

# HESI Admission Assessment, HESI Radiography Exit Exam, and ARRT Outcomes

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**Purpose** To analyze a radiography program's use of the Health Education Systems Incorporated Admission Assessment (HESI A2) and the HESI Exit Exam for preparing graduates to take the American Registry of Radiologic Technologists (ARRT) certification and registration exam for radiography.

**Methods** The program collected exam scores from the HESI Exit Exam for radiography and the ARRT radiography certification and registration exam for a 10-year period. The study included scores of 171 students who graduated from the radiography education program. The program administered the HESI A2 exam during the last 4 years of the study period, which included 81 students. The authors analyzed the data using mean differences, correlations, and a receiver operating characteristic curve analysis.

**Results** The correlation of HESI A2 scores with final HESI Exit Exam scores was 0.58 and with ARRT exam scores it was 0.64, which are extremely high correlations in an admissions context. The correlation of final HESI Exit Exam scores with ARRT exam scores was 0.73, which also is a strong correlation for predicting ARRT exam success. More than 94% of students who scored above the recommended performance level of 750 on the second HESI Exit Exam passed the ARRT exam on the first attempt. A receiver operating characteristic curve analysis indicated that the final HESI Exit Exam score was a strong predictor of pass or fail status on the ARRT exam.

**Discussion** The HESI A2 and Exit Exam are effective measurement tools when used with cogent testing policies. Such policies include strong proctoring practices such as rigorous in-person testing or online proctoring with an attentive, live proctor. Having practice exam results count for a reasonable amount of a course grade (eg, less than 30%) also could be a good policy for the HESI Exit Exam.

**Conclusion** The HESI A2 and Exit Exam are effective tools for helping radiography educators select students for admission and measure student knowledge to help achieve positive certification outcomes.

**Keywords** | *HESI, admissions, radiography, ARRT, certification, certification and registration*

**P**recise and accurate diagnostic imaging is essential for promoting high standards of patient care. Radiologic technologists ensure imaging is sufficient for diagnostic needs and safe for the patient and radiographer. Excellence in radiologic technology education begins with good admissions practices. Although there is some research addressing the selection of qualified radiologic technology applicants for radiologic technology programs, evidence concerning preadmission attributes and program success across time is lacking, especially regarding graduates' success on the

American Registry of Radiologic Technologists (ARRT) radiography certification and registration exam.

There are education programs in the radiologic sciences at the certificate, associate, and baccalaureate levels in nonprofit and for-profit schools. Graduates must have a minimum of an associate degree to be eligible to take the ARRT exam. The radiologic technologist's educational process includes didactic and clinical competency components. Programs of study usually are full-time, and program success requires substantial student effort and ability. Accreditation

is an indicator of quality radiography education and verification of high standards. This is provided by the Joint Review Committee on Education in Radiologic Technology (JRCERT) or another of the several institutional accreditation agencies (ie, mechanisms) recognized by ARRT.<sup>1,2</sup> Currently, JRCERT is the only programmatic accreditation agency recognized by ARRT for radiography. JRCERT indicates that more than 600 radiography programs hold JRCERT accreditation in the United States.<sup>2</sup>

The primary outcome of radiography education is the ability to work as a radiographer. Most states require licensure after completion of an accredited program, and many states require ARRT certification and registration as a requirement for licensure. ARRT is the premier provider of credentials in medical imaging. ARRT has more than 320 000 radiographers currently certified and registered.<sup>3</sup> ARRT radiography certification indicates that a professional radiographer has completed a formal education program, has demonstrated the knowledge and cognitive skills required for entry-level practice, will adhere to the ARRT Standards of Ethics, and will continue to maintain and grow in knowledge and skills through continuing education.

Quality admissions processes consider multiple pieces and sources of information. Many programs use admissions exam scores as a quantitative indicator to provide part of the information required in considering radiologic technology applicants. There is evidence to suggest appropriate selection of radiologic technology program applicants contributes to success in radiography education.<sup>4-6</sup> Preprogram academic indicators such as high school rank, SAT scores, and select prerequisite college courses support future student success,<sup>4,5</sup> but these indicators might not reflect the current abilities of diverse program applicants. The rigor of high school and external college courses can vary widely, and general college admissions exams, such as the SAT and ACT, are not necessarily tailored to admissions in the allied health professions. Standardized admissions tests for allied health programs, such as the Health Education Systems Incorporated (Elsevier, HESI) Admission Assessment (A2), have demonstrated utility in the admissions process but have not provided insight related to certification exam success.<sup>7-9</sup> Higher scores

on the HESI Exit Exam ( $\geq 750$ ) have demonstrated predictive validity with success on the ARRT certification exam,<sup>7,10</sup> but inconsistent measurement of applicant academic ability precludes a connection with preadmission factors. Therefore, the systematic evaluation of preadmission testing, resources used in radiography student preparation and program completion, and the evaluation of both factors with ARRT certification exam success is needed.

Building and properly using measurements that help with radiography admissions and that predict radiography applicant future success are extremely relevant to practice. Admitting too many applicants who likely will be unsuccessful in a radiography program limits a program's ability to prepare enough new radiographers to meet industry demand. Graduating students without gathering precise measurements about the knowledge and cognitive skills required for entry-level practice does not properly prepare the graduates for the ARRT exam. Because of recent declines in ARRT exam pass rate and the likely need for more medical imaging by an aging American population, quality assessments related to admissions or students' current level of radiography knowledge are vital to preparing and graduating enough practice-ready radiographers.<sup>11,12</sup>

This study examined whether admissions and testing tools, when used together with good testing policies, can measure readiness for radiography graduate success on the ARRT exam by analyzing correlations of student performance on a radiologic technology program admission exam (HESI A2), an end-of-program radiologic technology exam (HESI Exit Exam), and the ARRT exam. The study evaluated the HESI A2 and HESI Exit Exam scores as predictors of ARRT exam success. The guiding research questions were:

- Are HESI A2 scores related to HESI Exit Exam scores?
- Are HESI Exit Exam scores predictive of ARRT exam scores?
- Are the suggested HESI Exit Exam benchmark scores of 700 to 749 (acceptable) and 750 or higher (recommended) predictive of ARRT exam success?
- What is the relationship between HESI A2 scores and ARRT exam scores?

