

PubHlth 540 - Introductory Biostatistics
Fall 2008
Examination II
DUE: Post mark Monday November 24, 2008

Before you begin:

*As with the first exam, this is a “take-home” exam. You are welcome to use any reference materials you wish. You are welcome to use the computer as you wish, too. However, you **MUST** work this exam **by yourself** and you may **not** consult with anyone.*

Instructions and Checklist:

- __ 1. Start each problem on a new page.
- __ 2. Write your name on every page.
- __ 3. Make a photo-copy of your exam for safekeeping prior to submission
- __ 4. Complete the signature page

How to submit your exam:

Online Section	Worcester Section
(1) By mail (address and telephone number below) and post- marked no later than 11:59 PM Monday November 24, 2008 <p style="text-align: center;">OR</p> (2) By upload to EXAM II turn in link no later than 11:59 PM Monday November 24, 2008	(1) By mail (address and telephone number below) and post- marked no later than 11:59 PM Monday November 24, 2008 <p style="text-align: center;">OR</p> (2) Bring your exam to class Monday November 24, 2008
<i>Faxed exams are NOT permitted - sorry</i>	<i>Faxed exams are NOT permitted – sorry.</i>

Address and telephone number for mailing

Carol Bigelow
 School of Public Health/402 Arnold House
 University of Massachusetts/Amherst
 715 North Pleasant Street
 Amherst, MA 01003-9304
 Tel. 413-545-1319

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Signature

This is to confirm that in completing this exam, I worked independently and did not consult with anyone.

Signataure: _____

Printed Name: _____

Date: _____

1. (10 points total)**a. (3 points)**

How many ways can five photos be arranged on a shelf?

b. (3 points)

You've registered for a class in world history. The course syllabus tells you that it will cover nine (9) books and that the final exam will cover five (5). How many different choices of five (5) books are possible?

c. (2 points)

A student may receive a grade of EXCELLENT or GOOD or FAIR on exam I and a grade of PASS or FAIL on exam II. How many different outcomes of the form (EXAM I, EXAM II) are possible?

d. (2 points)

Consider your answer to problem #1C. What are these outcomes?

2. (5 points total)

Consider a binomial population for which $N=6$ and $\pi = 0.3$. What proportion of the population does $X=2$ represent?

3. (25 points total)

In 1889 a study was conducted by Geissler. Investigated were 53,680 families with 8 children. Of interest was an investigation of the probability of male gender. Is it .50? Does the probability of male gender change with birth order?

Geissler's observations are presented in the table below. As an example of its interpretation, the first row of this table is telling you that there were 215 families of 8 children in which the number of males was zero.

# of male births among 8 children	# Families	% of Families
0	215	0.4
1	1485	2.77
2	5331	9.93
3	10649	19.84
4	14959	27.87
5	11929	22.22
6	6678	12.44
7	2092	3.90
8	342	0.64
Total	53680	100%

a. (5 points)

Estimate π , the probability that a randomly selected birth is male. Assume that all births have the same probability of being male.

b. (5 points)

Using your answer for π in problem #3a, compute the binomial probabilities for number of boys in a family of eight equal to $X = 0, 1, 2, 3, 4, 5, 6, 7,$ and 8 . In reporting your answers, complete the following table.

# Male birth Outcomes $X = x$	Prob [$X = x$]
0	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

c. (5 points)

Using your answers to problem #3b, compare the observed **frequencies** of 0, 1, 2, 3, 4, 5, 6, 7, and 8 males to the expected **frequencies** of 0, 1, 2, 3, 4, 5, 6, 7, and 8 males. In obtaining the expected frequencies, assume that the binomial probability model is correct. In reporting your answer, complete the following table.

# of male births among 8 children	Observed # Families	Expected # of Families
0	215	
1	1485	
2	5331	
3	10649	
4	14959	
5	11929	
6	6678	
7	2092	
8	342	
Total	53680	53680

d. (5 points)

Now, using your answers to problem #3c, compare the observed **relative** frequencies of 0, 1, 2, 3, 4, 5, 6, 7, and 8 males to the expected **relative** frequencies. Again, assume that the binomial probability model is correct. In reporting your answer, complete the following table.

