





were included to make the results more generalizable.

### **Predictor variables**

#### *Undergraduate General Weighted Average (uGWA)*

The term "uGWA" indicates the average of all undergraduate course grades.

#### *National Medical Admission Test (NMAT)*

The NMAT is a two-part test: The four subtests that compose Part I measure aptitude, while the four subtests that compose Part II measure subject proficiency in areas which are part of the academic background required of applicants to the medical course.

Part I has five scores, one for each of the four aptitude subtests and their summative score, the APT Composite. Part II produces five scores, one for each of the four special subject areas and their summative score, the SA Composite. The General Performance Score (GPS) is the summative score derived from the eight subtests.

The results on the test are converted to standard scores from normalized scales with points ranging from 200 to 800 and a midpoint of 500. These scales were derived from the NMAT performance of the norm group. The test results of examinees are automatically compared to those of the norm group who has mean score of 500 and standard deviation of 100. A percentile rank scale is generated from the GPS for purposes of ranking. This scale has points ranging from 1- to 99+, with a midpoint of 50 which corresponds to the midpoint of 500 in the normalized standard score scales. (CEM, 2015)

### **Outcome variables**

#### *Medical school GWA (medGWA)*

Year 1 medical school final grades were treated as general weighted averages (medGWA). For each medical student, medGWA was computed by multiplying each course grade by the number of hours for that course, summing the weighted grades across courses, then dividing this sum by the total number of hours for that year. Each medical student's medGWA, together with the student's individual final

scores in the major subjects Anatomy, Biochemistry, Physiology, Histology and Neurology were extracted from the UST-FMS dean's office database.

#### *Failed*

Grades < 75points were considered as failures.

#### *Data gathering procedures*

Information regarding gender and premedical course together with the students' uGWA and NMAT scores were obtained from the UST-FMS admissions office database. medGWA was obtained from the UST-FMS dean's office database. Necessary information were collected and recorded using a data collection form that did not contain any personal identifiers. Only special code numbers appeared on the collection form.

#### *Ethical Considerations*

Any information that were obtained from the records was kept strictly confidential. The subjects were not identified by name in the data collection form and will not be identified in any future publication of the results. Moreover, information contained within the data collection form will only be used for this study.

#### *Statistical Analyses*

Means and ranges were utilized to summarize quantitative datasets uGWA, NMAT, and medGWA, while counts and percentages were used for qualitative datasets, gender and premedical course.

Linear regression was performed to determine factors that contributed to the students' final grades. Diagnostic checkings were performed to validate the results of the regression analysis. Univariate and multivariate logistic regression were performed to identify factors affecting whether medical students fail in their final grade. Area under the curve was used to determine optimal cut-off. The maximum Youden Index J identified the optimal cut-off in NMAT and uGWA scores in obtaining a passing mark in the medGWA, including the individual final grades in Anatomy, Biochemistry, Physiology, Histology and Neurology

All tests used 5% level of significance in SPSS version 20.0.

**Results**

A total of 1567 students were in the record but five had missing NMAT scores. Additionally, 34 students dropped out of the program prior to start of the first year of medical schooling, leading to 1528 students to be included in this

study. The demographic profile of the students are shown in Table 1.

The linear regression model had  $R^2 = 0.681$ , indicating that 68.1% of medGWA was predicted by the factors presented in Table 2.

**Table 1: Demographic profile**

Demographic Profile	Summary
Gender: Male count (percentage)	680 (44.5%)
uGWA: mean (range)	87.8 (65.1 – 96.7)
NMAT: mean (range)	86.0 (19 – 99)
Premedical Course: count (percentage)	
Medical Technology	415 (27.2%)
Biological, Health, Life, or Medical Sciences	298 (19.5%)
Nursing	352 (23.0%)
Physical or Occupational Therapy	59 (3.9%)
Pharmacy	167 (10.9%)
Psychology	106 (6.9%)
Public Health	15 (1.0%)
Microbiology, Environmental Sci, Speech Pathology, or Biochemistry	40 (2.6%)
Others (Chemistry, Physics, Sports Sci, Nutrition, Education, Liberal Arts)	76 (5.0%)
<b>Final Grade: mean (range)</b>	<b>81.1 (35.2 – 93.4)</b>
Anatomy	81.2 (33 – 95)
Biochemistry	80.4 (45 – 97)
Physiology	82.1 (61 – 95)
Histology	81.5 (60 – 97)
Neurology	80.0 (43 – 97)

Values expressed as mean (range), or counts (%)

Predictors that significantly affected medGWA were as follows: uGWA ( $p < 0.001$ ), NMAT score ( $p < 0.001$ ), premedical courses Nursing ( $p = 0.010$ ), Physical/Occupational Therapy ( $p < 0.001$ ), Pharmacy ( $p = 0.007$ ), and Psychology ( $p < 0.001$ ).