## Methods

This longitudinal retrospective study analyzed pre-existing data (HESI A2, HESI Exit Exam, and ARRT exam scores) from a particular radiography program in the Pacific Northwest of the United States. The program is designed to be completed in 2 years of full-time education, programmatically accredited by the JRCERT, and institutionally accredited by the Northwest Commission on Colleges and Universities. Programmatic data were systematically collected and maintained in real time as part of regular efforts to evaluate and improve the entire educational administration process, including policies for exam use and teaching emphasis in the curriculum. Students included in this study were enrolled in the radiography program throughout the 2011 to 2012 and 2021 to 2022 academic years and took their ARRT exams between 2013 and 2022. During the 10-year longitudinal study, the program received more applicants than it accepted, and attrition from course failure was 1.7% (171 out of 174 students completed the program).

After the Lewis-Clark State College Institutional Review Board approved this study as not qualifying as research on human subjects (proposal SS-22-25), the authors prepared the preexisting scores from 171 students for research analysis. Data were matched by a unique identifier before being shared with the research team; this allowed confidentiality of student names with performance metrics.

## Hypotheses

The 4 hypotheses corresponding to the research questions guiding this study were:

- HESI A2 scores are related to radiography success as measured by the HESI Exit Exam (ie, higher HESI A2 scores are related to higher HESI Exit Exam scores).
- HESI Exit Exam scores are predictive of ARRT exam scores (ie, higher HESI Exit Exam scores are related to higher ARRT exam scores).
- The suggested HESI Exit Exam benchmark scores of 700 to 749 (acceptable) and 750 or higher (recommended) are predictive of ARRT exam success.
- There is a positive relationship between preadmission HESI A2 scores and ARRT exam success.

## Instruments

The 3 measurement instruments in this study were the HESI A2, the HESI Exit Exam for radiography, and the ARRT certification and registration exam for radiography.

### HESI Admission Assessment

HESI A2 results provide a standardized and objective measure of academic knowledge via a comprehensive composite score. The HESI A2 covers subject areas of anatomy and physiology, biology, chemistry, grammar, mathematics, reading comprehension, and vocabulary. Dozens of radiography education programs use the HESI A2 as a part of the admissions process. The radiography program in this study administered all 7 of the HESI A2 subjects in the overall composite score.

The content tested by the HESI A2 is potentially highly applicable to predicting future achievement in radiography. As outlined by the ARRT Radiography Examination Content Specifications, effective January 2022, the ARRT radiography exam has content directly related to multiple HESI A2 subject areas such as anatomy and physiology (eg, procedures, topic area 2 of 4); biology (eg, safety, section 1.B.); chemistry (eg, patient care, section 1.G.); and mathematics (eg, safety, section 1.A.).<sup>13</sup> Furthermore, although the ARRT exam is not a test of English proficiency, the exam is administered in English. Successfully answering the questions requires reading comprehension skills and a fundamental level of grammar and vocabulary knowledge. Therefore, successful radiography students must be proficient in these areas. The HESI A2 is not tailored for measuring radiography-specific content; however, exploring whether it can predict future student achievement as measured by HESI Exit and ARRT exams is worth exploring.

HESI A2 scores range from 0% to 100% with higher scores indicating greater understanding and mastery of the academic area.<sup>14</sup> Although schools select their own admission parameters (eg, composite score vs minimum score for all individual assessments), scoring recommendations are that applicants who achieve 75% or more demonstrate an adequate understanding of the academic material.<sup>14</sup> Thus, some schools have shared with the HESI A2 vendor that they expect a minimum

## Original Research

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HESI A2 score of 75% as an important aspect of their admission process. The program in this study typically admitted applicants that achieved scores of 75% or higher on the composite score but also occasionally admitted applicants with lower scores if they met additional admittance criteria as determined by college officials. Because program admittance occurred annually, applicants were limited to a single entrance test attempt per admission cycle. During the duration of this study, there were no repeat HESI A2 exams recorded; therefore, all scores used corresponded to the applicant's first attempt.

#### HESI Radiography Exit Exam

The HESI Exit Exam is a summative assessment designed to measure a student's readiness to pass the ARRT exam. It includes 220 items designed to mimic the content and item writing style of the ARRT exam. All scored exam items undergo rigorous test development review. There are multiple parallel versions of the HESI Exit Exam, allowing for independent evaluation of student knowledge if repeat testing is needed. Scores on the HESI Exit Exam usually range from 0 to 1600 depending on the item difficulties on the exam. Scores of 700 to 749 are labeled as acceptable performance and 750 or more as recommended performance in the context of preparation and assessment ahead of a radiography certification exam.<sup>15</sup>

#### ARRT Radiography Certification Exam

The ARRT certification and registration exam is a crucial exam administered at Pearson VUE professional testing centers. During the years of this study, the exam consisted of 220 questions (200 scored and 20 pilot). Scores ranged from 1 to 99 with scaled scores of 75 or higher corresponding to a passing score. For the exams analyzed in this study, a scaled score of 75 corresponded to approximately 68% correct.<sup>16</sup>

#### Data Collection Process

The total number of participants in this longitudinal study was 171 students. This represents all students who took the HESI A2 and HESI Exit Exam, graduated from the radiography program, and took their ARRT exam between spring 2013 and spring 2022. This window of

time was ideal for 3 reasons. First, it was sufficient time to gather a large enough sample size for a meaningful study. Second, the ARRT exam content during this period was stable; ARRT made a substantial update to the content to eliminate analog imaging before this study began. ARRT updated their content specifications once during this study, and those updates were minor. Finally, ARRT used the same passing standard throughout this period. Therefore, all the ARRT exam scaled scores in this study can be interpreted similarly.

