Initial External Validation of
R E search on G lobal R egression E xpectations in S tatistic S
in Public Health Graduate Students

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Abstract

Linear regression is a fundamental of statistical analysis typically taught in the last required statistics course for most public health and medical students. Research describes students' attitudes toward basic regression, but there is a gap in validated tools for assessment of students' understanding of critical topics. This study is the first external validation of the REGRESS (REsearch on Global Regression Expectations in StatisticS) quiz outside of the creator's, Felicity Enders, institution (Mayo Clinic). The quiz assesses students' knowledge of simple and multiple linear regression topics. Our results support validation of REGRESS as a learning tool for students and an evaluation tool to identify topics for curricular improvement.

Implications for Teaching

Our results support the initial external validation of REGRESS as a tool for measuring students' knowledge of linear regression. Specifically REGRESS can be used as a useful:

- Tool for course assignment.
- Diagnostic for students and instructors.
- Outcome measure for inter-institutional studies designed to assess interventions.

Future Directions

- We hope to understand if some of the differences in the Michigan and Mayo cohorts were due to teaching and course differences or to issues with the REGRESS instrument.

- Clickers were incorporated in the 2014 U-M biostatistics classroom emphasizing graphical displays. We plan to compare 2013 and 2014 scores to check for sensitivity to implementing interventions.

- We added the option for students to comment on each question in the 2014 Michigan cohort to better understand if particular REGRESS questions are confusing and why.

- Combining qualitative and quantitative results of the 2014 Michigan cohort, we will investigate whether further changes to REGRESS or the curriculum may be necessary to strengthen external validity.

- We will implement REGRESS in a larger external audience through additional CTSA and compare results.

Methods

1. Development of the REGRESS Instrument

- Developed for Clinical and Translational Science and Public Health students by Enders (2013), reviewed by 11 researchers, tested on Mayo Clinic students.

- REGRESS consists of 27 questions organized into six domains to asses understanding of simple and multiple linear regression. (See sample questions in Figure 1 below.)
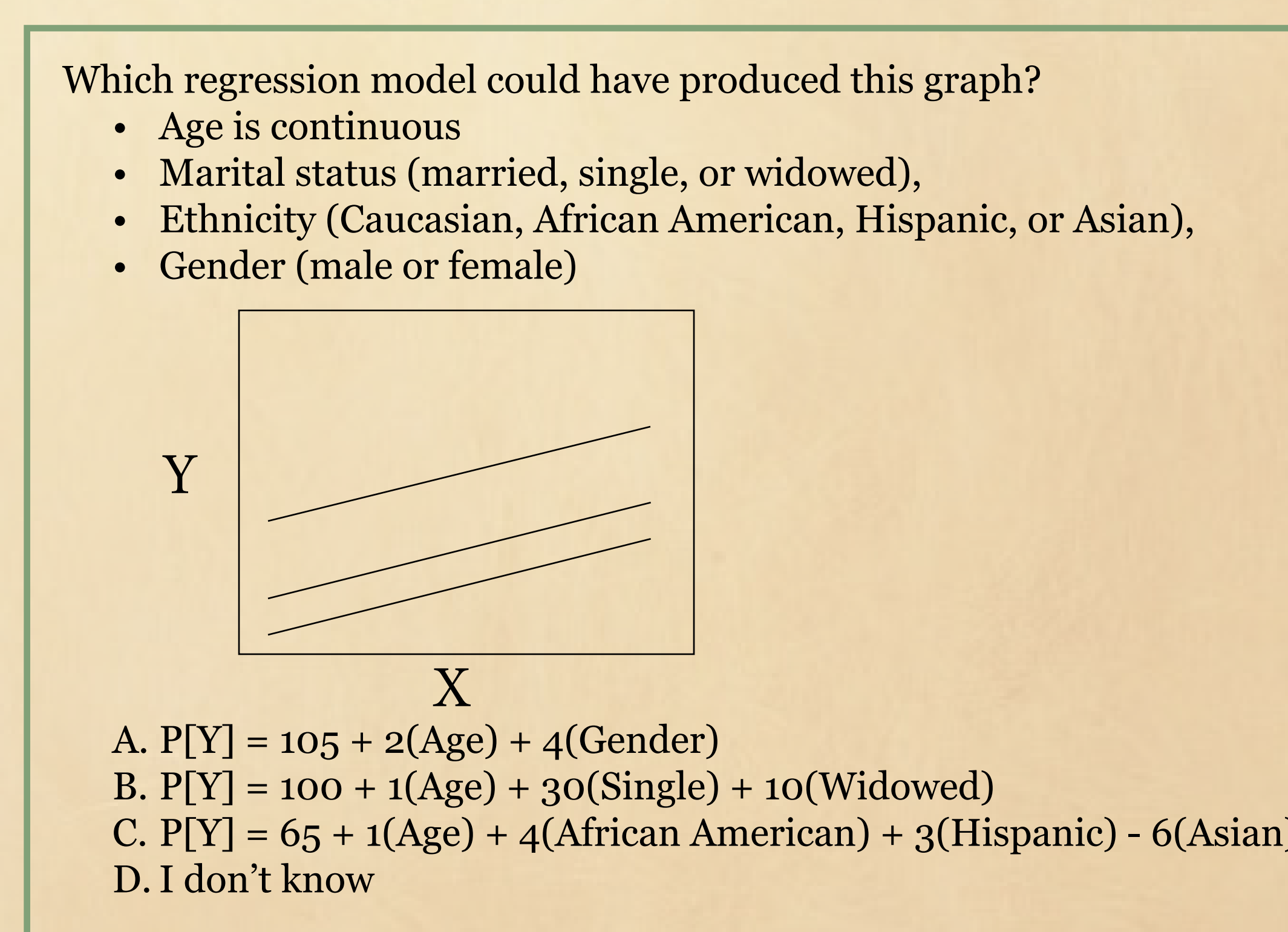