This shows that an increase of one point in uGWA led to an increase of 0.975 [95% CI: 0.893 to 1.057] in medGWA. One point increase in NMAT score increased medGWA by 0.118 [95% CI: 0.100 to 0.135]. Graduates of Nursing and Physical/Occupational Therapy had final scores 0.766 [95% CI: 0.181 to 1.351] and 2.791 [95% CI: 1.716 to 3.866],

respectively, higher as compared to Medical Technology graduates. On the other hand, graduates of Pharmacy, Psychology and other fields had final grades 0.960 [95% CI: 0.260 to 1.660], 2.621 [95% CI: 1.741 to 3.501] and 1.389 [95% CI: 0.337 to 2.441], respectively, lower than BS Medical Technology graduates.

Gender ( $p = 0.614$ ) and year of entry ( $p > 0.05$ ) are not predictors of medGWA. uGWA ( $r = 0.55$ ) and NMAT ( $r = 0.45$ ) were moderately correlated with final grades (medGWA). Final grades (medGWA) were categorized as passed ( $\geq 75$ ) or failed ( $< 75$ ).

**Table 2: Factors Affecting Student's Final Grade**

Variables	Coefficients	p-value
Gender: Male	-0.106	0.614
uGWA	0.975	<0.001
NMAT	0.118	<0.001
Premedical Course		
*Medical Technology	-	-
Biological, Health, Life, or Medical Sciences	-0.040	0.903
Nursing	0.766	0.010
Physical or Occupational Therapy	2.791	<0.001
Pharmacy	-0.960	0.007
Psychology	-2.621	<0.001
Public Health	0.228	0.835
Microbio, Envi Sci, Speech Pathology, or Biochem	-0.583	0.373
Others (Chemistry, Physics, Sports Sci, Nutrition, Education, Liberal Arts)	-1.389	0.010

\*Year 2012, Medical Technology and University of Santo Tomas were used as the baseline of the categorical variables: Year, PreMed major)

**Table 3: Factors Affecting Students' Performance in Getting a Passing Grade**

Variables	Logistic Regression			
	Univariate OR		Multivariate OR	
	Estimate	95% CI	Estimate	95% CI
Gender: Male	†0.6	0.4 – 0.8	†0.6	0.4 – 0.9
uGWA	†1.4	1.3 – 1.5	†1.4	1.3 – 1.5
NMAT	†1.06	1.05 – 1.07	†1.05	1.04 – 1.07
PreMed Major				
Biological, Health, Life, or Medical Sciences	0.9	0.6 – 1.4	-	-
Medical Technology	1.4	0.9 – 2.2	-	-
Nursing	1.4	0.9 – 2.3	-	-
Physical or Occupational Therapy	2.9	0.7 – 11.8	-	-
Pharmacy	†0.8	0.5 – 1.3	†0.5	0.3 – 0.9
Psychology	†0.4	0.2 – 0.6	†0.3	0.2 – 0.5
Public Health	1.4	0.2 – 10.5	-	-
Microbio, Envi Sci, Speech Pathology, or Biochem	0.5	0.2 – 1.3	-	-
Others (Chemistry, Physics, Sports Sci, Nutrition, Education, Liberal Arts)	0.8	0.4 – 1.7	-	-

†  $p < 0.05$ ; OR: Odds Ratio

Table 3 shows that after performing stepwise multivariate logistic regression, males were 40% less likely to pass [OR = 0.6; 95% CI: 0.4 to 0.9] compared to females. In addition, an

increase of one point in uGWA and NMAT scores increased the chance of passing by 40% [OR = 1.4; 95% CI: 1.3 to 1.5] and 5% [OR = 1.05; 95% CI: 1.04 – 1.07], respectively.

**Table 4: Optimal Cut-off scores in NMAT and uGWA in predicting performance of medical students**

	NMAT					uGWA				
	Cut-off	Youden Index J	Se	Sp	AUC	Cut-off	Youden Index J	Se	Sp	AUC
<b>Final Grade</b>	<b>79.5</b>	<b>0.40</b>	<b>0.82</b>	<b>0.59</b>	<b>0.75 (0.71 – 0.80)</b>	<b>86.96</b>	<b>0.49</b>	<b>0.66</b>	<b>0.83</b>	<b>0.81 (0.77 – 0.84)</b>
Anatomy	77.5	0.44	0.84	0.60	0.78 (0.72 – 0.83)	87.54	0.49	0.56	0.92	0.80 (0.75 – 0.84)
Biochemistry	80.5	0.37	0.81	0.57	0.74 (0.70 – 0.78)	86.97	0.47	0.66	0.81	0.78 (0.75 – 0.81)
Physiology	80.5	0.45	0.80	0.66	0.78 (0.73 – 0.83)	86.66	0.48	0.69	0.80	0.79 (0.75 – 0.83)
Histology	80.5	0.44	0.79	0.66	0.77 (0.70 – 0.83)	85.32	0.51	0.84	0.66	0.81 (0.76 – 0.86)
Neurology	91.5	0.21	0.43	0.79	0.66 (0.61 – 0.71)	87.68	0.41	0.56	0.85	0.75 (0.72 – 0.79)