All applicants completed the application process before acceptance into the program. The HESI A2 became part of the admission process with the fall 2017 cohort; HESI A2 data were available for 81 accepted applicants. The mean (standard deviation [SD]) HESI A2 composite score for applicants in this study was 82.8 (6.8).

The radiography program administered the HESI Exit Exam twice during the students' program of study. Students took the first HESI Exit Exam in the final 3 weeks of the program's penultimate semester. The radiography program used these results as an initial check of student preparedness before students had completed their clinical competency requirements. Students completed the second HESI Exit Exam near the end of the final semester in the education program. There was no repeat administration of the same HESI Exit Exam version; students had 1 attempt each. The HESI Exit Exam scores comprised 25% of a course grade during each of the 2 respective semesters in which the program administered the exams (1 in the penultimate semester and 1 in the final semester). HESI Exit Exam data were available for 171 students. Mean (SD) HESI Exit Exam scores for students in this study were 758.7 (150.6) for the first administration and 946.8 (154.3) for the second administration.

There was little deviation in HESI Exit Exam administration over time. From 2013 to 2017, the program director administered and proctored the HESI exams in a designated computer laboratory. The testing environment had a variety of security measures in place such as protected usernames and passwords, no outside materials allowed, access codes provided on site, and a 4-hour time limit. In 2018, a LockDown (Respondus, Inc) browser was incorporated as an additional security

measure. HESI testing in the spring of 2020 resulted in a nontypical testing scenario because of COVID-19 restrictions that prohibited students from attending the physical campus. Administration for these HESI exams allowed students to take exams from their homes. Proctoring occurred with Zoom Oversight (Zoom Video Communications, Inc) and the LockDown browser. Students completed all exams within the 4-hour time limit, but some students experienced interruptions from faulty internet connections or a range of miscellaneous disruptions from external factors due to taking an exam in a home environment. In 2022, the program modified HESI testing regulation to more closely mimic the ARRT testing experience. Testing took place at the campus testing center where students called to schedule their own exams and supplied 2 forms of identification on arrival. The goal of the program was to simulate the typical ARRT testing requirements and environment as closely as possible.

All graduates took the ARRT exam within 1 month of graduation. Graduates reported back to the program director with the exam date, the scaled score, and the pass or fail status of their first ARRT exam. This reporting back to the director was strictly optional. The program director clearly outlined that students did not have to report back scores and that the scores reported back were a part of the program's regular data gathering efforts to research quality improvement and student success. The program director confirmed the graduates' scores using ARRT's educator website. Although ARRT does not associate individual examinee information to test scores, the program director's weekly check of the educator website along with the graduates' self-reported information made it possible to confirm overall scaled-score information reported by graduates. This study recorded graduates' first attempts on ARRT exams. For this research, all 171 graduates had confirmed ARRT exam scores. Graduates in this study had a mean (SD) ARRT exam score of 82.4 (5.6).

The director of the radiography program in this study followed a structured process for collecting data. The director recorded every applicant's HESI A2 score corresponding to the successful admittance attempt for students from 2017 and later. The director recorded every student's first and second HESI Exit Exam scores.

Both data recording efforts used Elsevier's report builder software to help group these multiple exam scores to a single student's record. After associating graduate exam scores to each individual participant, the program director removed all identifying information from the data before analyzing the data as a part of the full research team. The director transferred data to a secure research platform only available to the research team and without student identifiers. The program director consolidated the data so that all academic years were in 1 data frame.

### Analyses

The research team examined whether there were significant performance differences on the HESI Exit Exam and ARRT exam between those who had HESI A2 scores and those who did not. There were 81 participants with HESI A2 scores and 90 participants without HESI A2 scores. Results from independent samples *t* tests showed that participants that had HESI A2 scores (ie, the final 4 years of the study) had significantly lower scores on the first HESI Exit Exam ( $P < .01$ ). Because the predictive power of the first HESI Exit Exam was not the central focus of the study, all participants remained a part of the total group for analysis.

In preparing data for analysis, the research team conducted basic descriptive statistics of the 3 exams. Comparing ARRT exam statistics between the radiography program and first-time ARRT examinees was most important. If the statistics between the radiography program and first-time ARRT examinees were highly dissimilar, then the results of this study could have limited generalizability.

