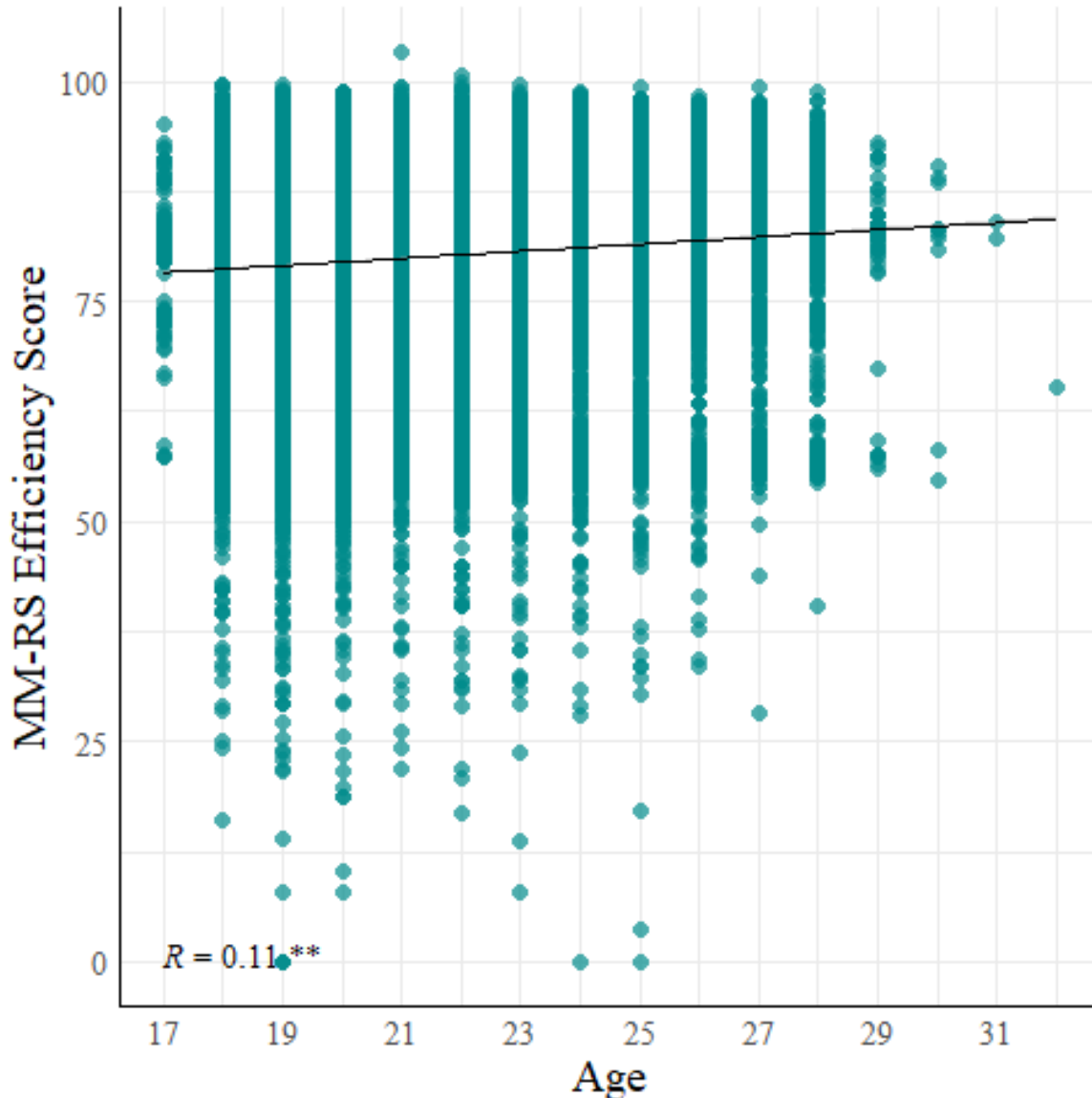


Figure 6. MMRS_{EFF} and Age Scatterplot

3.1.4. Education and Age Interaction

Whether the variance in MM-RS_{EFF} for different Education levels may be partially attributed to age was explored, as age naturally increases with increasing Education (Appendix Table C-1). A multiple regression analysis with Education as the categorical independent variable

and Age as a continuous independent variable was conducted. The significant model reflected a difference between the Education categories.

The criterion variable of MM-RS_{EFF} was significantly related to Age, $F(1,120619) = 81.06$ $p < .001$, and Education $F(4,120619) = 9.63$, $p < .001$. A significant interaction between Age and Education was also present in the model, $F(4,120619) = 4.75$, $p < .001$, indicating that the effect of Age in MM-RS_{EFF} is different among the Education categories. The overall model including just Education and Age predicted 1.7% of the variance associated with MM-RS_{EFF} ($R^2 = .0168$).

The results from these analyses suggested that Age affects MM-RS_{EFF} differently depending on Education level. Estimated marginal means of slope trends were computed to compare the slope of Age trend over the Education categories. Confirming the results of the interaction, this comparison found that alternative high school diploma (HSA) has the steepest slope, followed by some college (SC) and high school diploma (HSD; see Table 3).

Table 3. Trend Slopes

Education Level	Age Trend	SE	95%CI
HSL	0.21	0.09	0.03 - 0.40
HSA	0.48	0.11	0.26 - 0.69
HSD	0.32	0.01	0.29 - 0.34
SC	0.36	0.05	0.26 - 0.46
CD	0.11	0.05	0.004 - 0.21

Note: HSL = less than high school diploma; HSA = alternative high school diploma; HSD = high school diploma; SC = some college; CD = college degree or professional certificate

Figure 7 represents the relationship of MM-RS with Age for each of the education levels. Contrasts of the slope trends indicate significant differences of the CD slope compared to the HSA, HSD, and SC slopes, with these trends being larger than the CD slope (see Table 4). Although there is a visible difference among trend lines for SC, HSD, and HSL in Figure 7, the differences among these slopes are not significant (see Table 4).

Airmen with college degrees or other professional certifications had high MM-RS_{EFF} regardless of their age. High school graduates (with traditional diplomas or some alternative) and those who attended some college had moderate levels of MM-RS_{EFF} which increased sharply the older they were at time of enlistment. Those with less than a high school education tended to have lower MM-RS_{EFF} even as age increased.

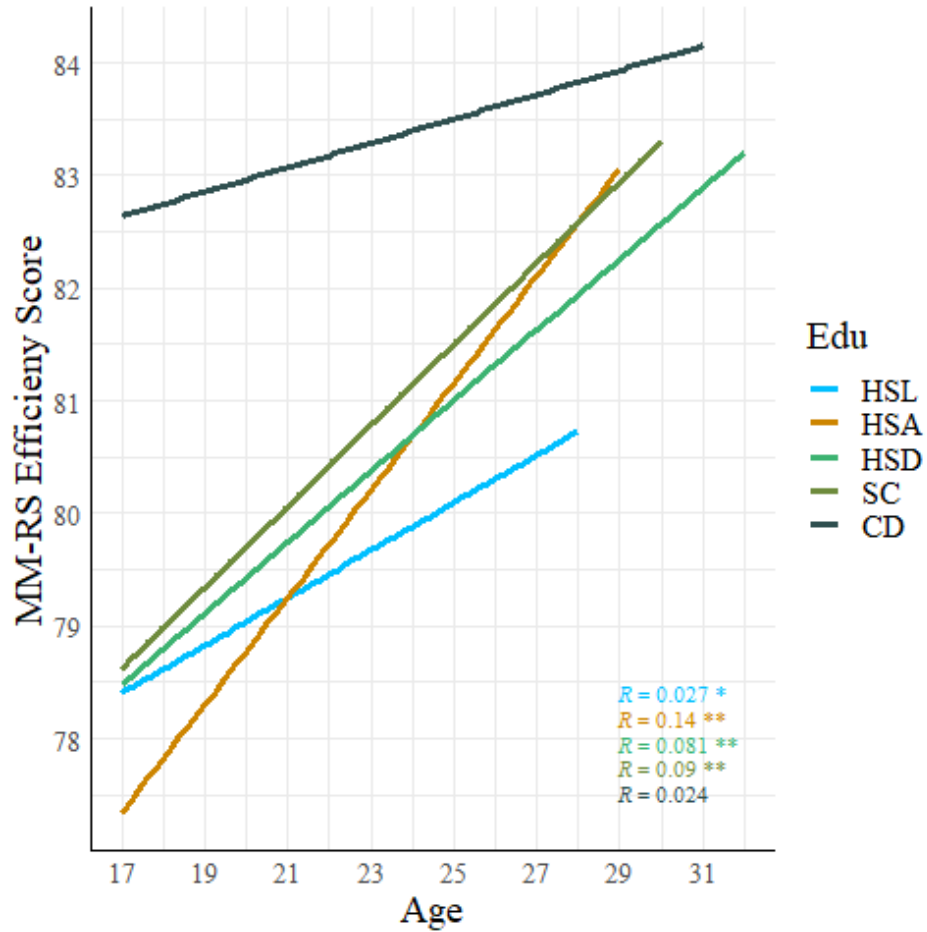


Figure 7. Age Trend Lines for Education Categories

Table 4. Education Level Slope Contrasts

Contrast	Estimate	SE	t-ratio	significance
HSA - CD	0.37	0.12	3.00	0.023
HSA - HSD	0.16	0.11	1.45	0.60
HSA - SC	0.12	0.12	0.95	0.88
HSD - CD	0.21	0.05	3.80	<0.01
HSD - SC	-0.05	0.05	-0.88	0.90
HSL - CD	0.10	0.11	0.95	0.88
HSL - HSA	-0.26	0.15	-1.82	0.36
HSL - HSD	-0.10	0.10	-1.08	0.81
HSL - SC	-0.15	0.11	-1.39	0.063
SC - CD	0.25	0.07	3.46	<0.01

Note: HSL = high school diploma; HSA = alternative high school diploma; HSD = high school diploma; SC = some college; CD = college degree or professional certificate

3.1.5. Enlistment Type

Figure 8 shows that the distributions for GTEP and Open AI enlistments are nearly identical. We also investigated the differences in MM-RS_{EFF} within Open AI enlistments by identifying the specific MAGE composite area for Airmen. A Welch's one-way analysis of variance (ANOVA) of MM-RS_{EFF} on the expanded five levels of Enlistment Type revealed a statistically significant main effect, Welch's $F(4,14999) = 67.56, p < .001$, indicating differences in mean MM-RS_{EFF} among the Enlistment Types. The effect size for this analysis ($\omega^2 = .002$) suggests Enlistment Type explains only 0.2% of the variance. Games-Howell post-hoc comparisons revealed that all except three pairs had significant differences in mean MM-RS_{EFF}. Figure 9 shows the distributions of all five levels. The non-significant differences were found between Open M compared to Open A, Open M compared to GTEP, and Open A compared to GTEP. Full descriptive statistics can be found in the Appendix Table C-3.