# of male births among 8 children	Observed proportion % Families	Expected proportion % of Families
0	0.4	
1	2.77	
2	9.93	
3	19.84	
4	27.87	
5	22.22	
6	12.44	
7	3.90	
8	0.64	
Total	100%	100%

e. (5 points)

What is your interpretation of Geissler's data with respect to the question of whether or not the probability of male birth is 0.50 and whether or not it is the same, regardless of birth order? Express your opinion in **1-3 sentences** written for a reader who is intelligent but who is not familiar with statistical jargon.

4. (10 points total)

A random variable Z is distributed standard normal, so that $\mu = 0$ and $\sigma = 1$.

a. (2 points)

Find Probability [$Z \leq 2$]

b. (2 points)

Find Probability [$Z \leq -1$]

c. (2 points)

Find $Z_{.975}$, the value of the 97.5th percentile

d. (2 points)

Find Probability [$0.4 \leq Z \leq 1$]

e. (2 points)

Find Probability [$Z \leq -1.96$ or $Z \geq +1.96$]

5. (10 points total)

A random variable X is distributed normal with parameters $\mu = 2$ and $\sigma^2 = 4$.

a. **(2 points)**

Find Probability [$X \leq 0$]

b. **(2 points)**

Find Probability [$X \geq -1$]

c. **(2 points)**

Find Probability [$1 \leq X \leq 3$]

d. **(2 points)**

Find Probability [$X \leq 0.66$ or $X \geq 2.54$]

e. **(2 points)**

Find $X_{.95}$, the value of the 95th percentile.

6. (10 points total)

Suppose it is known that a population distribution of a random variable X is normal with parameters $\mu = 1$ and $\sigma^2 = 9$. Simple random samples of sample size $n=9$ are taken and the sample means $\bar{X}_{n=9}$ are obtained.

(a) (2 points)

What is the correct probability model for the sampling distribution of $\bar{X}_{n=9}$? What are the values of its mean (μ) and variance parameters (σ^2)?

(b) (3 points)

Find Probability [$1 < \bar{X}_{n=9} \leq 2.85$]

(c) (5 points)

Consider next a new random variable $W = 4\bar{X}_{n=9}$. What is the correct normal probability model for the sampling distribution of W ? Specifically, what are the values of its mean (μ) and variance parameters (σ^2)?

7. (10 points total)

Interestingly, it is generally agreed that we are poor probabilists. The citation source of this exercise will be given to you in the solutions. Here is the question

“A certain town is served by two hospitals. In the larger hospital, about 45 babies are born each day, and in the smaller hospital about 15 babies are born each day. As you know, about 50% of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50%, sometimes lower. For a period of one year, each hospital recorded the days on which more than 60% of the babies born were boys. Which hospital do you think recorded more such days? The larger hospital, the smaller hospital, or where they about the same (that is within 5% of each other)?

In developing your answer to this question, you are being asked to work with two binomial probability distributions, once for the larger hospital and once for the smaller hospital. *Hint: What is the expected value of each of the two binomial distributions and how do they compare?*

8. (10 points total)

The duration of gestation in healthy humans is approximately 280 days with a standard deviation of 10 days.

(a) (5 points)

Under the assumption of normality, what proportion of (healthy) pregnant women will be overdue by 2 weeks or more?

(b) (3 points)

Suppose now that, typically, there are 200 births per week at the UMass Memorial Hospital. How many of these births would you expect to be premature by 4 weeks or more?

(c) (2 points)

Using your answer to problem #8b, suppose that all premature babies are put into the neonatal intensive care unit. In **1-3 well written sentences**, what is your recommendation to the administration of UMass Memorial Hospital with respect to the size of the neonatal intensive care unit. *Note – I am not looking for a particular answer here and I am not looking for formulas and calculations. I'm looking for you to show me that you have an understanding of the work you did in problem 8b.*

9. (10 points total)

(a) **(5 points)**.

A factory is producing thermometers and testing their quality with readings in a room that is known to be 32 degrees. Assume that the readings of a thermometer are distributed Normal with a mean of 32 degrees and a standard deviation of 2 degrees. If 3% of thermometers will be discarded because their readings are too low and another 3% of thermometers will be discarded because their readings are too high, find the two readings that separate the rejected thermometers from the accepted thermometers.

(b) **(5 points)**

The Air Force uses ACES-II ejection seats that are designed for men who weigh between 140 lb and 211 lb. Suppose it is known that women's weights are distributed Normal with mean 143 lb and standard deviation 29 lb. What proportion of women have weights that are *outside* the ACES-II ejection seat acceptable range?