After the preliminary screenings, the research team analyzed the data based on the 4 research hypotheses. The nominal alpha was .05 for tests of statistical significance. The analyses that corresponded to hypothesis 1 included correlations between HESI A2 exam scores and the first and second HESI Exit Exam scores, and mean scores for the HESI Exit Exam conditional on various HESI A2 score ranges. Correlations and patterns in conditional means are a classic measure that gives validity evidence.<sup>17</sup>

For hypothesis 2, analyses included correlation between HESI Exit Exam scores and ARRT exam scores, mean scores from the first and second HESI

Exit Exam for participants who passed the ARRT exam vs those who failed, and mean ARRT exam scores and pass rates conditional on various HESI Exit Exam score ranges. Contrasting group means are a measure of validity evidence.<sup>17</sup>

Hypothesis 3 analyses included receiver operating characteristic (ROC) curve analysis of second HESI Exit Exam scores predicting ARRT exam scores; prediction-related metrics (sensitivity, specificity, positive predictive value, negative predictive value) at several key HESI score cut points; and mean HESI Exit Exam scores for participants with nearly passing ARRT exam scores. ROC analyses, along with various prediction metrics, are important tools to quantify how well a given test predicts whether an examinee falls into a certain group (eg, passing vs failing the ARRT exam).<sup>18,19</sup> The research team conducted the ROC analyses using the ROCit package in R; the remaining analyses were conducted using the base R packages.<sup>20,21</sup> Mean HESI Exit Exam scores for participants with nearly passing ARRT exam scores are a specific case of contrasting group means, which can be used to evaluate whether HESI benchmarks are appropriate.

For hypothesis 4, correlations between HESI A2 exam scores and ARRT scores, and mean scores for the ARRT exam conditional on various HESI A2 score ranges were analyzed.

### Results

The statistical comparison of scores from the current study with those from all ARRT exams is important (see **Table 1**). The statistics for all ARRT exam scores came from statistical reports that ARRT publishes<sup>16</sup> and are the annual volume-weighted mean of the reported statistics for first-time examinees. Statistical reports were available on the ARRT website for exams taken from 2017 through 2021.

The mean performances of all first-time ARRT examinees and first-time examinees from this study were close. The mean scores were within 1 scaled-score point. The ARRT exam pass rates were within 4%. The variation of scores for those in the current study was lower than that for all ARRT examinees because the program in this study had no very low (< 65) or very high (> 95) ARRT scaled scores.

### *Hypothesis 1: Relationship Between HESI A2 Scores and HESI Exit Exam Scores*

All Pearson correlations between exam scores observed in this study were significantly greater than 0 (see **Table 2**). Among those correlations are the correlations between scores on the HESI A2 and the HESI Exit Exams. The correlation between the HESI A2 scores and the first HESI Exit Exam scores was 0.55, and it was 0.58 between the HESI A2 scores the second HESI Exit Exam scores. These correlations are high in the admissions context and indicate that HESI A2 scores have predictive power for HESI Exit Exam scores; for context, a meta-analysis found that the uncorrected correlation between ACT score and first-semester college grade point average was 0.38.<sup>22</sup> However, there is restriction of range because the program typically does not admit applicants with very low admission scores, which is the case with most entrance exams. The HESI A2 correlations would have been higher when correcting for this restriction of range.

Performance on the first and second HESI Exit Exams increased as the HESI A2 performance range increased (see **Figure 1**). Although the sample size for the groups was small, the lower score performance for those scoring less than 75% on the HESI A2 provides some evidence supporting 75% as a reasonable potential admittance score for radiography education programs. As with the correlation results, these results indicate that HESI A2 scores are a good predictor of HESI Exit Exam performance.

### *Hypothesis 2: Relationship Between HESI Exit Exam Scores and ARRT Scores*

Table 2 also contains correlations between scores from both HESI Exit Exams and ARRT exam scores. The correlation between the first HESI Exit Exam scores and ARRT exam scores was 0.69, and between the second HESI Exit Exam scores and ARRT exam scores, it was 0.73. This indicates a strong linear relationship between performance on the HESI Exit Exams and on the ARRT exam, which is evidence for HESI Exit Exam scores being a strong predictor of ARRT exam scores.

The mean HESI Exit Exam score was substantially different between those who failed the ARRT exam and those who passed (see **Figure 2**). On the first HESI Exit

Table 1

**Descriptive Statistics of Scores by Exam**

| Exam                             | N   | Mean (SD)     | Median (IQR)         | Midspread | No. passing, % |
|----------------------------------|-----|---------------|----------------------|-----------|----------------|
| HESI A2 <sup>a</sup>             | 81  | 82.8 (6.8)    | 82.9 (77.7-87.4)     | 9.7       | -              |
| HESI Exit Exam, 1st <sup>b</sup> | 171 | 758.7 (159.6) | 741.5 (643.0-855.8)  | 212.8     | -              |
| HESI Exit Exam, 2nd              | 171 | 946.8 (154.3) | 943.0 (827.0-1052.0) | 225.0     | -              |
| ARRT, current study <sup>c</sup> | 171 | 82.4 (5.6)    | 83.0 (79.0-86.0)     | 7.0       | 91.2           |
| ARRT, 2017-2021                  | -   | 83.2 (7.5)    | 84.2 (79.0-88.8)     | 9.8       | 87.9           |

<sup>a</sup> HESI A2 scores range from 0%-100%.

<sup>b</sup> HESI Exit Exam scores range from 0 to 1600: for radiography, 700-749 was acceptable performance and  $\geq 750$  was recommended performance.

<sup>c</sup> Scores range from 1 to 99; scaled scores  $\geq 75$  correspond to a passing score.