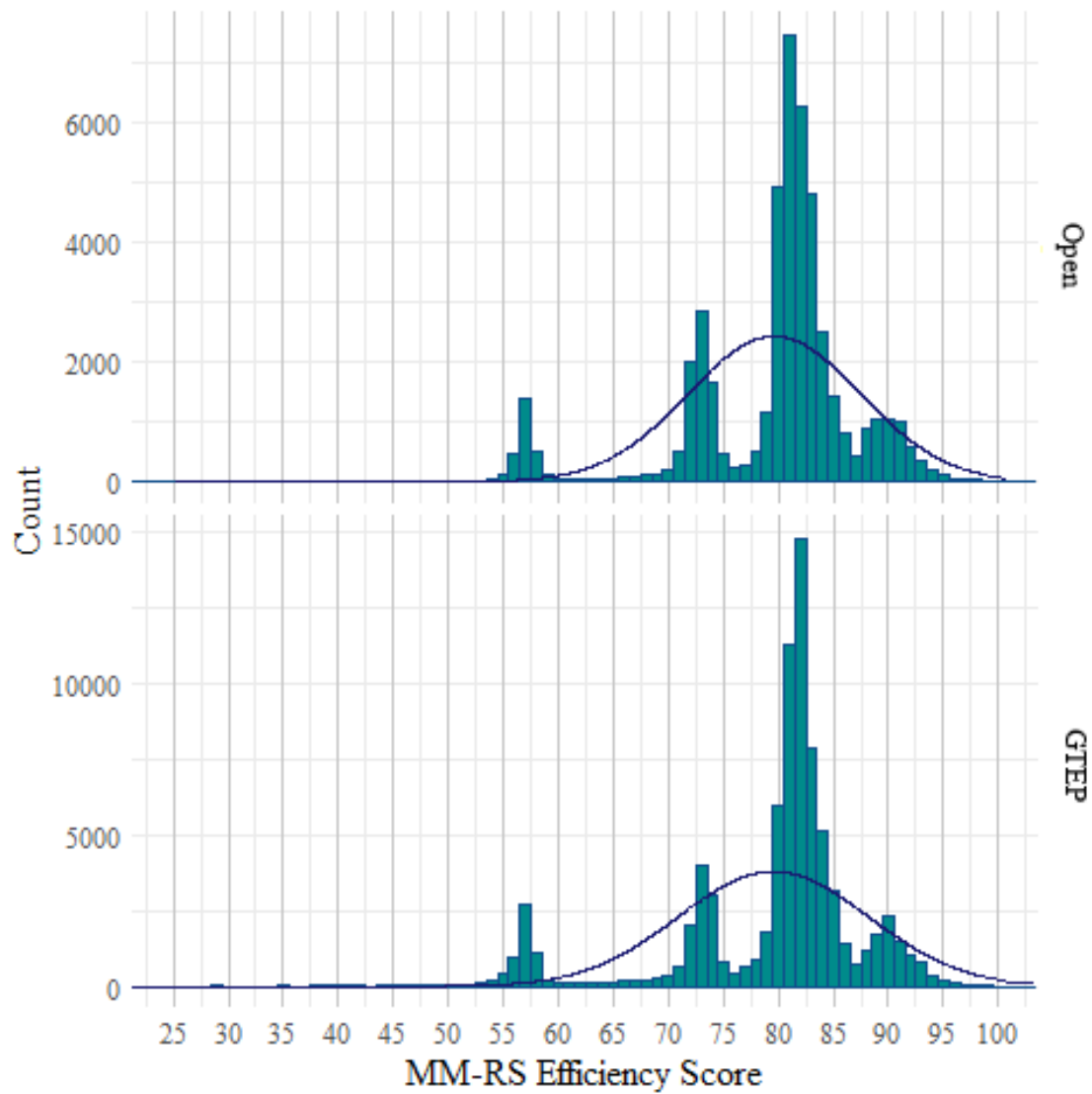


Figure 8. MM-RS_{EFF} Distributions by Open and General Enlistment

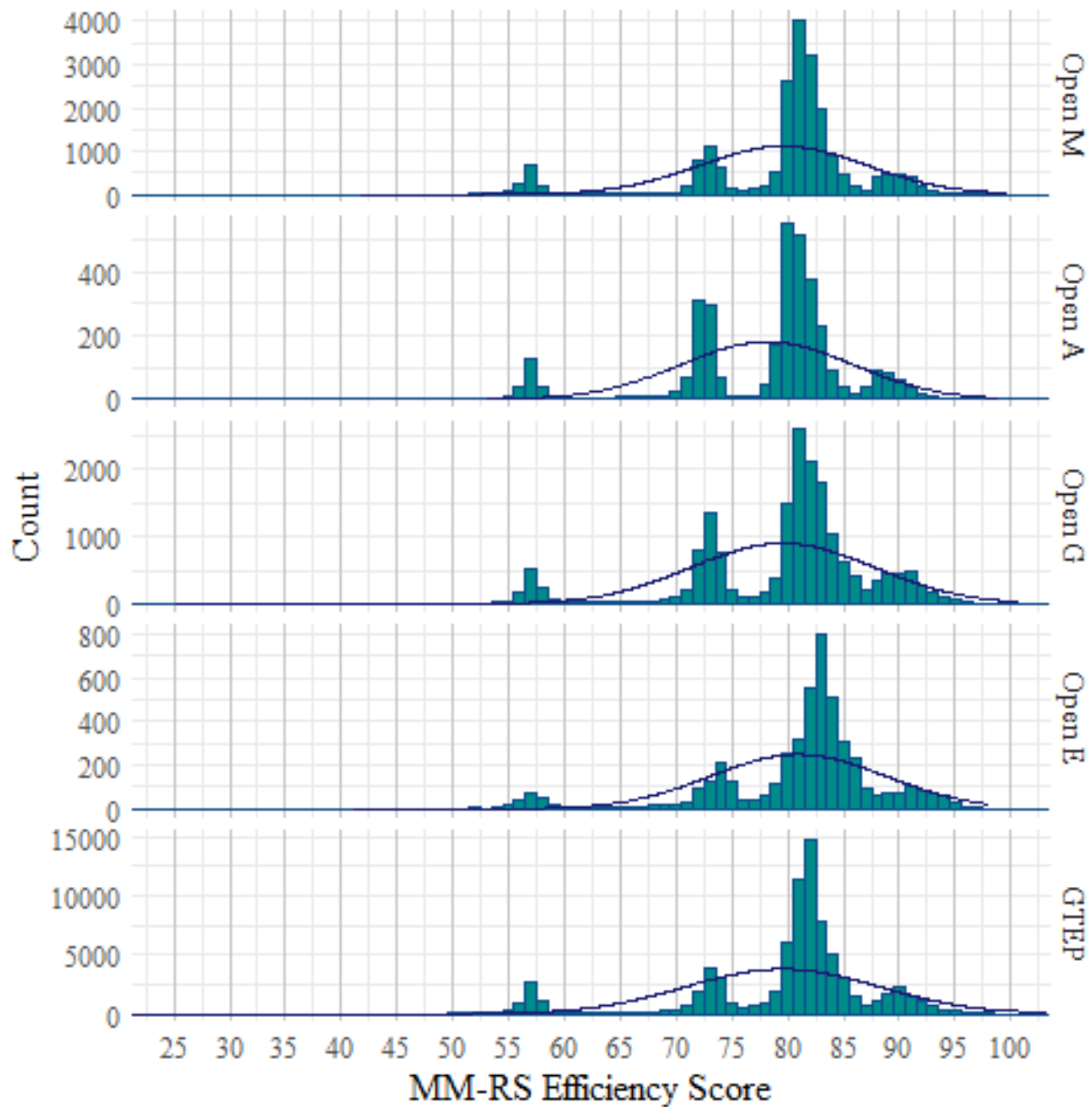


Figure 9. MM-RS_{EFF} Distributions by Enlistment Type

3.1.6. Term of Enlistment

Airmen with four-year TOEs had lower MM-RS_{EFF} than those with six-year TOEs (see Figure 10). Placement of the peaks suggests most six-year enlistees upgrade to a 5-skill level in 24 months or less, while most four-year enlistees spend much more time in 3-skill level at 30 months. A Welch's *t*-test showed that individuals with a six-year TOE had significantly higher MM-RS_{EFF}, $t(69659) = -69.602, p < .001$, than those with a four-year enlistment. The effect size of this analysis suggests a moderate effect ($d = -.460$). Full descriptive statistics can be found in the Appendix Table C-4.

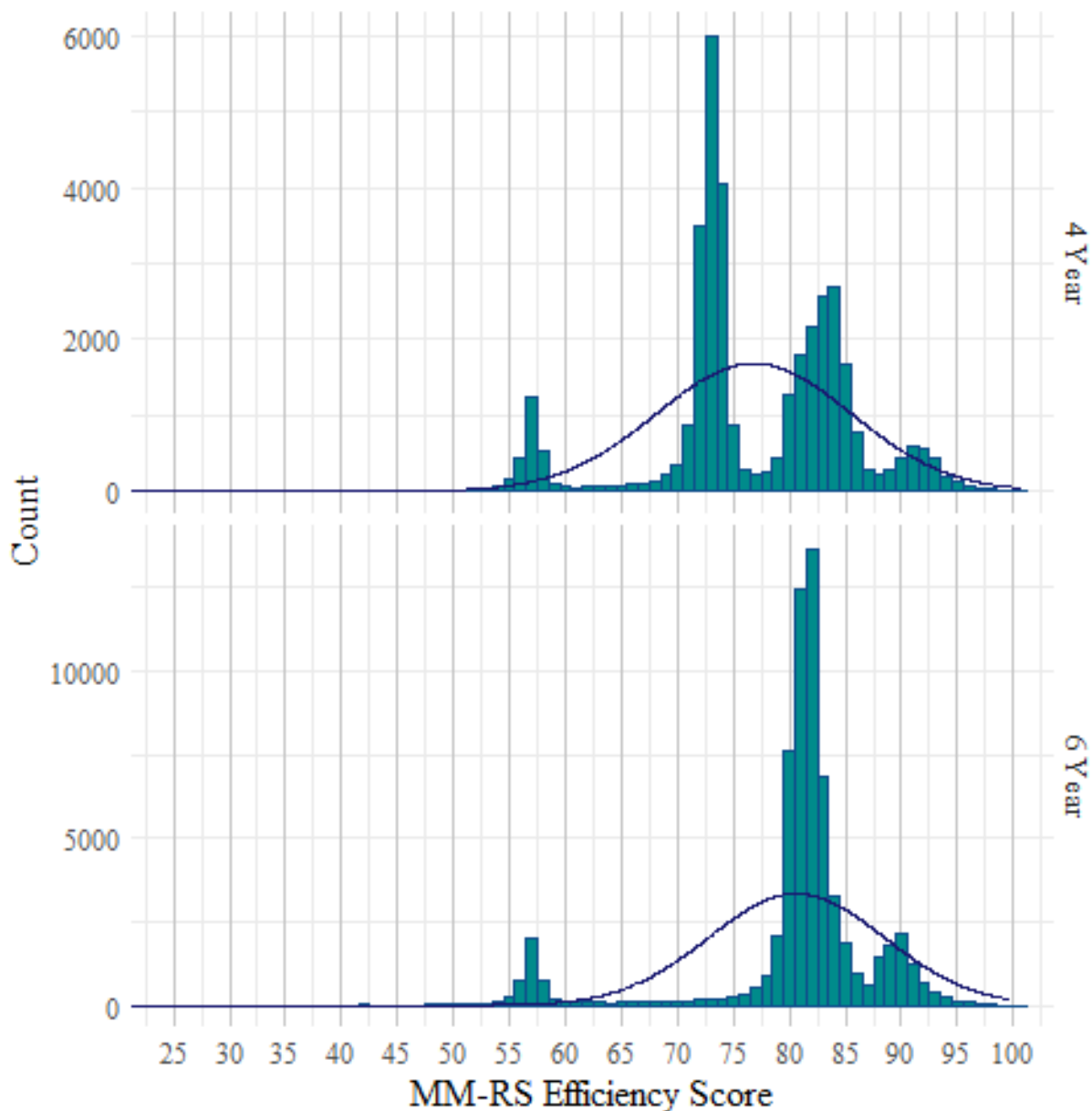


Figure 10. MM-RS_{EFF} distributions by TOE

3.1.7. Accelerated Promotion

Accelerated Promotion was associated with slightly higher MM-RS_{EFF} on average. Accelerated promotion had a significantly higher MM-RS $t(26164) = -13.002, p < .001$, however, the Cohen's d effect size coefficient suggests a small effect ($d = -.105$). Distributions are similar with a much less pronounced peak at 73 MM-RS_{EFF} for Airmen with accelerated promotion (Figure 11). Full descriptive statistics can be found in the Appendix Table C-5.

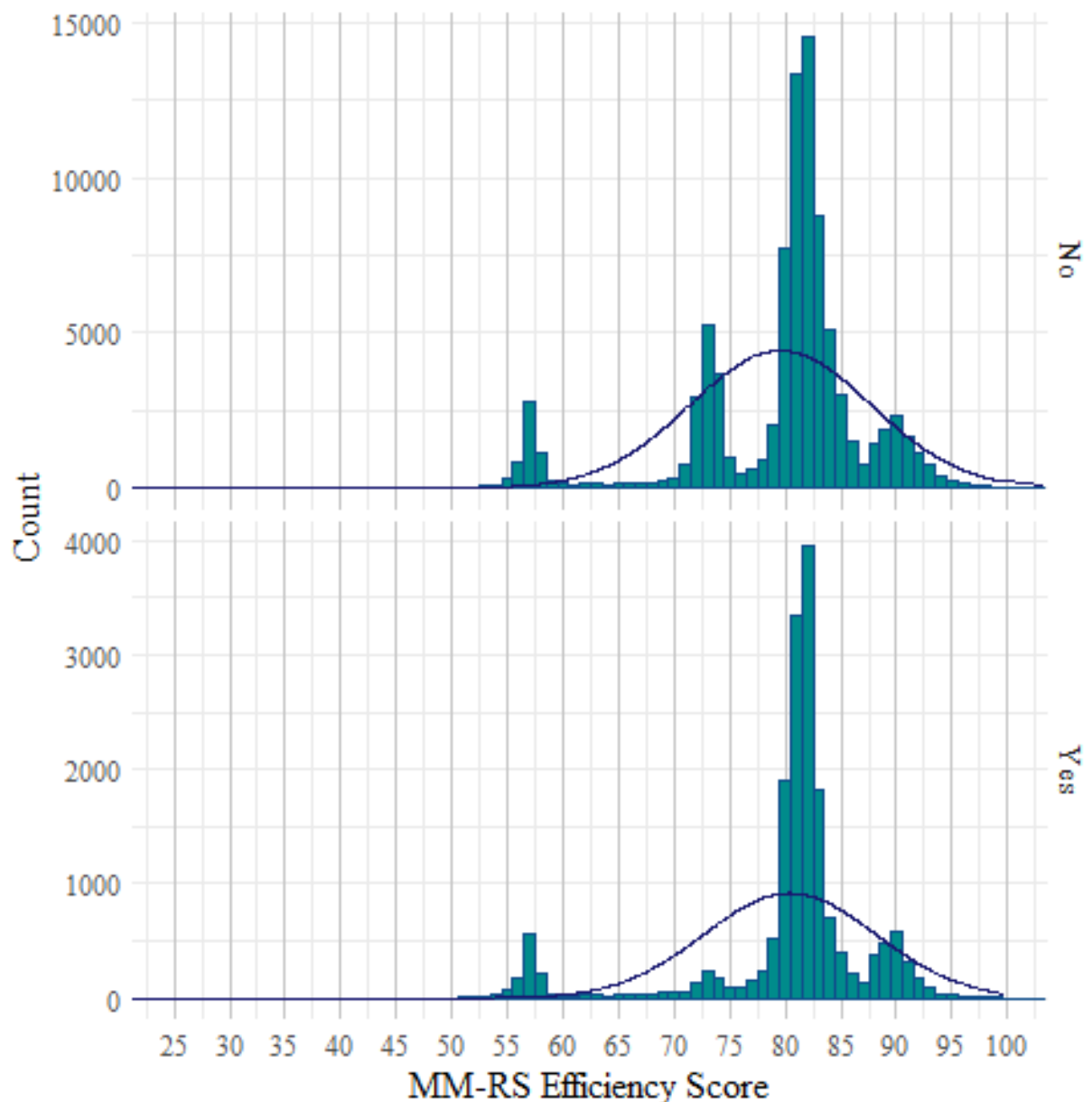


Figure 11. MM-RS_{EFF} Distributions by Accelerated Promotion Status

3.1.8. Waiver

There was no difference in MM-RS_{EFF} by Waiver with nearly identical distributions (see Figure 12). A Welch's two sample *t*-test showed that individuals with a waiver had significantly higher MM-RS, $t(16021) = -2.29$, $p = .02$. However, Cohen's *d* effect size coefficient suggests a negligible effect ($d = -.02$). Full descriptive statistics can be found in the Appendix Table C-6.