Which regression model could have produced this graph?
- Age is continuous
- Marital status (married, single, or widowed),
- Ethnicity (Caucasian, African American, Hispanic, or Asian),
- Gender (male or female)

A. P[Y] = 105 + 2(Age) + 4(Gender)
B. P[Y] = 100 + 1(Age) + 30(Single) + 10(Widowed)
C. P[Y] = 65 + 1(Age) + 4(African American) + 3(Hispanic) - 6(Asian)
D. I don't know

Figure 1: Sample questions from REGRESS

2. University of Michigan Validation

- REGRESS was implemented as part of the first regression course offered to public health students during winter semester 2013 (58 enrolled for credit).

- Students took REGRESS at the beginning and end of the term. 52 students completed the pre- and post-quiz.
    - 87% MPH or MS students, 6% MD/MPH, and 8% sought a PhD.
    - 92% reported taking at least one previous statistics course where regression was introduced.

- Post-course REGRESS scores were compared to student performance on other linear regression-related assessments

- U-M post-course REGRESS scores were compared with those of 52 students and 22 practicing statistician from Mayo Clinic. (Recruited by Ender, 2013.)

References
Enders, F. (2013), "Do Clinical and Translational Science Graduate Students Understand Linear Regression? Development and Early Validation of the REGRESS Quiz." *Clinical and Translational Science*, 6(6), 444-451. doi: 10.1111/cts.12088

Findings

- **REGRESS is responsive to changes in understanding following a graduate-level course on regression.**
The overall mean REGRESS pre-course score was 11.3 (SD=2.8) and the overall post-course mean score was 15.17 (SD=3.1), for a statistically significant increase of 3.9 (p<.0001). Figure 2 shows the shift.
    - Areas of difficulty corresponded with instructional emphases. Although demonstrating improvement, students struggled with interpreting questions and concepts from graphical displays of data.

Figure 2: Distribution in pre-course and post-course scores

- **The REGRESS tool demonstrated a good level of internal consistency** (Cronbach's alpha=0.68) in total, but internal consistency was lacking for the domains of assumptions and interaction. Post-course REGRESS scores were significantly and positively correlated to grades on linear regression-related assignments (r=0.43, p=0.002)

- **Comparison with Mayo Cohorts**

Table 1 Comparison of Mean Scores Between UM Students and Mayo Results*

REGRESS Scores (out of 27)	N	Mean(STD)	Range	P-value[+]
Pre-Course				
UM Students	52	11.3 (2.8)	6-18	
Mayo Students	52	9.3 (4.3)	0-21	0.018
Post-Course				
UM Students	52	15.2 (3.1)	8-22	
Mayo Students	59	19.0 (3.5)	10-27	<0.0001
Statisticians	22	20.1 (3.5)	13-24	<0.0001

*Data from Mayo students and practicing statisticians reprinted with permission from Enders (2013)
[+]P-value from t-test comparing UM students' scores to Mayo students' scores and UM students' scores to Mayo statisticians' scores