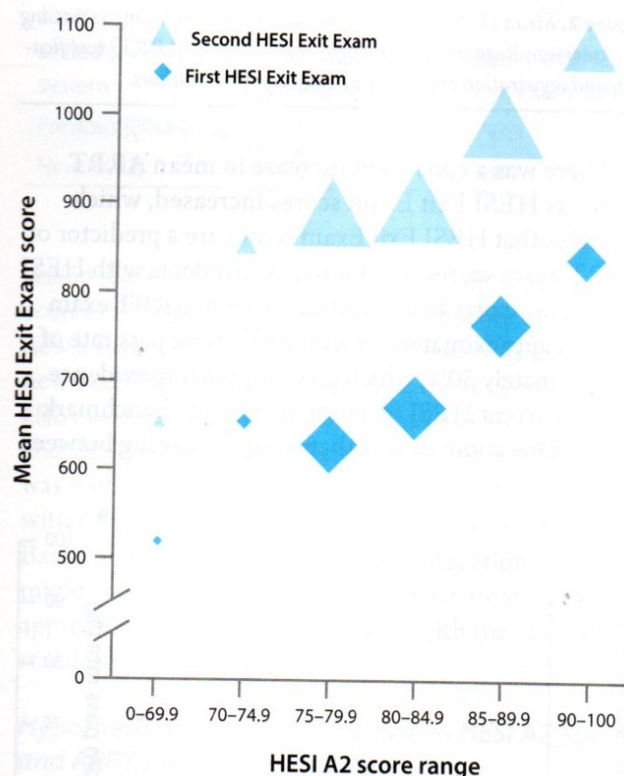
Abbreviations: A2, Admission Assessment; ARRT, American Registry of Radiologic Technologists; HESI, Health Education Systems Incorporated; IQR, interquartile range; SD, standard deviation.

Table 2

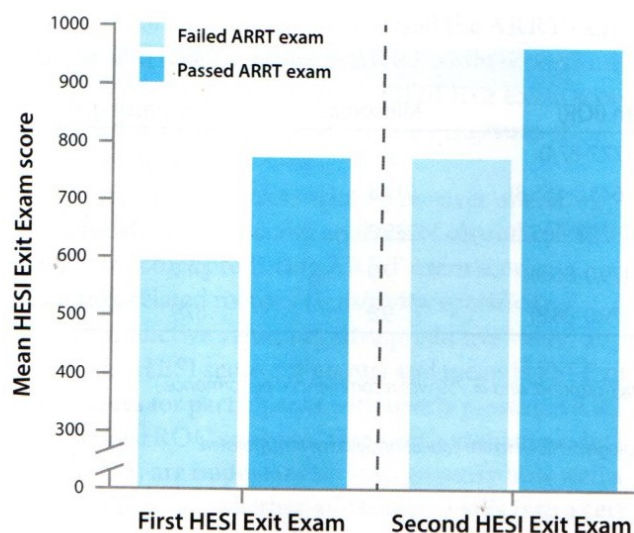
**Correlation in Performance Between Exams**

|                     | HESI A2 | HESI Exit Exam, 1st | HESI Exit Exam, 2nd | ARRT, current study |
|---------------------|---------|---------------------|---------------------|---------------------|
| HESI A2             | -       | -                   | -                   | -                   |
| HESI Exit Exam, 1st | 0.55    | -                   | -                   | -                   |
| HESI Exit Exam, 2nd | 0.58    | 0.73                | -                   | -                   |
| ARRT, current study | 0.64    | 0.69                | 0.73                | -                   |

Exam, the difference was 180 points higher for those who passed the ARRT exam, and the difference on the second HESI Exit Exam was 192 points higher for those who passed the ARRT exam. Both mean differences exceed 1 SD (see Table 1), which is a large difference by conventional standards. Graduates who failed the ARRT exam attained a mean score of 771.8 on the second HESI Exit Exam. That mean was lower than the mean of the first HESI Exit Exam for those who passed the ARRT exam (774.6). Students who would later pass the ARRT exam could, without an additional semester of study, achieve higher mean HESI Exit Exam scores than the failing ARRT exam group, which is an indication of how strong of a predictor that HESI Exit Exam scores were of future ARRT exam performance.



**Figure 1.** 1. Mean Health Education Systems Incorporated (HESI) Exit Exam score conditional on the HESI Admission Assessment (A2) score range. Graph shows correlation between performance on the HESI A2 and that on the HESI Exit Exams. Mean HESI Exit Exam scores, calculated from first and second attempt on the exam, plotted by key HESI A2 score ranges. Point size indicates relative sample size. Figure courtesy of the authors.



**Figure 2.** Mean HESI Exit Exam scores for students failing vs passing the American Registry of Radiologic Technologists (ARRT) certification and registration exam. Figure courtesy of the authors.

There was a consistent increase in mean ARRT scores as HESI Exit Exam scores increased, which indicates that HESI Exit Exam scores are a predictor of ARRT exam scores (see **Figure 3**). Students with HESI Exit Exam scores below 750 had a mean ARRT exam score of approximately 75 with a first-time pass rate of approximately 50%, which gives supporting evidence for the current HESI recommended score benchmark of 750. One anomaly was that students scoring between

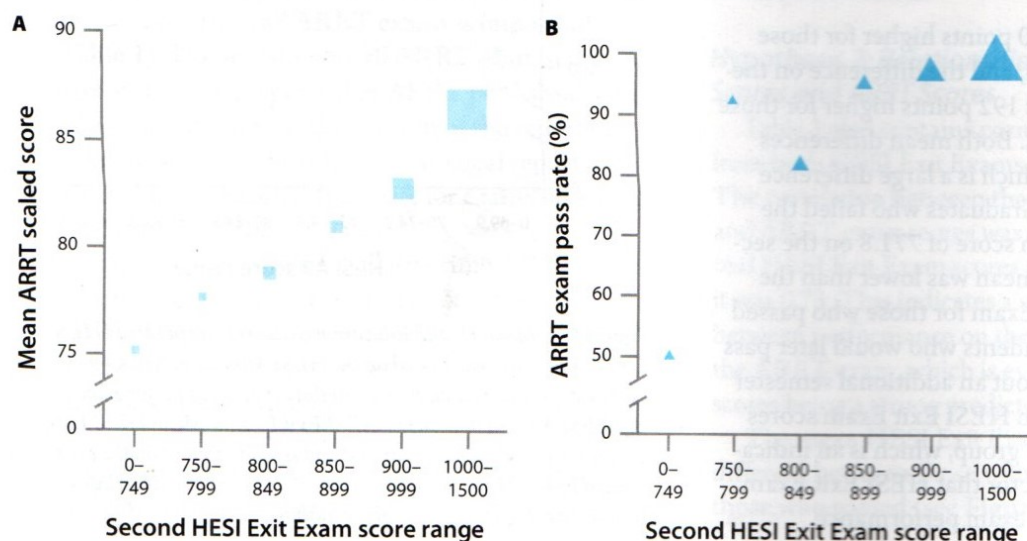
750 and 799 had a higher ARRT pass rate than students scoring from 800 to 849. This occurred because multiple people in the 750 to 799 range barely passed the ARRT exam, and several people in the 800 to 849 range barely failed the ARRT exam, with a small sample in both ranges.