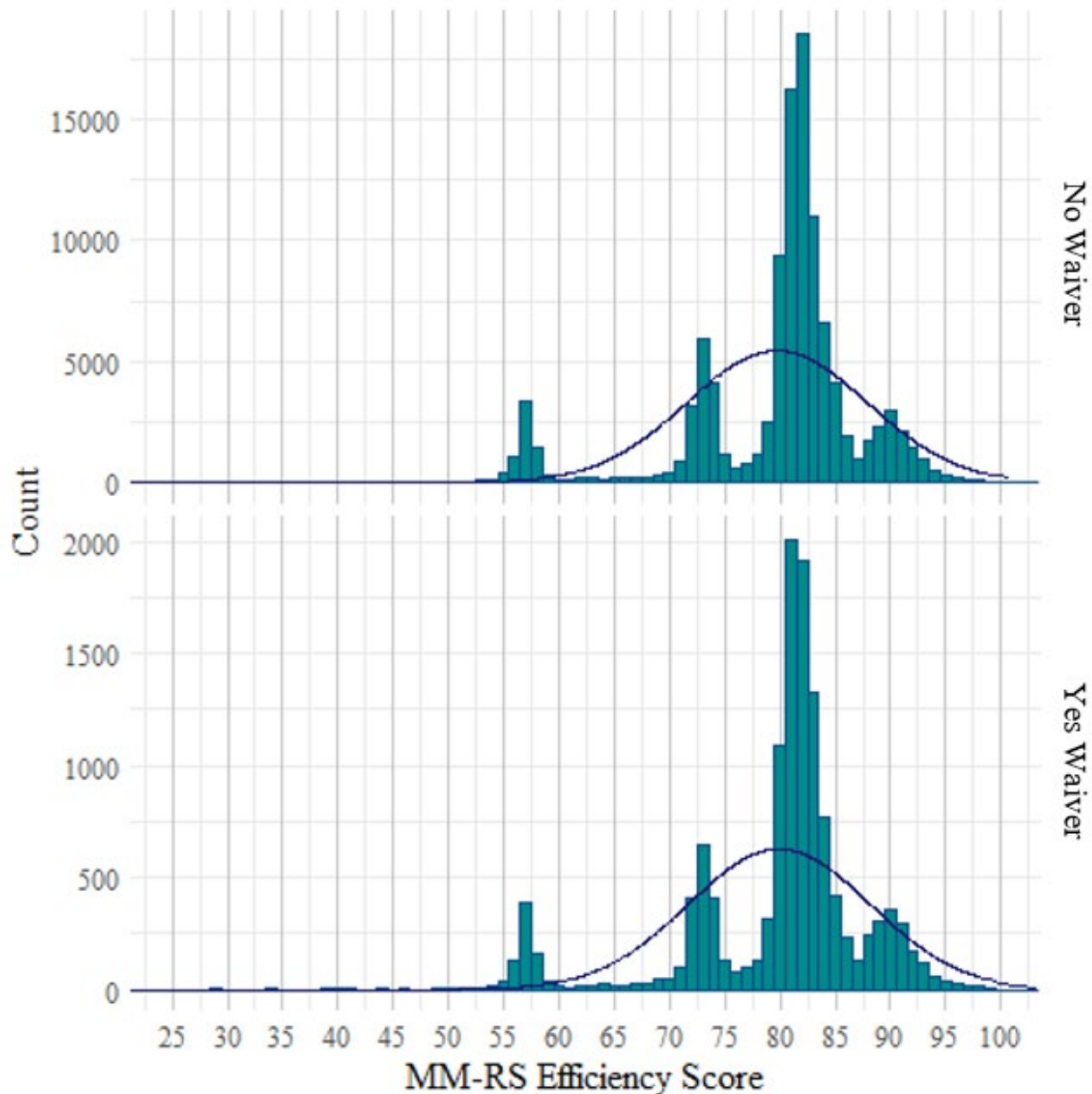


Figure 12. MM-RS_{EFF} Distributions by Waiver Status

3.1.9. Personality (TAPAS)

The three TAPAS facets with the most promising correlations were Achievement, Non-Delinquency, and Order which appear at the top of Table 5. The remaining TAPAS variables are listed in alphabetical order. Scatterplots for the three facets across all versions appear in Figures 13, 14, and 15. All 21 TAPAS facets were retained for regression equations.

Table 5. TAPAS and MM-RS Efficiency Score Correlation

	V 3	V 4	V 5	V 7	V 8
N	134	12267	10795	4474	4436
Achievement	0.15	0.06**	0.05**	0.05**	0.04**
Non-Delinquency	0.22*	0.02**	0.05**	0.03*	0.03*
Order	0.11	0.03**	0.04**	0.04*	-
Adjustment	-	-0.02*	-0.01	0.01	-0.01
Adventure Seeking	-	-	-	-0.03*	-
Attention Seeking	-0.12	-0.02*	-0.02*	-0.02	-0.03
Commitment to Serve	-	-	-	0.03	-
Cooperation	0.16	0.01	0.02*	0.02	-
Courage	-	-	-	-	-0.02
Dominance	-0.14	0.01	0.02	0.04**	0.04**
Even Tempered	0.13	0.01	0.02*	0.04**	0.01
Intellectual Efficiency	0.12	0	0.03**	0.02	0.03*
Optimism	0.04	0.01	0.03**	0.02	0.01
Physical Conditioning	-0.03	-0.01	-0.03**	0	0.01
Responsibility	-	-	-	-	0.03
Self-Control	-	0.02*	0.01	-	0.04**
Selflessness	0.1	-0.01	0.04**	0.02	-
Situational Awareness	-	-	-	0	-
Sociability	0.01	-0.02**	-0.01	-	-0.02
Team Orientation	-	-	-	-	0.02
Tolerance	-0.09	0.01	0.01	-	0

Note: V# = TAPAS versions 3, 4, 5, 7, and 8.

* Correlation is significant at the $p < .05$ level.