Youden Index J = max {Se + Sp – 1}; where **Se** = Sensitivity & **Sp** = Specificity  
**AUC**: Area Under Curve, values in parentheses are the 95% confidence interval

Moreover, graduates of Pharmacy and Psychology were 50% [OR = 0.5; 95% CI: 0.3 to 0.9] and 70% [OR = 0.3; 95% CI: 0.2 to 0.5], respectively, less likely to pass compared to other graduates.

After dichotomizing the final grades as passed (≥75) or failed (<75), optimal cut-off scores of NMAT and uGWA were identified (Table 4).

In identifying whether medical students will pass or fail in their final grade, the optimal cut-off for NMAT and uGWA grades were 79.5 and 86.96, respectively. These have sensitivities of 0.82 and 0.66, respectively, and specificities were 0.59 and 0.83, respectively. These models have predictive accuracy (AUC) of 75% [95% CI: 0.71 to 0.80] and 81% [95% CI: 0.77 to 0.84] for NMAT and uGWA, respectively.

Other cut-offs in predicting performance in Anatomy, Biochemistry, Physiology, Histology and Neurology are also shown in Table 4. All these models have acceptable predictive accuracy (AUC > 0.5, p<0.05).

### Discussion

This study showed that both uGWA scores (r = 0.55 p<0.001) and NMAT scores (r = 0.45 p<0.001) positively correlated with final grades (medGWA) which is similar to the findings in a study at the Cebu Institute of Medicine which showed a positive relationship between NMAT score, premedical grade point average and year 1 final grade of first year medical students admitted in school year 2008-2009 with a problem-based learning curriculum.

The NMAT score has moderate correlation (r = 0.45 p<0.001) with the final grades (medGWA) similar to the results of a meta-analysis where MCAT (Medical College Admissions Test in the USA and Canada) also showed moderate correlations of 0.58–0.67 with Year 1 performance (Donnon *et al.*, 2007). This is in contrast to the United Kingdom Clinical Aptitude Test (UKCAT) which did not predict Year 1 performance at two UK medical schools studied (Lynch *et al.*, 2009).

What is unique about this study is that the premedical course was proven to significantly affect medGWA. Graduates of premedical courses in BS Nursing and BS Physical/Occupational Therapy significantly garnered higher scores compared to graduates of other premedical courses.

Other notable findings are that males were 40% less likely to pass [OR = 0.6; 95% CI: 0.4 to 0.9] compared to females, graduates of BS Pharmacy and BS Psychology were 50% [OR = 0.5; 95% CI: 0.3 to 0.9] and 70% [OR = 0.3; 95% CI: 0.2 to 0.5], respectively, less likely to pass compared to graduates of other premedical courses.

The estimated optimal cut-off to get a passing grade (>75points) for uGWA is 86.96 with predictive accuracy of 81% [95% CI: 0.77 to 0.84]. Estimated optimal cut-off for NMAT is 79.5 with predictive accuracy of 75% [95% CI: 0.71 to 0.80].

## Conclusion

This study showed that both uGWA ( $r = 0.55$   $p < 0.001$ ) and NMAT scores ( $r = 0.45$   $p < 0.001$ ) had significant moderate linear correlations with medGWA. Optimal cut-off score to get a passing grade (>75points) for uGWA is 86.96 with predictive accuracy of 81% [95% CI: 0.77 to 0.84]. Optimal cut-off score for NMAT is 79.5 with predictive accuracy of 75% [95% CI: 0.71 to 0.80].

The premedical course also significantly affected medGWA, with graduates of Nursing and Physical/Occupational Therapy significantly garnering higher scores compared to graduates of other premedical courses. Males were 40% less likely to pass [OR = 0.6; 95% CI: 0.4 to 0.9] compared to females. Graduates of Pharmacy and Psychology were 50% [OR = 0.5; 95% CI: 0.3 to 0.9] and 70% [OR = 0.3; 95% CI: 0.2 to 0.5], respectively, less likely to pass compared to graduates of other premedical courses.

This study is mainly limited by its retrospective nature. The author recommends extending the study to determine whether the same factors also predict second and third year final grades and eventual performance in the Philippine Physicians' licensure examinations. The author also recommends coming up with a validated predictive scoring system utilizing the factors found to be significant predictors as the parameters.

## Conflict of Interest

The authors declare no conflict of interest.

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