### Hypothesis 3: Relationship Between HESI Exit Exam Benchmark Scores

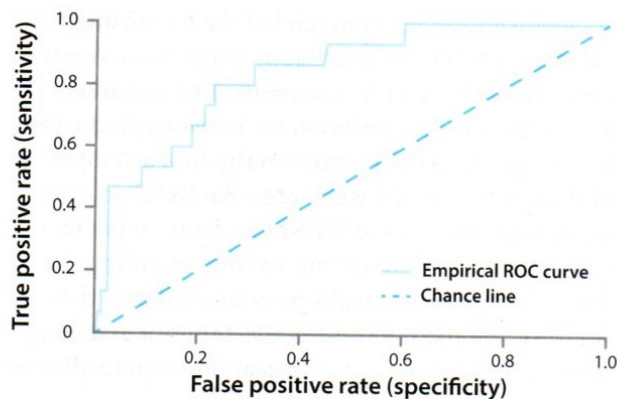
The shape of the ROC curve indicates that the HESI Exit Exam appears to be an effective predictor of ARRT exam pass or fail status (see **Figure 4**).<sup>23</sup> The area under the ROC curve was 0.84 (1.00 is perfect prediction, and 0.50 is chance prediction); this statistical amount is indicative of good prediction in the context of psychological measurement.<sup>23</sup>

Statistics for predicting an ARRT failing score based on cut scores from the second HESI Exit Exam were calculated (see **Table 3**). Lower cut scores tended to have a lower sensitivity to detecting failing scores on the ARRT exam but a higher positive predictive value. The specificity and negative predictive values, which were indicators of predicting a passing ARRT exam score, were high at all points examined.

The base rate of failing ARRT exam scores was low in this study (< 10%). A prediction scenario with a low base rate tends to have lower positive predictive values. Participants with low HESI Exit Exam scores received targeted remediation activities between the second



**Figure 3.** ARRT exam performance conditional on HESI Exit Exam score range. Graphs showing correlation between performance on the HESI Exit Exam and that on the ARRT exam. A. Mean ARRT scaled scores plotted by key second HESI Exit Exam score ranges. B. ARRT first-time pass rates plotted by key second HESI Exit Exam score ranges. Point size indicates relative sample size. Figures courtesy of the authors.



**Figure 4.** Receiver operating characteristic (ROC) curve for predicting failing scores on ARRT exam based on scores from second attempt of HESI Exit Exam. The ROC area under the curve was 0.84. Figure courtesy of the authors.

HESI Exit Exam and the ARRT exam. These activities might have helped some participants achieve better scores on the ARRT exam after graduation, which often is the goal of using HESI Exit Exams.

During the years covered by this research, the recommended score benchmarks for the HESI Exit Exam for radiography were 700 to 749 for acceptable performance and 750 or more for recommended performance. These benchmarks should correspond to certification exam score performance. In the current study, more than 94% of participants who scored above the recommended performance level of 750 on the second HESI Exit Exam passed the ARRT exam on the first attempt. To further evaluate these score benchmarks, the mean second HESI Exit Exam scores for those receiving near-passing ARRT exam scores (73, 74, and 75) were examined (see **Table 4**). The mean score of the 13 people in this group was 793.9. Although the sample size was small for this group, the results are indicative that the recommended benchmark score of 750 was in the appropriate range for this exam's purpose.

The ARRT announced that the passing standard for the ARRT exam will increase by approximately 4 questions in 2023.<sup>24</sup> Because of the scaling equation that ARRT uses and the general location of the cut points,<sup>16</sup> each scaled-score point corresponds to 2 or 3 questions. Thus, after the new ARRT standard goes into effect,

**Table 3**

**Statistics for Predicting an ARRT Failing Score Based on Cut Scores From Second HESI Exit Exam**

| Statistic                           | Cut scores |      |      |      |
|-------------------------------------|------------|------|------|------|
|                                     | 700        | 750  | 800  | 850  |
| Sensitivity (predicting failing)    | 0.40       | 0.47 | 0.53 | 0.80 |
| Specificity                         | 0.97       | 0.96 | 0.88 | 0.76 |
| Positive predictive value (failing) | 0.60       | 0.50 | 0.30 | 0.24 |
| Negative predictive value           | 0.94       | 0.95 | 0.95 | 0.98 |

**Table 4**

**Mean Second HESI Exit Exam Scores for Near-Passing Score Groups According to Previous And Current ARRT Scaled-Scoring Systems**

| ARRT scaled-scoring system | ARRT near-passing scoring range | N  | Mean 2nd HESI Exit Exam score |
|----------------------------|---------------------------------|----|-------------------------------|
| Previous (2013-2022)       | 73-75                           | 13 | 793.9                         |
| New (2023)                 | 75-78                           | 25 | 839.7                         |