**Correlation is significant at the $p < .01$ level.

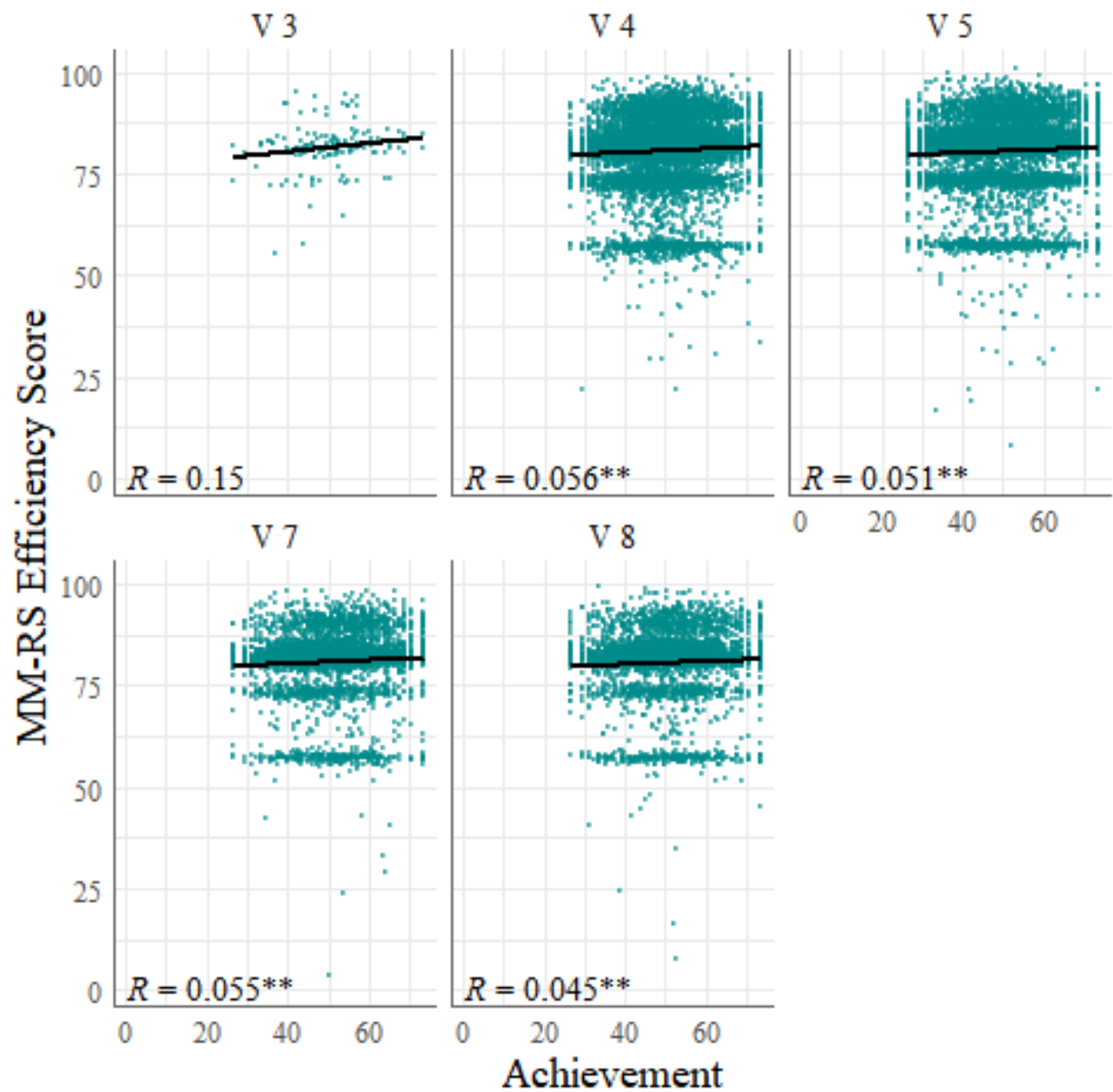


Figure 13. MM-RS_{EFF} and Achievement Scatterplots by TAPAS Version

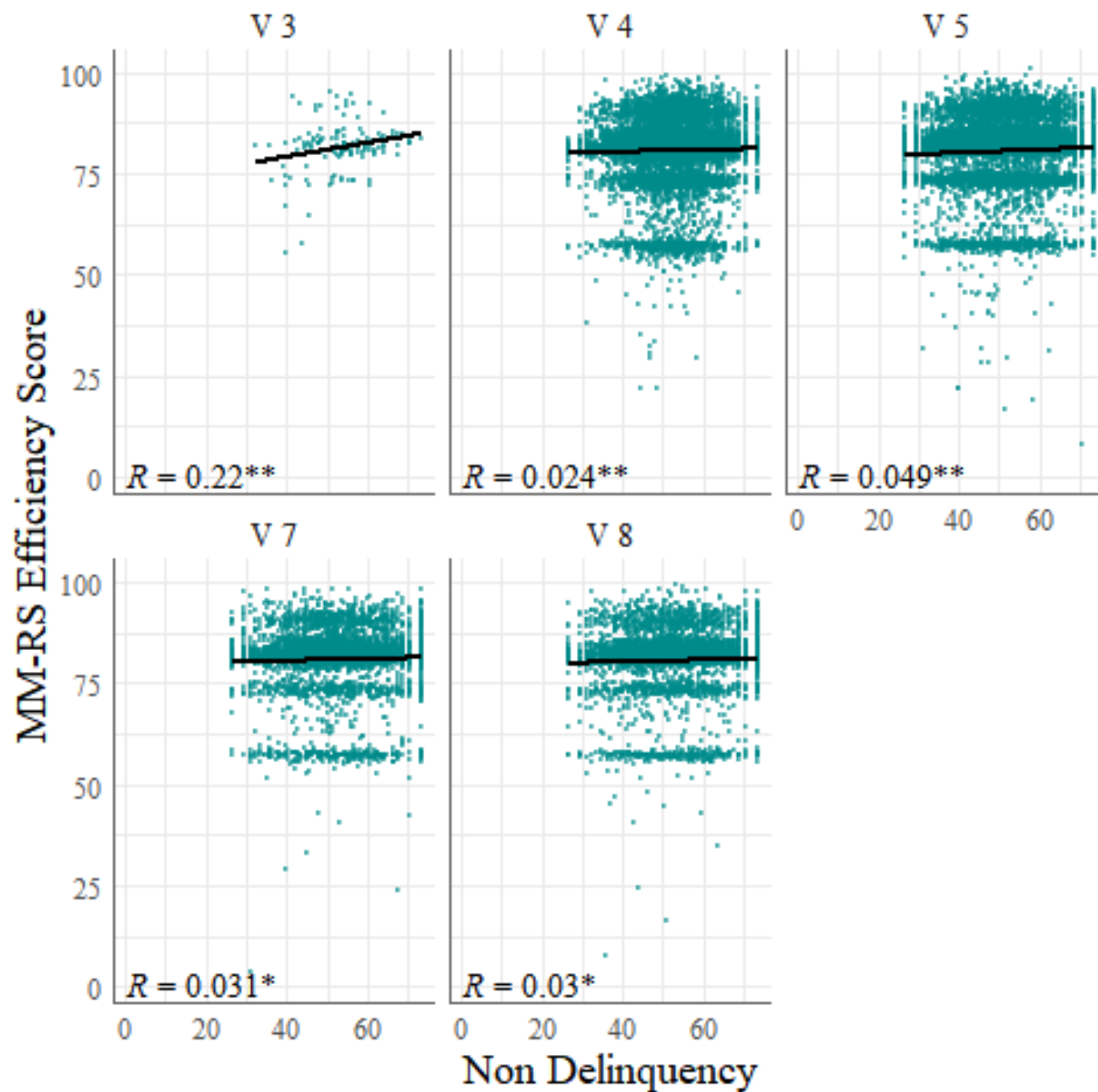


Figure 14. MM-RS_{EFF} and Non Delinquency Scatterplots by TAPAS Version

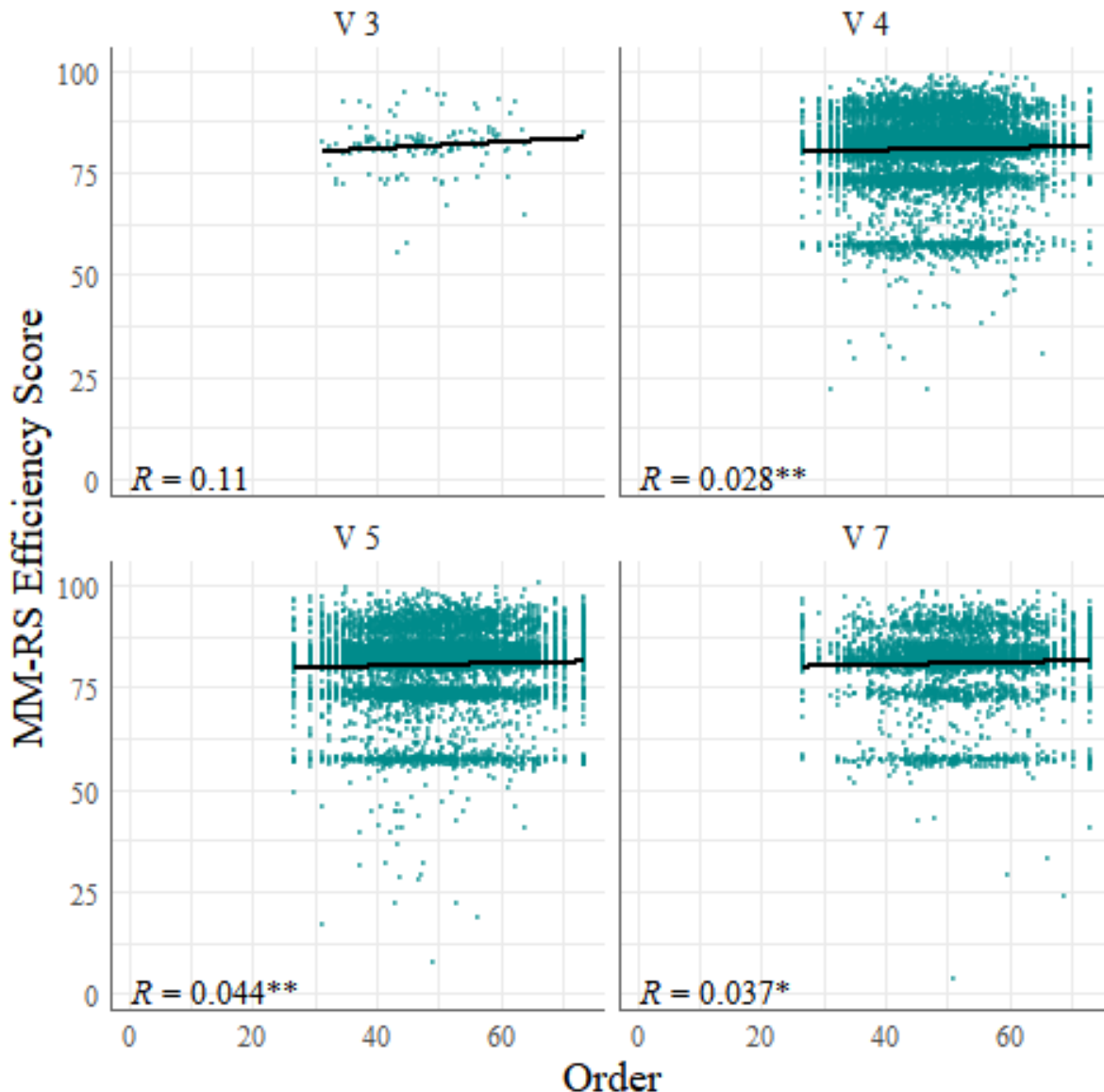


Figure 15. MM-RS_{EFF} and Order Scatterplots by TAPAS Version

3.2 Predicting MM-RS

3.2.1. Air Force Wide Analyses

The results of the full sample regressions were examined to determine if MM-RS_{EFF} could be predicted by routinely collected data. The regressions for both the development and hold-out sample were statistically significant. Table 6 shows small adjusted R^2 values in the development sample, however, the value was replicated in the hold-out sample, indicating good stability. Correcting for range restriction did not increase the R values. When predictors that did not contribute to the model were removed, the adjusted R^2 value did not decrease. The regressions remained statistically significant. Sample sizes increased in the reduced models because fewer

variables resulted in fewer cases with missing data. Results did not change when sample sizes were held constant.

Table 6. Regression Statistics for Air Force Wide Sample

Regression Type	Sample Type	<i>N</i>	<i>R</i>	Adj <i>R</i> ²	Range Corrected <i>R</i>	Range Corrected Adj <i>R</i> ²
All Variables	Development	40041	.31	.09	-	-
	Hold-out	40267	.30	.09	.30	.09
Reduced Equations	Development	47212	.30	.09	-	-
	Hold-out	47437	.29	.08	.30	.09

Adj R²-coefficient of multiple determination adjusted for number of predictors in the model

The reduced model showed marginal improvements in MM-RS_{EFF} for individuals who scored higher on the Administrative ASVAB component, were older, and had a six-year term of enlistment. Compared to having earned a HSD, SC education was related to higher MM-RS_{EFF}, and having earned a CD was related to even higher MM-RS_{EFF}. The development sample suggested some difference for those with HSL or HSA, but this was not replicated in the hold-out sample. Compared to GTEP, those with Open Administrative had lower MM-RS_{EFF}, and those with Open General or Open Electronics had higher MM-RS_{EFF}. Table 7 presents the predictors that were retained in the reduced equation, along with their directionality.

Table 7. Important Predictors for Air Force Wide Sample

Predictor	Development	Hold-out
Mechanical		
Administrative	+X	+X
General		
Electronics		
Less than High School	+X	
High School Alternative	-X	
High School Diploma	REF	REF
Some College	+X	+X
College Degree	+X	+X
Age	+X	+X
Open General	+X	+X
Open Mechanical		
Open Electronics	+X	+X
Open Administrative	-X	-X
GTEP	REF	REF

Term of Enlistment	+X	+X
Accelerated Promotion		
Waiver		

Note: High school diploma and GTEP (Guaranteed Training Enlistment Program) were used as reference variables (noted as REF), and thus not entered in the equation.

3.2.2. ASVAB Composite Analyses

Regressions conducted for each ASVAB requirement group were statistically significant, but the adjusted R^2 remained small, a finding commonly observed with very large sample sizes. The Mechanical requirement AFS group had the largest effect size, and the smallest was found for the General requirement AFS group. Table 8 presents the predictors that were retained in the reduced equations for ASVAB requirement groups along with their directionality and statistics for the reduced equations.

Table 8. Important Predictors ASVAB Requirement Groups

Predictor↓	M	A	G	E
Adjusted R^2 →	.11	.10	.07	.09
n →	33230	7645	45047	7487
Mechanical				
Administrative	+X	+X	+X	
General				
Electronics				
Less than High School				
High School Alternative				
High School Diploma				
Some College	+X	+X	+X	
College Degree	+X	+X	+X	+X
Age	+X	+X	+X	+X
Open General			+X	
Open Mechanical				
Open Electronics				+X
Open Administrative			-X	
GTEP		+X		
Term of Enlistment	+X	+X	+X	+X
Accelerated Promotion				-X
Waiver				

Note: High school diploma and GTEP (Guaranteed Training Enlistment Program) were reference variables, and thus not entered in the equation.

3.2.3. AFS Specific Analyses

Overall, individual AFS regression equation R^2 values were higher than Air Force wide results. The mean adjusted R^2 value across AFSs was .12, which was slightly higher than the value for the overall Air Force (i.e., .09). However, the ability of variables to predict MM-RS_{EFF} varied depending on AFS, as can be seen by comparing maximum and minimum adjusted R^2 values (see Table 9). The job with the highest R value was Physical Medicine (4J0X2). The lowest value was Cardiopulmonary Laboratory (4H0X1), for which the R^2 became negative when adjusted for the increase due to the number of predictors in the model. All but seven of the 106 regressions for the AFSs were significant. The regressions for Biomedical Equipment (4A2X1), Cardiopulmonary Laboratory (4H0X1), Airborne Intelligence Surveillance and Reconnaissance (1A8X2), Signals Intelligence Analyst (1N2X1A), Sensor Operator (1U0X1), Missile and Space Facilities (2M0X3), and Bomber/Special Electronic Warfare and Radar Surveillance Integrated Avionics (2A9X3) were not significant. Table 9 presents descriptive statistics for the R and adjusted R^2 values from both the full and reduced model equations.

Table 9. Regression Statistics for AFSs

Regression Type	Variables	Mean R	SD R	Max R	Min R	Mean Adj R^2	SD Adj R^2	Max Adj R^2	Min Adj R^2
AFS	All	.39	0.08	.61	.12	.12	0.06	.29	-.04
	Reduced	.35	0.08	.57	.07	.12	0.05	.32	.00
Range Corrected AFS	All	.39	0.08	.74	.19	.14	0.06	.51	.01
	Reduced	.36	0.09	.71	.09	.13	0.07	.50	.00

Note: AFS = Air Force Specialty; R = multiple correlation coefficient; SD = Standard Deviation; Adj R^2 = Adjusted R^2

In the reduced equations, several variables emerged as consistently important predictors for MM-RS_{EFF} across AFSs. These were Age, Term of Enlistment, and Education (specifically, having a College Degree). Information on the frequency with which predictors were retained in the reduced equations is reported in Table 10.

Table 10. Important Predictors for MM-RS

Model	Frequency Retained	Percent Retained
Mechanical	6	6%
Administrative	30	28%
General	12	11%
Electronics	17	16%
Less than High School	7	7%
High School Alternative	3	3%

High School Diploma	3	3%
Some College	22	21%
College Degree	68	64%
Age	82	77%
Open General	3	3%
Open Mechanical	3	3%
Open Electronics	1	1%
Open Administrative	0	0%
GTEP	17	16%
Term of Enlistment	102	95%
Accelerated Promotion	14	13%
Waiver	20	19%

College Degree had a positive coefficient in every reduced equation in which it appeared, indicating that those with a college degree had higher MM-RS_{EFF} than those without. Term of Enlistment was positive in all but two regression models, indicating that those with six-year enlistment periods generally had higher MM-RS_{EFF} than those with four-year enlistments. The jobs where four-year enlistments had higher MM-RS_{EFF} were Pararescue (1Z1X1) and Airborne Intelligence Survey (1A8X2). Despite past research findings that the oldest and youngest members have higher rates of attrition (Fischl & Blackwell, 2000; Hooper, et al., 2008), Age was positive and linear in all reduced equations for AFSs except for Survival, Evasion, Resistance, and Escape (SERE; 1T0X1). For SERE, MM-RS_{EFF} was highest for those in the middle of the age range, mirroring the results of past research. Age was determined to be the only important predictor for this AFS. The scatterplot is presented in Appendix D.

3.3 Incremental Validity of Personality (TAPAS)

We sought to determine whether personality variables could add incremental validity over the other predictors by using TAPAS facet scores. This question was assessed using two methods. First, regressions for each TAPAS version were developed and replicated using the stratified randomized halves of the full sample. Second, hierarchical regressions were calculated for groups of AFSs with the same ASVAB MAGE requirement. All regressions were significant.

As can be seen in Table 11, predictors found to be important in the development sample (VX-1) tended to remain important for the hold-out sample (VX-2), except for TAPAS facets, which frequently lost significance and magnitude when the model was replicated. For example, when TAPAS version 7 was replicated (V7-2), none of the TAPAS facets originally identified as important remained important, even though all the other predictors did.

Table 11. Important Predictors Across TAPAS Versions

	V4-1	V4-2	V5-1	V5-2	V7-1	V7-2	V8-1	V8-2
Mechanical								
Administrative	+X	+X	+X	+X	+X	+X	+X	+X
General								
Electronics								
Less than High School								
High School Alternative								
High School Diploma								
Some College	+X		+X	+X				
College Degree	+X	+X	+X	+X	+X	+X	+X	
Age	+X	+X	+X	+X	+X	+X	+X	+X
Open General	+X	+X						
Open Mechanical								
Open Electrical			+X	+X				
Open Administrative								
GTEP								
Term of Enlistment	+X	+X	+X	+X	+X	+X	+X	+X
Accelerated Promotion								
Waiver								
Dominance					+X		+X	
Even-Tempered								
Intellectual Efficiency	-X		-X					
Non-Delinquency								
Physical Conditioning								
Cooperation								
Order			+X		+X			
Sociability								
Tolerance								
Achievement	+X	+X					+X	
Adjustment								
Self-Control								
Attention Seeking					-X			
Optimism								
Selflessness			+X	+X				
Adventure Seeking								
Commitment to Serve								
Situational Awareness								
Courage								
Responsibility								
Team Orientation								

Note: V# = A given TAPAS version, 1 = First half of the sample; 2 = Second half of the sample

Additionally, the R^2 change after the addition of TAPAS facets hovered near zero. Table 12 shows R and adjusted R^2 values for the regression models with TAPAS facets and the R^2 change

above the models without TAPAS facets. Finally, the adjusted R^2 change hovered near zero for all MAGE groups as well, with a mean value of .006. The largest adjusted R^2 value was found for the Administrative group in TAPAS version 7 at Adj $R^2 = .06$. The TAPAS facets did not contribute incremental validity over the other predictors.

It is possible that the TAPAS facets which are predictive differ widely from one AFS to another and combining across AFSs for analysis neutralized these relationships. To evaluate this possibility, correlations between TAPAS facets and MM-RS_{EFF} for the four AFSs with the largest total TAPAS samples were calculated (see Appendix E). Most TAPAS facets still had small relationships with MM-RS_{EFF}, and those that had larger correlations had low stability across versions. The predictiveness of TAPAS facets was highly dependent on the sample. Sample sizes ranged from $n = 65$ to $n = 2080$.

Table 12. Regression Development and Hold-Out Sample Replication: TAPAS Included

Regression Type	Sample & TAPAS Version	N	R	Adj R^2	R^2 Change	Range Corrected R	Range Corrected Adj R^2	Range Corrected R^2 Change
All Variables	Dev V4-1	3852	.29	.08	.01	-	-	-
	Hold-out V4-2	3744	.29	.08	.01	.28	.07	.00
	Dev V5-1	3211	.37	.13	.01	-	-	-
	Hold-out V5-2	3281	.37	.13	.01	.37	.13	.00
	Dev V7-1	1140	.33	.09	.02	-	-	-
	Hold-out V7-2	1132	.36	.10	.01	.37	.13	.01
	Dev V8-1	1156	.37	.11	.01	-	-	-
	Hold-out V8-2	1150	.34	.09	.01	.29	.07	.01
Reduced Equations	Dev V4-1	4488	.28	.08	-	-	-	-
	Hold-out V4-2	4392	.28	.08	-	.26	.07	-
	Dev V5-1	3663	.35	.12	-	-	-	-
	Hold-out V5-2	3750	.34	.12	-	.35	.12	-
	Dev V7-1	1289	.31	.09	-	-	-	-
	Hold-out V7-2	1284	.32	.10	-	.35	.12	-
	Dev V8-1	1305	.36	.12	-	-	-	-
	Hold-out V8-2	1295	.29	.08	-	.25	.06	-

Note: AFS = Air Force Specialty; R = multiple correlation coefficient; Adj R^2 = Adjusted R^2

3.4 Range Restriction

Unexpectedly, for many regressions corrected for range restriction, the size of the R values *decreased* after the correction was applied. This phenomenon is known as range enhancement, where variance increases in the selected sample. The R values decreased instead of increasing for over half of the models, but the size of the change was small regardless of whether an increase or decrease occurred (see Table 13). While unusual, range enhancement can occur under certain conditions, such as when one or both tails of the distribution are disproportionately represented in the sample (Schmidt & Hunter, 2015), when extreme outliers that inflate the sample correlation are present (Ree & Carretta, 2020), when the correlation between two predictors is much higher

than the correlation between the predictor that was used in selection and criterion, or when the correlation between the predictor that was used in selection and the criterion is much greater than the correlation between the two predictors (Levin, 1972). In this study, the four ASVAB composites were highly correlated with one another in contrast to the relatively low correlations between all predictors and MM-RS_{EFF}. Certain other predictors were also more highly correlated with one another than MM-RS_{EFF} (see Appendix F for the zero-order correlations among predictors). Therefore, the most applicable explanation for range enhancement in this study is the case where correlations between predictors were higher than those between the directly selected predictors and criterion.

An exception to this general rule was the Computer Systems Programming (3D0X4) specialty for which the full regression R improved from $R = .48$ to $R = .74$ after the correction was applied, and the reduced regression improved from $R = .31$ to $R = .71$.

Table 13. Changes in R after Corrections for Range Restriction

Regression type→	TAPAS	AFS	Reduced TAPAS	Reduced AFS
Percent of models with decreased R values	69%	56%	69%	53%
Mean of decreases across models	-0.05	-0.04	-0.03	-0.03
Mean of increases across models	0.03	0.05	0.04	0.05

Note: TAPAS = full regressions for each MAGE grouping variables including TAPAS facets; AFS = full AFS regressions; Reduced TAPAS = reduced equations including TAPAS facets; Reduced AFS = reduced equations for individual AFSs.

Sign switching when the correction was applied also occurred. For instance, in the reduced equation for 3P0X1, Accelerated Promotion was positive in the observed equation and negative in the corrected regression. The ASVAB composite A was positive in the observed equations for both 4M0X1 and C60X1 but negative in their corrected equations, and Waiver status was negative in the observed equation for 1Z1X1 but positive in the corrected equation. Ree et al. (1994) demonstrated that legitimate sign changes can occur when range restriction corrections are applied.

4.0 IMPLICATIONS AND FUTURE DIRECTIONS

The basic issue of this study is whether the Air Force would benefit from further consideration of MM-RS as a criterion on which to base modifications to the selection and classification process. Viewed in isolation, this study provides some evidence that MM-RS is difficult to predict but disregarding it would overlook the broader selection and classification issues for which it might provide some benefit.

Study predictors which can be modified to improve MM-RS must be distinguished from those that would be difficult or impossible to change. The strongest predictors in this study were in the latter category: TOE, Age, and Education. Whether this finding would be useful to recruiting service is beyond our knowledge, and it might even fluctuate as market conditions change. We do not mean to suggest a shift in recruiting strategy regarding these predictors, but individuals with these characteristics will enlist. Those recruits should be preferred over recruits without those characteristics competing for the same AFS assignment within the current classification systems.

The usefulness of MM-RS as a criterion for the other predictors in our study may depend on the context. Summing across all AFSs, they may indicate an actionable relationship with MM-RS. But MM-RS may have increased usefulness to specific AFSs, especially in the case when there are known job performance problems. Selecting a small number of candidate AFSs to examine more closely with the available predictors and MM-RS may prove fruitful.

Given that academic performance is well-predicted by the ASVAB, consideration should be given to the possibility that mission-readiness is better predicted by other variables. Aiming to predict MM-RS as well as other criteria may reduce adverse impact. Some research has suggested that expanding the criterion-space is an effective method of mitigating adverse impact (e.g., Murphy, 2010). Valid predictors of academic performance, such as the ASVAB, may not predict MM-RS well. On the other hand, valid predictors of MM-RS may not be valid for academic success. With that assumption, valid predictors of MM-RS may serve to decrease adverse impact if they have small score differences between majority and minority groups.

Such variables that may better predict MM-RS should be investigated. Attributes covered in an Air Force-wide needs-analysis (Gonzalez, Peña, Wolliston, & Haight, 2019; Shore, Peña, Gonzalez, Haight, & Wolliston, 2019) are potential predictors of MM-RS. Self-Discipline, Reasoning, and Working Memory are examples of promising variables. They were rated to be highly important by front line supervisors and technical trainers for Airman job performance success, and measures for them are available within the Department of Defense (DoD). These constructs have also garnered evidence of low subgroup differences (Shore, Haight, & Martinez, 2020). Further assessment of these abilities, including a validation study, would provide information about their likely contribution to selection and classification. MM-RS could be used to help determine their usefulness.

Vocational interest also may have relevance to MM-RS. The Air Force has recently developed a sophisticated computerized vocational interest survey, the Air Force Work Interest Navigator (AF-WIN) for enlisted applicants and job incumbents. AF-WIN Fit Scores could be a promising predictor of MM-RS and should be investigated once AF-WIN data have matured.

4.1 Pre- and Post-Enlistment Person Job Match Systems

Sophisticated Pre- and Post-Enlistment Person-Job Match (PJM) assignment systems have been used in the Air Force in the past, the most recent being the Advanced Personnel Data System

Procurement Management Information system (APDS-PROMIS; for pre-enlistment) and Processing and Classification of Enlistees system (PACE; for post-enlistment). More detailed information can be found in Hendrix, Ward, Pina, and Haney (1979), Piña (2007), Roberts and Ward (1982), and Ward and Haltman (1974). Changes in Air Force requirements and recruiting system computing capabilities caused these systems to be discontinued and replaced with a pared down version of PACE commonly referred to as Job Spin, which now functions as the only PJM assignment system. This post-enlistment system uses three components to make AFS assignments: Job Preference (50%), Desirable Prerequisites (30%), and Aptitude (20%). Job Spin exists as a way to classify Open AI enlistees into available training class seats a few weeks before recruits graduate from BMT.

One component that was dropped when Job Spin became the de facto PJM system was a vocational interest survey called the Vocational Interest Career Examination (VOICE; Alley, 1978). Another component of the previous systems was Completion Probability, an individual's predicted probability of completing their first term based on age, test scores, and high school courses. The Air Force has recently added the AF-WIN as an updated computerized vocational interest survey, and while MM-RS is not a measure of Completion Probability, it is aimed at performance that extends beyond technical school pass/fail.

It is possible to restore lost capability in the form of a Pre-Enlistment PJM system as a tool for recruiters to use while guiding recruits to a career field that both best suits them and is also beneficial to the Air Force. The system could combine the AF-WIN Fit Score, MM-RS Efficiency Score, Desirable Prerequisites, and Aptitude (MAGE) in a weighted algorithm to provide prospective enlistees and recruiters with an ordered list of jobs optimized with these components. This Pre-Enlistment PJM would primarily serve those entering under the Guaranteed Training Enlistment Program.

Open AI enlistees can benefit by modifying Job Spin to accept MM-RS_{EFF} as a fourth component. ASVAB minimum requirements by AFS and the Aptitude component of Job Spin function as short-term criteria and prioritizes those that are most likely to graduate from technical school for AFS assignment. MM-RS fills in the medium-term criterion space, prioritizing expediency in training of those already deemed likely to graduate. While MM-RS_{EFF} is not a replacement for the Air Force selection and classification system, it is expected to be useful as an added component in the current infrastructure that serves that mission.

4.2 MM-RS: A Possible Paradigm Shift

While MM-RS_{EFF} could be used effectively as a component in pre- and post-enlistment PJM systems, its use as an additional criterion to technical school outcomes is somewhat impractical. Gathering the trainee data required to minimize the amount of error possible in MM-RS_{MAX} takes considerable effort. Smaller, focused studies on one or two specialties may alleviate the level of effort required. Limitations intrinsic to the operational definition of MM-RS lead to sources of unavoidable error. Splitting an Airmen's career into training and mission-readiness assumes any deviation from scheduled training length, and thus variance in MM-RS, to be the responsibility of the trainee. However, we are unable to account for increased training time outside of an Airman's control: casual time waiting for courses to start, travel time to and from schoolhouses, security clearance delays, and deployments during 3-skill level time where working on CDCs is a low priority. MM-RS_{EFF}, as operationally defined in this study, was unable to capture the variance associated with training failures that resulted in a reclassification event; an obvious negative outcome the Air Force would want to avoid. If desirable, MM-RS scores could be

calculated for Airmen who failed to complete their first term of enlistment, provided the reason for separation was available.

One potential solution is to focus on the negative training events that result in decreased MM-RS. The criterion would shift from measuring the resulting outcome of inefficient career progression to measuring the causes. These events include instances of recycling through BMT and technical training blocks, reclassification decisions, and failure to upgrade to a 5-skill level in a timely manner. Developing this idea beyond a notional concept is outside the scope of this project but it could be worth pursuing in the future.

4.3 A Research Focused Database

Most, if not all, the operational sources feeding into the study dataset are transactional databases, which are updated every time a new event occurs. Not only is it difficult for AFPC/DSYX to navigate every update event attached to a particular Airman so that the most salient data for a given study can be pulled, but these operational databases are not managed with research in mind. They serve a specific purpose: to keep the day-to-day operations of the Air Force running smoothly and efficiently.

Enhanced coordination between AFPC/DSYX, AFRS, and AETC for collecting and maintaining data records, for the express purpose of research, would be extremely beneficial to furthering the mission of selection and classification enhancement. Foremost, capturing enlistee data available to recruiters at time of enlistment in a database that exists as a permanent snapshot of that point in time would be invaluable for validation studies. Likewise, first term career progression data from the Military Personnel Data System (MilPDS) and technical school course information from the AETC Decision Support System (ADSS), captured in a way that is more amenable to research efforts, would benefit many future projects.

4.4 Meaningful, Measurable, Practical

Modern methods of data classification, analysis, and prediction present researchers with new large-scale data exploration opportunities. These methods of data management and analysis can enhance the efficiency and accuracy of complex analyses carried out on large amounts of data. The personnel data that are accumulated throughout an Airman's career are an extremely useful resource in investigating new constructs and predicting medium to long-term performance. MM-RS as a medium-term forecast exists in the criterion space untapped by current Air Force criteria. Building on previous research, the criterion has been refined to minimize error of measurement and allow for more appropriate comparisons to be made between Airmen and Air Force Specialties. Standardization comes with challenges, however, access to more complete and accurate information through enhanced cooperation with relevant data holders may be the key to clearing this hurdle. Despite the effort required, MM-RS provides rich information that could propel the Air Force's strategic testing and research program towards a more modernized future.