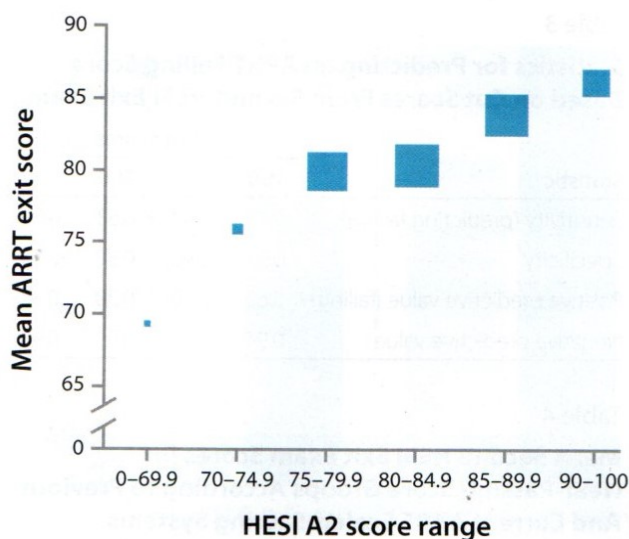
scaled scores of 75 will correspond to former scaled scores of 76 and 77. The former scaled score of 75 is now a scaled score of 73. To evaluate according to the new HESI Exit Exam benchmarks, the research team also evaluated HESI Exit Exam scores of 75, 76, 77, and 78. The mean HESI Exit Exam score for this group was 839.7. This is a difference of 45.8 points compared with the group of participants scoring 73, 74, and 75. Based on the new ARRT standard, education programs might use benchmark score ranges that are increased by approximately 50 points compared with the old ARRT standard, for example 750 vs 700.

**Hypothesis 4: Relationship Between HESI A2 Scores and ARRT Exam Performance**

The correlation between HESI A2 scores and ARRT exam performance was 0.64 (see **Table 2**). This correlation is high in the context of admissions correlations, especially because of the range restriction. Mean ARRT scaled scores increased as HESI A2 scores increased (see **Figure 5**). The mean ARRT scaled score for those in the 70 to 74.9 HESI A2 score range was slightly

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**Figure 5.** ARRT exam performance conditional on HESI A2 score range. Graph showing correlation between performance on the HESI A2 and that on the ARRT exam. Mean ARRT scaled scores plotted by key HESI A2 score ranges. Point size indicates relative sample size. Figure courtesy of the authors.

above 75, which is the passing point for the ARRT exam. Higher-scoring HESI A2 groups had mean ARRT performance well above passing. This evidence supports that HESI A2 scores, in addition to HESI Exit Exam scores, can predict ARRT performance.

### Discussion

This research studied the relationships between scores from the HESI A2, HESI Exit Exam for radiography, and ARRT radiography certification and registration exam in a radiologic technology program during a specific period to evaluate the effectiveness of HESI exams in predicting future ARRT exam performance. Participant scores on the HESI A2 were related to scores on the first and second administration of the HESI Exit Exam. The HESI A2 scores also were significantly related to graduate ARRT exam outcomes. Thus, higher scores on the HESI A2 were related to higher HESI Exit Exam scores and better ARRT pass rates. This provides evidence for HESI A2 score utility for admissions into a radiography program.

Student performance on the HESI Exit Exam improved from the first administration (third semester) to

the second administration (end of the fourth and final semester). The HESI Exit Exam scores were significantly related to ARRT outcomes. The mean score differences in HESI performance between graduates who passed the ARRT exam on the first attempt and those who failed it were large. An ROC analysis revealed that the second HESI Exit Exam score was highly effective at predicting passing vs failing the ARRT exam. These results provide evidence that the HESI Exit Exams are effective tools for assessing student achievement and certification exam readiness in radiography.

### Comparison With Previous Research

Similar to previous research,<sup>7,9</sup> applicants scoring at or above the recommended HESI A2 score were admitted to the radiography program examined in this research. However, accepted applicants participating in this program had higher average HESI A2 composite scores than did radiography program applicants in 2 other studies.<sup>7,9</sup> Previous research examining repeated administration of the HESI Exit Exam found little or no changes in performance. Participants in this study had a mean improvement in HESI Exit Exam scores of 188 after completing clinical competencies and additional coursework. The mean HESI Exit Exam scores for participants was similar to that reported in previous research.<sup>10</sup>

Correlations among the first HESI Exit Exam, second HESI Exit Exam, and ARRT exam scores were all high. This was consistent with past research on the HESI Exit Exam.<sup>7</sup> The HESI A2 correlations were high in the context of admission assessments, especially because of the effect that restriction of range had on correlations. This was consistent with past research showing that HESI A2 scores are an effective admittance tool for radiography programs,<sup>7</sup> adding further validity evidence for the use of HESI A2 scores. Because applicants scoring lower on admissions assessments typically are not admitted, the low range of scores on the HESI A2 and other exams is not available. This restriction suppresses the size of correlations,<sup>25,26</sup> thus the true correlations involving all HESI A2 and Exit Exam scores might be higher than reported in this study.

### Implications

This study examined acceptable performance and recommended performance benchmarks for HESI scores. Results found that graduates with near-passing ARRT exam scores had a mean HESI Exit Exam score close to the current recommended benchmark of 750. This provided some evidence that acceptable and recommended benchmarks were in the proper range for the period studied. The ARRT, however, raised the passing standard for the ARRT exam in 2023. Because of the change in near-passing scores, there are 2 possibilities to consider. First, the benchmarks for acceptable and recommended could be moved to 750 and 800, respectively. Second, the HESI Exit Exam scoring formula could be changed such that students must demonstrate higher performance to achieve the benchmark scores of 700 and 750.