5.0 REFERENCES

- Alley, W. E. (1978). *Vocational Interest Career Examination: Use and application in counseling and job placement* (AFHRL-TR-78-62, AD-A063 657). Brooks Air Force Base, TX: Manpower and Personnel Division.
- Alley, W. E., Pacheco, L. J., & Birkelbach, D. B. (2007). *Modeling individual performance criteria in the Air Force*. San Antonio, Texas: Operational Technologies Corporation.
- Armor, D. J., Fernandez, R. L., Bers, K., Schwarzbach, D., Moore, S. C., & Cutler, L. (1982). *Recruit aptitudes and Army job performance: Setting enlistment standards for infantrymen* (R-2874-MRAL). San Monica, CA: RAND Corporation.
- Drasgow, F., Stark, S., Chernyshenko, O. S., Nye, C. D., Hulin, C. L., & White, L. A. (2012). *Development of the Tailored Adaptive Personality Assessment System, (TAPAS) to Support Army Selection and Classification Decisions*. Ft. Belvoir, VA: United States Army Research Institute for the Behavioral and Social Sciences.
- Fernandez, R. L., & Garfinkle, J. B. (1984). *Setting enlistment standards and matching recruits to jobs using job performance criteria* (R-3067-MIL, ADA150821). Santa Monica, CA: RAND Corporation.
- Fischl, M. A., & Blackwell, D. L. (2000). *Attrition in the Army from signing of the enlistment contract through 180 days of service* (Report No. 1750). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Gonzalez, M., Peña, D. A., Wolliston, D. J., & Haight, N. R. (2019). *USAF Assessment of Needs Analysis: Enlisted and Officer AFS Clusters*, Task Order #47QFAA18F0043. San Antonio, TX: Operational Technologies Corporation.
- Halper, M. L., Goodman, T. M., & Alley, W. E. (2010). *Months of mission-ready service*. San Antonio, TX: Operational Technologies Corporation.
- Hendrix, W. H., Ward, J. H., Piña, M., & Haney, D. L. (1979). *Pre-enlistment person job match system* (AFHRL-TR-79-29). Brooks Air Force Base, TX: Occupation and Manpower Research Division.
- Herzberg, P. A. (1969). The parameters of cross-validation. *Psychometrika Monograph Supplement*, 34(2, Pt. 2).
- Hooper, A. C., Paullin, C., Putka, D. J., & Strickland, W. S. (2008). *An empirical analysis of reasons for attrition among first-term airmen in the United States Air Force* (Report No. FR-08-32). Alexandria, VA: Human Resources Research Organization.
- Knapik, J. J., Jones, B. H., Hauret, K., Darakjy, S., & Piskator, E. (2004). *A review of the literature on attrition from the military services: Risk factors for attrition and strategies to reduce attrition* (Report No. 12-HF-01Q9A-04). Fort Knox, KY: Center for Accessions Research.
- Lawley, D. N. (1943). A note on Karl Pearson's selection formulae. *Proceedings of the Royal Society of Edinburgh, Section A*, 62, Part 1, 28-30.
- Levin, J. (1972). The occurrence of an increase in correlation by restriction of range. *Psychometrika*, 37, 93-97.

- Murphy, K. R. (2010). How a broader definition of the criterion domain changes our thinking about adverse impact. In J. L. Outtz (Ed.), *Adverse impact: Implications for organizational staffing and high stakes selection* (pp. 137-160). NY: Taylor & Francis.
- Piña, M. (2007). *Pre and post enlistment person job match (PJM)*. San Antonio, TX: Operational Technologies Corporation.
- Ree, M. J., & Carretta, T. R. (2020). *A systematic review of corrections for range restriction: Five things consultants should know*, AFRL-RH-WP-TR-2020-0050. Wright-Patterson AFB, OH: Air Force Research Laboratory, 711 Human Performance Wing, Airman Systems Directorate.
- Ree, M., J., Carretta, T. R., Earles, J. A., & Albert, W. (1994). Sign changes when correcting for range restriction: A note on Pearson's and Lawley's selection formulas. *Journal of Applied Psychology*, 79, 298-301.
- Roberts, D. K., & Ward, J. H. (1982). *General purpose person-job match system for Air Force enlisted accessions* (AFHRL-SR-82-2). Brooks Air Force Base, TX: Manpower and Personnel Division.
- Roecker, E. B. (1991). Prediction error and its estimation for subset-selected models. *Technometrics*, 33, 459-468.
- Schmidt, F. L., & Hunter, J. E. (2015). *Methods of meta-analysis: Correcting error and bias in research findings* (3rd ed.). <https://dx.doi.org/10.4135/9781483398105>
- Shore, C. W., Haight, N. R., & Martinez, L. (2020). *Identify potential I/O or non-I/O psychology assessment tools/methods: AFOQT methods to reduce adverse impact*. Task Order #47QFAA18F0043. San Antonio, TX: Operational Technologies Corporation.
- Shore, C. W., Peña, D. A., Gonzalez, M., Haight, N. R., & Wolliston, D. J. (2019). *Officer and enlisted needs analysis*, Task Order #47QFAA18F0043. San Antonio, TX: Operational Technologies Corporation.
- Smith, G. (2018). Step away from stepwise. *Journal of Big Data*, 5(32). <https://doi.org/10.1186/s40537-018-0143-6>
- Thayer, J. D. (2002, April 1-5). *Stepwise regression as an exploratory data analysis procedure* [Paper presentation]. American Educational Research Association 2002 Annual Meeting, New Orleans, LA.
- Ward, J. H., & Haltman, H. P. (1974). *Computer-based enlistment quota reservation system using the general data management system 2000* (AFHRL-TR-74-62). Lackland Air Force Base, TX: Manpower and Personnel Systems Division.
- Welch, B. L. (1947). The generalization of 'student's' problem when several different population variances are involved. *Biometrika*, 34, 28-35.
- Whittingham, M. J., Stephens, P. A., Bradbury, R. B., & Freckleton, R. P. (2006). Why do we still use stepwise modelling in ecology and behavior? *Journal of Animal Ecology*, 75(5), 1182-1189. <https://doi.org/10.1111/j.1365-2656.2006.01141.x>

APPENDIX A – Variable Cleaning and Context

ASVAB COMPOSITES

The ASVAB is routinely used by the Air Force to determine if an applicant qualifies for AFSs. Minimum scores for one or more ASVAB composites are required for candidacy in a given AFS. The composite for which a minimum score is required depends on the skills required in that job. These composites are Mechanical (M), Administrative (A), General (G), and Electronics (E), and are calculated by combining the scores of ASVAB subtests. As visible in Table A-1, the subtests included in each composite overlap. Five original sets of MAGE variables were supplied to us, each of which had scores for some cases. Test date variables for the scores were used to determine which set for each case was the earliest test administration. ASVAB subtest scores could not be included in the model due to insufficient data available for our sample.

Table A-1. ASVAB Composites and Subtests

Subtests Composites	Mechanical	Administrative	General	Electronics
General Science	X			X
Mechanical Comprehension	X			
Auto/Shop	X			
Verbal Expression		X	X	
Arithmetic Reasoning			X	X
Mathematics Knowledge				X
Electronics Information				X

EDUCATION

Education was divided into five categories shown in Table A-2. Less than high school (HSL), alternative high school certificate (HSA), and high school diploma (HSD) were present in Halper et al. (2010) with a final category of more than high school. This study separated that final category into some college (SC) and college degree or professional certificate (CD). Two sources for education were available in our dataset, a variable labeled Education, appearing twice, and a variable labeled Education Certificate appearing once. The Education variable is a mix of numeric coding structures. Numerals 0-14 are used throughout all years we had available (i.e., 2005-2014). The 11-99 codes appear in our data from 2005 to 2008. Frequency tables revealed the existence of codes 15-20 unrepresented in either code structure, and an unusually high sample size for cases coded as 12. We took this as evidence number of years of education is mixed in to this variable between 2005 and 2010. The Education Certificate variable contains an alphanumeric code structure. Any ambiguity within the Education variable or inconsistencies between Education and Education Certificate resulted in the case being coded as missing.

Table A-2. Education Recoding

Recoded	Education		Education Cert	Description
	0-14	11-99		
HSL		11	1	Less than high school diploma
		24	5, 6, or J	High school attendance certificate
		12	9	Currently in high school
		13	S	High school senior
		14		Credential near completion
		48		Completed high school but did not pass the high school exit exam
	1			1 to 7 years of education
	2			8 years of education
	3			1 year of high school
	4			2 years of high school
	5			3 to 4 years of high school no diploma
HSA			3	Certificate of high school equivalency
			4	Certificate of completion
		26	B	Adult diploma
		21	E	Test-based equivalency diploma
		23	7	Correspondence school diploma
			H	Route study diploma
		25		Home study diploma
		27		Army Guard Challenge program GED
	13			High school GED
	14			Alternate credential
HSD	6	31	2 or L	High school diploma
SC			A	First year college level of education certificate equivalency
		41	8	Completed one semester of college
	7	42		1 year of college
	8			2 years of college
	9			3-4 years of college (no degree)
CD		44	D	Associate degree
		45	G	Professional nursing diploma
		51	K	Baccalaureate
		61	N	Master's
		62	R	Post master's
		64	U	Doctorate
		63	W	First - professional.
		28	C	Occupational program certificate
		22		Occupational program certificate
		65		Post doctorate degree
	10			College graduate
	11			Masters or equivalent
	12			Doctors or equivalent

Missing	0	99	Unknown
---------	---	----	---------

ENLISTMENT TYPE

Enlistment Type was divided into five categories. The first is GTEP, where recruits receive a contract to train for a specific AFS. The AFS is known to recruits prior to arrival at BMT. The other four are Open AI recruits, who receive one of the four ASVAB composite aptitude areas (i.e., Open Mechanical, Open Administrative, Open General, or Open Electronics). Recruits will be assigned an AFS in one of those areas in their last two weeks of BMT using the Job Spin Post-Enlistment PJM assignment system. This information is recorded in a variable from AFRS called SHIP_AFS. If a recruit enters as GTEP, this variable records the five-digit AFSC (no shreds) for which they have been contracted. If the recruit is an Open AI enlistee, the five-digit code is formatted as 9TXXX. The third character records an M, A, G, or E, corresponding to aptitude area.

TERM OF ENLISTMENT

Two potential enlistment terms were included in this study; the 6-year term of enlistment and the 4-year term of enlistment. We were provided with five variables that included data on TOE. These variables were often in disagreement. Comparison with relevant dates (e.g., enlistment date, 3-level award date) and discussion with Air Force personnel revealed that TOE variables are updated due to term extensions and reenlistment decisions. Cross-referencing the dates of separation variables would sometimes yield clues as to which TOE was correct, as dates of separation variables are most often expected dates of separation. The researchers best judgment was used to reconcile variables into one study variable. Slightly more than 20% of the dataset had to be coded as missing due to ambiguity over which TOE was correct.

ACCELERATED PROMOTION

The data for Accelerated Promotion were retrieved from the Enlistment Option variables. These variables included several accelerated promotion types (e.g., accelerated promotion plus buddy program). Table A-3 shows Enlistment Option variable codes that were recoded as “Yes” for Accelerated Promotion (No = 0, Yes = 1). Data analysis suggested source coding switched sometime in 2010 to a numeric structure. Prior to this the Enlistment Option variable is recorded in a two-character letter code. The first character was used to identify accelerated promotion status. Code documentation for this variable was difficult to track down and its accuracy in the dataset is somewhat questionable. Signing bonus is indicated by the second character in the letter code, however, there is inconsistency between the coding tables and what is represented in the data. Signing bonus is recorded in a separate variable for 2010-Present but was largely missing. For this reason, signing bonus was dropped from the study. Data for accelerated promotion were present throughout the entire range of years (i.e., 2005-2014) and was deemed salvageable despite our concerns about accuracy.

Table A-3. Accelerated Promotion Types

Enlistment Option		Accelerated Promotion Type
2005-2010	2010-Present	
	08	Accelerated promotion plus training or skill guarantee, unit or geographic location and buddy program
H		Accelerated promotion plus unit or geographic location unit or geographic location and buddy program
J	09	Accelerated promotion plus unit or geographic location and buddy program
K	10	Accelerated promotion plus unit or geographic location
L	11	Accelerated promotion
M	12	Accelerated promotion plus buddy program and training or skill guarantee
N	13	Accelerated promotion plus training or skill guarantee
P	14	Accelerated promotion plus buddy program

WAIVER

Waiver was recoded as a binary variable from two variables, DEP Waiver Type and Accession Waiver Type. Recruits can receive more than one waiver but the variables available in the dataset only ever designate one waiver. This makes it only possible to differentiate recruits who receive any waiver from those who do not.

TAPAS

The TAPAS is a forced choice personality inventory which has been given at MEPS since 2009. During the timeframe for the data used in this study, five TAPAS versions were used (i.e., V3, V4, V5, V7, and V8), each containing personality facets shown in Table A-3. While there were common variables across TAPAS versions, they could not be combined for analysis upon guidance from test developers. Facets with the same names measure the same construct. Attention Seeking, Optimism, and Selflessness appeared on V3 as Excitement Seeking, Well-Being, and Generosity. The facets were renamed by test developers. They appear in our dataset as both the original names for V3 and the new names for V4 through V8. Test developers do not use the original facet labels found in the dataset for V3 in their development report (Drasgow, Stark, Chernyshenko, Nye, Hulin, & White, 2012) so we refer to the facets in their renamed form.

Table A-4. TAPAS Variables in the Test Versions

Variable	V3	V4	V5	V7	V8
Dominance	X	X	X	X	X
Even Tempered	X	X	X	X	X
Intellectual Efficiency	X	X	X	X	X
Non-Delinquency	X	X	X	X	X
Physical Cond	X	X	X	X	X
Cooperation	X	X	X	X	
Order	X	X	X	X	
Sociability	X	X	X		X
Tolerance	X	X	X		X
Achievement	X	X	X	X	X
Attention Seeking	X	X	X	X	X
Optimism	X	X	X	X	X
Selflessness	X	X	X	X	
Adjustment		X	X	X	X
Self-Control		X	X		X
Adventure Seek				X	
Commitment to Serve				X	
Situational Awareness				X	
Courage					X
Responsibility					X
Team Orientation					X
Variable Count	13	15	15	15	15

APPENDIX B – AFS MAGE Groups

Table B-1. MAGE Requirements for AFSs

AFSC	Name	N
M		45697
1A9X1	Special Missions Aviator	29
1P0X1	Aircrew Flight Equipment	701
2A3X3E	Tactical Aircraft Maintenance	633
2A3X3L	Tactical Aircraft Maintenance	389
2A3X3M	Tactical Aircraft Maintenance	390
2A3X7A	Tactical Aircraft Maintenance (5th Gen)	175
2A3X7B	Tactical Aircraft Maintenance (5th Gen)	47
2A3X8A	Remotely Piloted Aircraft Maintenance-MQ-1/MQ-9	32
2A3X8B	Remotely Piloted Aircraft Maintenance-RQ-4	6
2A5X1B	Aerospace Maintenance	2736
2A5X1C	Aerospace Maintenance	684
2A5X1D	Aerospace Maintenance	1277
2A5X2B	Helicopter Maintenance	354
2A5X2D	Helicopter Maintenance	170
2A5X4A	Refuel/Bomber Aircraft Maintenance	489
2A5X4B	Refuel/Bomber Aircraft Maintenance	109
2A5X4D	Refuel/Bomber Aircraft Maintenance	206
2A5X4E	Refuel/Bomber Aircraft Maintenance	109
2A5X4F	Refuel/Bomber Aircraft Maintenance	47
2A6X1C	Aerospace Propulsion	1047
2A6X1D	Aerospace Propulsion	894
2A6X1E	Aerospace Propulsion	828
2A6X1H	Aerospace Propulsion	206
2A6X2	Aerospace Ground Equipment	2770
2A6X3	Aircrew Egress Systems	409
2A6X4	Aircraft Fuel Systems	1498
2A6X5	Aircraft Hydraulic Systems	1510
2A7X1	Aircraft Metals Technology	473
2A7X2	Nondestructive Inspection	554
2A7X3	Aircraft Structural Maintenance	1953
2A7X5	Low Observable Aircraft Structural Maintenance	307
2F0X1	Fuels	2391
2M0X1A	Missile and Space System Electronic Maintenance- ICBM	322
2M0X1B	Missile and Space System Electronic Maintenance- ICBM	246
2M0X2	Missile and Space Systems Maintenance	387

2T1X1	Ground Transportation	1672
2T2X1	Air Transportation	3358
2T3X1	Mission Generation Vehicular Equipment Maintenance	1268
2W0X1	Munitions Systems	4684
2W1X1C	Aircraft Armament Systems - A-10	370
2W1X1E	Aircraft Armament Systems - A-10	1162
2W1X1F	Aircraft Armament Systems - A-10	1661
2W1X1J	Aircraft Armament Systems - A-10	50
2W1X1K	Aircraft Armament Systems - A-10	402
2W1X1L	Aircraft Armament Systems - A-10	305
2W1X1N	Aircraft Armament Systems - A-10	355
2W1X1Q	Aircraft Armament Systems - A-10	5
2W1X1Z	Aircraft Armament Systems - A-10	210
2W2X1	Nuclear Weapons	547
3D1X7	Cable and Antenna Systems	253
3E0X2	Electrical and Power Production	945
3E1X1	Heating, Ventilation, AC, and Refrigeration	995
3E2X1	Pavement and Construction Equipment	1248
3E3X1	Structural	1149
3E4X1	Water and Fuel Systems Maintenance	680
A		10437
1C0X2	Aviation Resource Management	1094
1N0X1	Operations Intelligence	2190
1N2X1A	Signals Intelligence Analyst	190
1N2X1C	Signals Intelligence Analyst	401
2G0X1	Logistics Plan	355
2T0X1	Traffic Management	1188
2T3X7	Fleet Management and Analysis	349
3D0X1	Knowledge Operations Management	1189
4A1X1	Medical Materiel	707
4C0X1	Mental Health Service	526
4E0X1	Public Health	834
4J0X2	Physical Medicine	197
4M0X1	Aerospace Physiology	183
4N1X1	Surgeon	447
4P0X1	Pharmacy	471
4V0X1	Ophthalmic	116
G		61091
1A8X2	Airborne Intelligence Surveillance and Reconnaissance Operator	226
1C1X1	Air Traffic Control	3524
1C3X1	Command Post	590

1C5X1	Aerospace Control and Warning Systems	797
1C7X1	Airfield Management	462
1N1X1A	Geospatial Intelligence	1276
1N4X1A	Fusion Analyst	15
1N4X1B	Fusion Analyst	378
1T0X1	Survival, Evasion, Resistance, and Escape (SERE) Specialist	201
1T2X1	Pararescue	369
1U0X1	Sensor Operator	396
1W0X1	Weather	1707
2R0X1	Maintenance Management Analysis	376
2R1X1	Maintenance Management Production	477
2S0X1	Material Management	4264
3D0X2	Cyber Systems Operation	2073
3D0X3	Cyber Surety	635
3D0X4	Computer Systems Programming	208
3E4X3	Pest Management	139
3E5X1	Engineering	648
3E6X1	Operations Management	270
3E7X1	Fire Protection	2921
3E9X1	Emergency Management	487
3M0X1	Services	327
3N0X2	Broadcast Journalist/Photojournalist	283
3N0X5	Photojournalist	48
3P0X1	Security Forces	25584
4A0X1	Health Services Management	1686
4B0X1	Bioenvironmental Engineering	599
4D0X1	Diet Therapy	194
4H0X1	Cardiopulmonary Laboratory	254
4N0X1	Aerospace Medical Service	4383
4R0X1	Diagnostic Imaging	584
4T0X1	Medical Laboratory	724
4T0X2	Histopathology	64
4Y0X1	Dental Assistant	1285
4Y0X2	Dental Lab	237
5J0X1	Occupational Therapy	249
5R0X1	Religious Affairs	26
6C0X1	Contracting	841
6F0X1	Financial Management and Comptroller	1284
E		12214
1A3X1	Airborne Missions Systems	880
1C6X1	Space Systems Operations	378

2A0X1K	Avionics Test Station and Components	44
2A0X1M	Avionics Test Station and Components	37
2A0X1P	Avionics Test Station and Components	274
2A2X1	Special Operations Forces/Personnel Recovery (SOF/PR)	114
2A2X1A	Special Operations Forces/Personnel Recovery (SOF/PR)	16
2A2X2	Special Operations Forces/Personnel Recovery (SOF/PR)	86
2A2X3	Special Operations Forces/Personnel Recovery (SOF/PR)	73
2A3X4A	Legacy Fighter Avionics	94
2A3X4B	Legacy Fighter Avionics	162
2A3X4C	Legacy Fighter Avionics	185
2A3X5A	Advance Fighters	99
2A3X5B	Advance Fighters	31
2A3X5C	Advance Fighters	131
2A6X6	Aircraft Electrical and Environmental Systems	2689
2A8X1A	Mobility Air Forces Integrated Communication/Navigation/Mission Systems	21
2A8X1B	Mobility Air Forces Integrated Communication/Navigation/Mission Systems	40
2A8X1C	Mobility Air Forces Integrated Communication/Navigation/Mission Systems	40
2A8X1F	Mobility Air Forces Integrated Communication/Navigation/Mission Systems	8
2A8X1G	Mobility Air Forces Integrated Communication/Navigation/Mission Systems	39
2A8X2A	Mobility Air Forces Integrated Instrument and Flight Control System	25
2A8X2B	Mobility Air Forces Integrated Instrument and Flight Control System	40
2A8X2C	Mobility Air Forces Integrated Instrument and Flight Control System	44
2A8X2F	Mobility Air Forces Integrated Instrument and Flight Control System	15
2A8X2G	Mobility Air Forces Integrated Instrument and Flight Control System	56
2A9X1A	Bomber/Special Integrated Communication/Navigation/Mission Systems- E-3	28
2A9X1B	Bomber/Special Integrated Communication/Navigation/Mission Systems- E-4, VC-25	5
2A9X1C	Bomber/Special Integrated Communication/Navigation/Mission Systems- E-8	5
2A9X1D	Bomber/Special Integrated Communication/Navigation/Mission Systems- RC-135	9
2A9X1E	Bomber/Special Integrated Communication/Navigation/Mission Systems- B-1	22
2A9X1F	Bomber/Special Integrated Communication/Navigation/Mission Systems- B-2	6
2A9X1G	Bomber/Special Integrated Communication/Navigation/Mission Systems- B-52	27
2A9X2A	Bomber/Special Integrated Instrument and Flight Control Systems- E-3	24
2A9X2B	Bomber/Special Integrated Instrument and Flight Control Systems- E-4, VC-25	1
2A9X2C	Bomber/Special Integrated Instrument and Flight Control Systems- E-8	4
2A9X2D	Bomber/Special Integrated Instrument and Flight Control Systems- RC-135	13
2A9X2E	Bomber/Special Integrated Instrument and Flight Control Systems- B-1	23
2A9X2F	Bomber/Special Integrated Instrument and Flight Control Systems- B-2	4
2A9X2G	Bomber/Special Integrated Instrument and Flight Control Systems- B-52	20
2A9X3A	Bomber/Special Electronic Warfare and Radar Surveillance	25

2A9X3B	Bomber/Special Electronic Warfare and Radar Surveillance	33
2A9X3C	Bomber/Special Electronic Warfare and Radar Surveillance	6
2A9X3D	Bomber/Special Electronic Warfare and Radar Surveillance	33
2A9X3E	Bomber/Special Electronic Warfare and Radar Surveillance	13
2A9X3F	Bomber/Special Electronic Warfare and Radar Surveillance	10
2A9X3G	Bomber/Special Electronic Warfare and Radar Surveillance	33
2A9X3H	Bomber/Special Electronic Warfare and Radar Surveillance	10
2M0X3	Missile and Space Facilities	296
2P0X1	Precision Measurement Equipment Laboratory	623
3D1X1	Client Systems	1024
3D1X2	Cyber Transport Systems	1770
3D1X3	RF Transmission Systems	1214
3E0X1	Ground Radar Systems	974
4A2X1	Biomedical Equipment	338
	Total	129439

Table B-2. Results of Regression Analyses by AFS

Click on the paperclip to the left to access the Excel spreadsheet.

APPENDIX C – Descriptive Statistics of Predictors

Table C-1. Descriptive Statistics for Age by Education Level

	N	Mean	SD	Median	Min	Max	Range	Skew	Kurtosis
HSL	6778	18.67	1.04	18	17	28	11	3.32	17.48
HSA	987	21.19	2.33	21	17	29	12	0.87	0.35
HSD	101661	20.45	2.07	20	17	32	15	1.18	1.28
SC	5711	22.06	2.13	22	17	30	13	0.72	0.14
CD	5492	24.23	2.06	24	17	31	14	-0.12	-0.23

Note: HSL = less than high school diploma; HSA = alternative high school diploma; HSD = high school diploma; SC = some college; CD = college degree.

Table C-2. Descriptive Statistics for MM-RS Efficiency Score by Education Level

	N	Mean	SD	Median	Min	Max	Range	Skew	Kurtosis
HSL	6778	78.76	8.06	81.25	31.84	98.05	66.21	-1.42	2.34
HSA	987	79.34	8.08	81.17	23.62	98.86	75.24	-1.51	3.85
HSD	101661	79.57	8.02	81.40	0.00	103.20	103.20	-1.61	4.18
SC	5711	80.44	8.51	82.19	26.17	99.56	73.39	-1.50	2.84
CD	5492	83.42	9.32	84.35	0.00	100.73	100.73	-2.11	5.75

Note: HSL = less than high school diploma; HSA = alternative high school diploma; HSD = high school diploma; SC = some college; CD = college degree.