Differences among the 3 exams should be considered. The HESI A2 is used in screening applicants to radiologic technology programs and provides a baseline measure of academic knowledge and ability. The HESI Exit Exams, however, are educational assessments. The goal of HESI Exit Exams often is threefold: to serve as a practice experience similar to the ARRT exam, to determine students' current achievement levels, and to identify areas where additional learning and remediation could benefit selected students. The hope is that students scoring low on a HESI Exit Exam will have time to improve their knowledge before the ARRT exam and beginning clinical practice. Any improvement would represent a good application of educational assessment. The ARRT exam is a certification assessment designed as a gatekeeping function to permit only people with sufficient knowledge and cognitive skills to become certified and registered as radiographers. Achieving a certain level of performance represents the goal of this measurement.

Additional learning interventions could be applied more heavily for low-scoring students than for high-scoring students, which could affect the correlation between HESI Exit Exam and ARRT exam scores. The correlation between HESI Exit Exam scores and ARRT exam scores likely would have been higher if the 2 tests were taken in the same week. The same is true if students scoring low on HESI Exit Exams had not

diligently participated in additional learning activities. Closer administration of exams and not participating in additional learning activities, however, are not beneficial to students' achievement or clinical practice.

The program in this study used strong proctoring practices for these exams. Students took exams in person, on campus with an attentive, on-site proctor or online with a live, remote proctor. Less rigorous practices, such as online record-and-review style administration or on-campus testing with no proctor in the room, can easily lead to circumstances where the scores achieved do not reflect students' ability levels. Further, the HESI Exit Exam scores counted for 25% of student course grades. Having the HESI Exit Exam count for 10% to 25% of a course grade is a reasonable amount of weight for an exam. Grading policies that weigh the HESI Exit Exam score as a higher percentage of a course grade (eg,  $\geq 33\%$ ) can inadvertently encourage students to participate in subversive exam behaviors.

### Limitations and Future Research

This study involved 1 education program. Although the ARRT exam scores from this education program were not substantially different from national ARRT scores, this program's scores were less variable with a slightly higher pass rate. This program implemented strong admissions criteria, secure proctoring practices, and recommended exam use practices. The program also gave students extensive resources for exam-score-guided learning and remediation. Programs not following these types of quality practices might experience worse results than those observed in this study. Future research could investigate how these policies affect how well HESI exams prepare students for the ARRT exam and radiography practice in the field.

A second limitation was that the radiologic technology program did not have many scores on the second HESI Exit Exam that were below the acceptable benchmark of 700. This result is a quantitative indicator of a quality radiography program but also makes it difficult to make strong claims about the characteristics of participants scoring very low on a HESI Exit Exam. Future research should attempt to obtain a larger number of very low scores to see if the trends hold for HESI Exit Exam scores predicting ARRT exam failing results.

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A third limitation of this study was the small sample size for the HESI A2. Although the HESI Exit Exams and ARRT exams had 10 years of data yielding a sample size of 171, less than half of the participants had HESI A2 scores because the HESI A2 had been implemented more recently. Future research should attempt to gather a larger HESI A2 sample size to study the properties of HESI A2 scores more thoroughly.

A fourth limitation is that the cause of the predictive relationship between the HESI A2, HESI Exit Exam, and ARRT exam is unknown. Although results demonstrated that HESI A2 scores can predict future success on the HESI Exit Exam and the ARRT exam, determining whether this prediction is because the HESI A2 content is relevant to the content of the ARRT and HESI Exit Exams or because the HESI A2 measures how well applicants take exams is not possible. However, the importance that passing ARRT exam scores have for individual graduate success and measuring overall program success is undeniable. A measuring instrument that can make accurate predictions about future ARRT exam success and success in key milestone measurements in a radiography program would be a useful tool to help decide which applicants to admit.

A fifth limitation of this study was the small sample size of graduates with borderline ARRT exam scores. Although these candidates' scores gave supporting evidence for the HESI Exit Exam benchmarks and guidance for future benchmarks, there were 25 or fewer people in each of the borderline groups. Future research should gather a larger group of borderline ARRT exam scores to evaluate the HESI Exit Exam benchmarks more thoroughly.

A sixth limitation was that this study only used HESI Exit Exam scores and not HESI Specialty Exam scores. Although HESI Exit Exam scores provide useful summative information when students will take the ARRT exam in the near future, HESI Specialty Exams measure more focused portions of radiography knowledge and commonly are administered earlier in the program. Future research should examine the relationship between HESI A2 scores and HESI Specialty Exam scores for exams administered early in the program.

## Conclusion

This study examined a decade of HESI and ARRT exam data from a radiography education program. Results showed HESI A2 and HESI Exit Exams to be effective tools when used with proper testing practices and score-use policies. Radiography programs can use the HESI Exit Exam to guide learning. When used with strong proctoring practices and cogent exam score-use policies, the HESI Exit Exam can be an important part of preparing students for the ARRT exam. Using HESI exams alone is not enough to guarantee success. Faculty should pair these scores with a solid plan of learning and remediation materials designed to enhance students' knowledge in the areas where scores are lowest. The HESI A2 scores also are useful in making prudent admission decisions and knowing which applicants might require more educational attention because they are coming in with near-passing performance. With the help of rigorous educational measurement, radiography programs can more effectively prepare their students for certification exam achievement and effective clinical practice.

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