Table C-3. Descriptive Statistics for MM-RS Efficiency Score by Enlistment Type

	N	Mean	SD	Median	Min	Max	Range	Skew	Kurtosis
GTEP	81958	79.55	8.61	81.60	0.00	103.20	103.20	-1.65	4.11
Open M	20713	79.60	7.43	81.12	41.88	99.69	57.80	-1.52	3.01
Open A	3455	78.15	7.65	80.34	53.18	98.94	45.77	-1.15	1.63
Open G	18455	79.56	8.18	81.27	25.25	100.73	75.47	-1.15	1.82
Open E	4858	80.94	7.78	82.62	41.25	97.96	56.71	-1.51	3.14

Table C-4. Descriptive Statistics for MM-RS Efficiency Score by Term of Enlistment

	N	Mean	SD	Median	Min	Max	Range	Skew	Kurtosis
Four Year	36728	76.82	8.70	74.47	0.00	100.73	100.73	-0.64	1.28
Six Year	65668	80.64	7.85	81.66	0	99.64	99.64	-2.15	6.14

Table C-5. Descriptive Statistics for MM-RS Efficiency Score by Accelerated Promotion

	N	Mean	SD	Median	Min	Max	Range	Skew	Kurtosis
No	90198	79.58	8.13	81.42	0.00	103.2	103.2	-1.55	3.91
Yes	17810	80.41	7.75	81.61	0	99.64	99.64	-2.05	6.01

Table C-6. Descriptive Statistics for MM-RS Efficiency Score by Waiver

	N	Mean	SD	Median	Min	Max	Range	Skew	Kurtosis
No	111157	79.75	8.13	81.5	0	100.73	100.73	-1.57	3.86
Yes	12940	79.92	8.23	81.5	8.01	103.2	95.19	-1.61	4.29

APPENDIX D – Age Scatterplot 1T0X1

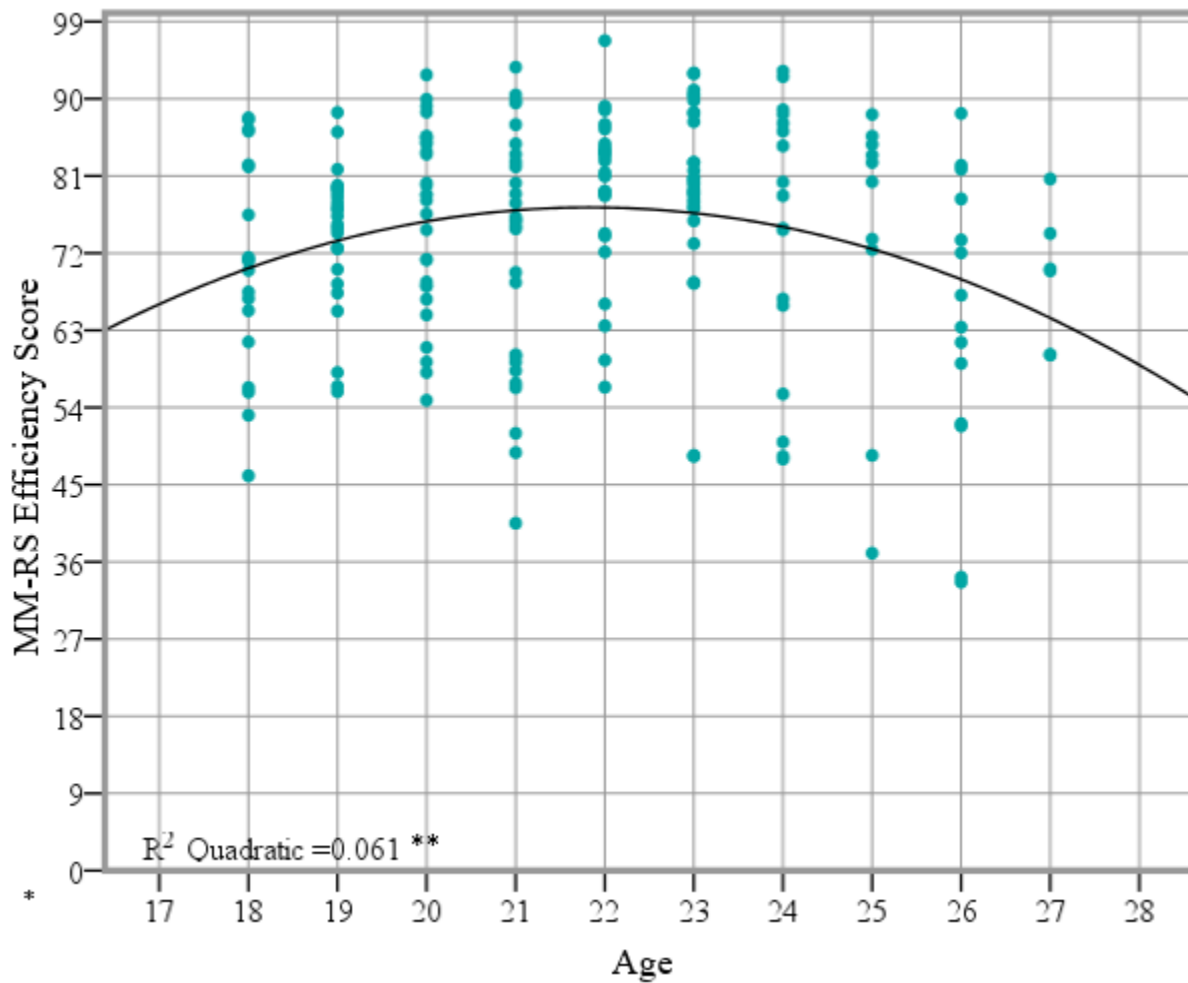


Figure D-1. Scatterplot for 1T0X1

APPENDIX E – TAPAS Version and MM-RS_{EFF} Correlations for Select AFSs

Table E-1. Correlations Between TAPAS Variables and MM-RS_{EFF} for Individual AFSs

	2A5X1				2W0X1				3P0X1				4N0X1			
	V4	V5	V7	V8	V4	V5	V7	V8	V4	V5	V7	V8	V4	V5	V7	V8
Dominance	.12	.05	.02	.17	-.03	.08	.14	.08	.02	-.01	.03	.03	.05	-.04	.23	-.08
Even Tempered	.01	-.01	-.04	.03	.00	.01	.06	.14	.01	-.01	.04	.06	.00	.02	.13	.06
Intellectual Eff	-.06	.03	-.10	.19	.03	-.01	.20	.04	-.02	-.02	.04	.05	.05	-.03	-.01	.02
Non-Delinquency	.01	.02	-.01	.09	.09	.01	.03	.07	-.01	.00	.07	.03	-.12	.16	.12	.01
Physical Cond	-.05	-.03	.18	.03	.05	.12	.06	.01	.04	-.02	.07	-.01	.03	.08	.10	-.01
Cooperation	-.02	-.14	-.07		-.09	.00	.01		.04	.00	-.05		-.02	.14	.05	
Order	-.03	-.04	-.12		.06	.01	.03		.03	.05	.06		.09	.08	.06	
Sociability	-.05	.13		.05	-.09	.06		-.05	.00	-.05		-.03	-.07	-.13		.12
Tolerance	-.01	-.17		.21	.02	.04		.08	.02	.01		-.03	.04	.01		-.07
Achievement	.04	-.08	-.08	.13	.06	.01	.16	.12	.05	.03	.06	.05	.08	.13	.07	.07
Adjustment	-.11	-.02	.03	-.19	-.06	.01	-.11	-.10	-.02	.03	.01	-.02	.00	.01	.18	-.03
Self-Control	.04	-.03		.04	-.03	.02		.14	.02	-.02		.05	-.01	.10		.07
Attention Seeking	-.01	.04	-.10	.08	-.06	-.04	-.06	.01	-.03	-.03	.01	-.03	-.02	-.19	-.05	.04
Optimism	-.05	.05	-.14	-.06	.06	.05	.04	.01	.03	.07	.05	.08	-.06	.04	.05	-.03
Selflessness	.03	-.17	-.15		.04	.11	.19		.01	.04	.04		.05	.08	-.04	
Adventure Seek			-.05				-.04				-.06				.07	
Commit to Serve			.12				.17				.03				-.20	
Situational Aware			-.10				.03				-.01				.07	
Courage				-.10				.03				-.05				-.14
Responsibility				.08				.04				.05				.11
Team Orientation				.22				.16				-.05				.06

Note: Significant values are in bold.

APPENDIX F – Correlation Table for MM-RS Predictors Except TAPAS

Table F-1. Zero-Order Correlations

	Variable	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	M	124689	1	.66	.81	.78	.24	.06	-.02	-.08	.04	-.05	.06	.09	-.01	-.11	.15	.09	-.18	.00	.05
2	A	124689	.83	1	.81	.74	.14	.02	-.04	-.07	.01	-.07	.07	.13	-.01	.01	-.02	.11	-.10	-.01	.08
3	G	124689	.90	.94	1	.78	.20	.04	-.04	-.09	.04	-.06	.07	.12	-.01	.01	.03	.11	-.17	-.01	.07
4	E	124689	.91	.92	.93	1	.13	.03	-.01	-.06	.02	-.05	.05	.09	.00	-.07	.06	.16	-.16	.00	.07
5	Age	129070	.27	.19	.23	.19	1	.12	-.10	-.21	.02	-.16	.14	.35	-.01	.03	-.02	.02	-.02	-.04	.12
6	Waiv	123753	.08	.05	.06	.06	.13	1	.00	-.03	.01	-.01	.03	.02	-.02	-.01	.03	.01	.00	-.01	.01
7	TOE	102122	.02	.00	.01	.02	-.09	.00	1	.01	.00	.10	-.06	-.12	.07	-.12	.04	.01	-.05	.23	.22
8	HSL	120283	-.08	-.08	-.08	-.07	-.21	-.03	.00	1	-.02	-.57	-.05	-.05	.02	.00	-.02	-.02	.02	.00	-.03
9	HSA	120283	.03	.01	.02	.02	.02	.01	.00	-.02	1	-.21	-.02	-.02	.00	.00	.01	.00	-.01	.01	-.01
10	HSD	120283	-.06	-.08	-.07	-.07	-.16	-.01	.09	-.56	-.21	1	-.52	-.50	-.01	-.03	.04	.01	.00	.03	-.05
11	SC	120283	.07	.08	.08	.07	.15	.03	-.05	-.06	-.02	-.52	1	-.05	-.01	.03	-.02	.00	-.01	-.02	.02
12	CD	120283	.11	.13	.13	.12	.35	.02	-.12	-.05	-.02	-.50	-.05	1	.02	.02	-.04	.00	-.01	-.04	.11
13	GTEP	129070	.00	.00	.00	.00	.00	-.02	.07	.02	.00	-.02	-.01	.02	1	-.54	-.57	-.26	-.22	.10	.01
14	OPG	129070	-.33	-.23	-.25	-.29	-.05	-.03	-.12	.02	-.01	-.01	.00	-.01	-.51	1	-.18	-.08	-.07	-.06	-.01
15	OPM	129070	.31	.18	.22	.24	.04	.04	.05	-.04	.02	.03	.00	-.01	-.55	-.24	1	-.09	-.07	-.05	.00
16	OPE	129070	.25	.28	.27	.30	.06	.02	.01	-.03	.00	-.01	.02	.03	-.25	-.15	-.02	1	-.03	-.03	.03
17	OPA	129070	-.28	-.24	-.27	-.27	-.05	-.01	-.05	.02	-.01	.01	-.02	-.02	-.21	.01	-.13	-.09	1	-.03	-.03
18	AccP	107724	.01	.00	.01	.01	-.04	-.01	.23	.00	.01	.03	-.02	-.04	.10	-.06	-.05	-.02	-.03	1	.04
19	MM-RS	129070	.09	.12	.11	.11	.13	.01	.23	-.03	.00	-.06	.02	.11	.01	-.03	.02	.05	-.05	.04	1

Note: Range restriction corrected correlations are reported below the diagonal. Significant observed correlations are in bold. Significance for corrected correlations is not reported. M = mechanical ASVAB composite; A = administrative ASVAB composite; G = general ASVAB composite; E = electrical ASVAB composite; HSL = less than high school degree; HSA = alternative high school degree; HSD = high school diploma; SC = some college; CD = college degree; OPG = open general; OPM = open mechanical; OPE = open electrical; OPA = open administrative; GTEP = guaranteed enlistment; TOE = term of enlistment; AccP = accelerated promotion; Waiv = waiver.

LIST OF SYMBOLS, ABBREVIATIONS, AND ACRONYMS

<	less than
%	percent
A	Administrative ASVAB composite
Adj R ²	coefficient of multiple determination adjusted for number of predictors in the model
ADSS	AETC Decision Support System
AETC	Air Education and Training Command
AFECD	Air Force Enlisted Classification Directory
AFRS	Air Force Recruiting Service
AFS	Air Force Specialty
AFSC	Air Force Specialty Code
AF-WIN	Air Force Work Interest Navigator
APDS-PROMIS	Advanced Personnel Data System Procurement Management Information System
ANOVA	analysis of variance
ASVAB	Armed Services Vocational Aptitude Battery
BMT	Basic Military Training
CAFSC	Control Air Force Specialty Code
CD	college degree or professional certification
CDC	career development course
<i>d</i>	Cohen's <i>d</i> effect size
DEP	delayed enlistment program
DoD	Department of Defense
DSYX	Air Force Personnel Center Strategic Research and Assessment Branch
E	Electrical ASVAB composite
G	General ASVAB composite
GTEP	Guaranteed Training Enlistment Program
HSA	alternative high school diploma
HSD	high school diploma
HSL	less than high school diploma
M	Mechanical ASVAB composite
MAGE	Mechanical, Administrative, General, and Electrical ASVAB composites
MEPS	Military Entrance Processing Stations
MilPDS	Military Personnel Data System
MM-RS	Months of Mission-Ready Service
MMRS _{EFF}	MM-RS Efficiency Score; the MM-RS _{WTS} divided by the MM-RS _{MAX}
MM-RS _{MAX}	MM-RS Maximum Score; the maximum MM-RS _{WTS} in a given specialization
MM-RS _{WTS}	MM-RS Weighted Score; Raw MM-RS score with weighted skill levels
N	sample size
OJT	on the job training
OPA	open Administrative enlistment
OPE	open Electrical enlistment
Open AI	Open Aptitude Indicator

OPG	open general enlistment
OPM	open Mechanical enlistment
p	probability
PACE	Processing and Classification of Enlistees system
PJM	Person-Job Match
QMM	Qualified Man-Months
R	multiple correlation coefficient
R^2	coefficient of multiple determination
REF	reference variable in dummy coding
SC	some college but no degree
SD	standard deviation
SERE	Survival, Evasion, Resistance, and Escape
SPSS	Statistical Package for the Social Sciences
SQT	Army Skill Qualification Test
TAPAS	Tailored Adaptive Personality Assessment System
TOE	term of enlistment
USAF	United States Air Force
VOICE	Vocational Interest Career Examination